

**Effect of Interventions on Vitamin A and Iron Nutritional
Status among Primitive Tribal Children
in Nilgiris District**

By

K.U. Pavitra Krishna

Supervisor

Dr. M.Sylvia Subapriya

A Thesis Submitted to

**Avinashilingam Institute for Home Science and Higher Education
for Women, Coimbatore - 641 043.**

In Partial Fulfilment of the Requirements for the Degree of

**Doctor of Philosophy
in
Food Science and Nutrition**

April 2015

Certificate

I certify that the thesis titled “**Effect of Interventions on Vitamin A and Iron Nutritional Status among Primitive Tribal Children in Nilgiris District**”, submitted for the Degree of **Doctor of Philosophy (Ph.D.)** by **Ms. K.U.Pavitra Krishna** is the record of research work carried out by her during the period from February 2012 to April 2015 under my guidance and supervision, and that this work has not formed the basis for the award of any Degree, Diploma, Associateship, Fellowship or other titles in this University or any other University or Institution of Higher Learning.

M. Anitha
30/4/15

Signature of the
Head of the Department

M. Sylvia

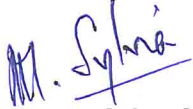
Signature of the Supervisor

N. M. S.
30/4/15

Signature of Dean

Declaration

I declare that the thesis titled “**Effect of Interventions on Vitamin A and Iron Nutritional Status among Primitive Tribal Children in Nilgiris District**” submitted by me for the Degree of **Doctor of Philosophy (Ph.D.)** is the record of work carried out by me during the period from February 2012 to April 2015 under the guidance of **Dr. M.Sylvia Subapriya** and has not formed the basis for the award of any Degree, Diploma, Associateship, Fellowship, Titles in this University or any other University or other similar Institution of Higher Learning.



Signature of the Supervisor



Signature of the Candidate

ACKNOWLEDGEMENT

Knowledge is in the end based on acknowledgement

- Ludwig Wittgenstein

The investigator thanks the Almighty **GOD**, for His manifold blessings, abiding Grace and protection which enabled her to complete this research work successfully.

She records her profound sense of gratitude to **Dr.T.S.K.Meenakshisundaram, Ph.D. Chancellor**, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for giving her an opportunity to pursue higher education and research in this esteemed institute. She owes her deep and sincere thanks to **Dr. Hon. Colonel (Tmt.) Sheela Ramachandran, M.Sc., P.G.Dip., (Fd.Sc. & P), Ph.D. Vice Chancellor**, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for her profound, keen interest and constant encouragement for this research work in Tribal Nutrition and for providing all the amenities to carry out and complete the research. She is obliged to express her sincere thanks to **Dr.A.Venmathi, M.Sc., M.Phil., Ph.D., Registrar i/c.**, and **Dr.(Tmt). Gowri Ramakrishnan, M.Sc., M.Phil., Ph.D., Former Registrar**, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for facilitating the research.

The investigator expresses her heartfelt thanks to **Dr. (Tmt). G.P.Jayanthi, M.Sc. MPhil., Ph.D., Controller of Examinations** for graciously facilitating each and every step in the academic progress of the research. She thanks **Dr. (Tmt). N.Vasugi Raaja, M.Sc., M.Phil., Ph.D., Dean**, Faculty of Home Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for her constant support.

The investigator expresses her special thanks to **Dr.(Tmt.) M. Amirthaveni M.Sc., Dip. Ed., M.Phil., Ph.D (Madras)**, Professor and Head of the Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for

her concern and encouragement which has helped in the successful completion of this study. She thanks **Dr.(Tmt.) S. Premakumari M.Sc., Dip. Ed., M.Phil., Ph.D (Madras)**, Dean, Faculty of Community Education and Entrepreneurship Development for initiating the research work.

The investigator will forever be thankful and deeply indebted to her research supervisor advisor and mentor, **Dr. M.Sylvia Subapriya, M.Sc.,B.Ed., M.Phil., Ph.D.**, Associate Professor, Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, whose expertise, continuous guidance, thoughtful feedback and tremendous encouragement truly helped her to complete the research work. Her Herculean support truly strengthened the investigator's commitment and determination to complete each stage of the study. The investigator feels extremely privileged to have worked under the able supervision and esteemed guidance of her research supervisor and thanks her for the excellent, inspiring and ceaseless guidance, valuable suggestions and advice, untiring help and enduring support rendered throughout for the successful completion of the study.

The investigator is extremely grateful to **(Tmt).S. Radha Devi M.Sc (Kerala), M.Phil (Madras)**, Associate Professor, Department of Food Science and Nutrition, Avinashilingam Deemed University for Women, Coimbatore, for the guidance rendered in completion of the statistical analysis in the study.

The investigator thanks all the **Staff members of the Department of Food Science and Nutrition**, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for their advice and continuous encouragement during the period of project.

The investigator expresses her deepest sense of gratitude to **Mr.Alwas, Secretary, Mr.K.Vijayakumar, Project Manager** and the concerned authorities, medical and paramedical staff, field workers and office staff of the **Nilgiris Adivasi Welfare Association (NAWA)** for permitting the study and especially for their overwhelming co-operation in facilitating visit into interior tribal hamlets for data collection. She thanks **Mr. Antony Kokoth, Former Team Leader, Partner Support, Child Fund India** for his cooperation and wishes.

The investigator acknowledges the **District Collector of Nilgiris, Joint Director of Health Services and the government officials** who rendered permission to carry out the research in Nilgiris District.

To the tribal participants in the study, the investigator owes a deep sense of gratitude. Without their support and cooperation the research would not have been possible. She sincerely hopes that this piece of research work would be one of the steps to pave the way for the upliftment and subsequent empowerment of the PTG.

The investigator is very much blessed and obliged to the continuous encouragement and support of her father **Mr. N.Krishnan**, and mother **Mrs. V Usha Krishnan** who were the pillars and encouraged physically and morally with showers of love, blessings and affection, which enabled her to succeed in all her works. They were the instruments and guiding stars throughout her study period. She thanks them wholeheartedly.

Finally, the investigator thanks all her friends and well wishers who directly and indirectly helped her in all stages of research work and for their good wishes.

Contents

Chapter No.	Title	Page No.
	LIST OF CONTENTS	
	LIST OF TABLES	
	LIST OF FIGURES	
	LIST OF PLATES	
	LIST OF APPENDICES	
I	INTRODUCTION	1
II	REVIEW OF LITERATURE	10
	A. Tribals in India and the Nilgiris	10
	B. Health and Nutritional Status of Tribals	19
	C. Vitamin A and Iron Nutritional Status of PTG Children	22
	D. Methods of Assessing Nutritional Status among Tribal Children	25
	E. Strategies to Combat Malnutrition among PTG Children	27
III	METHODOLOGY	43
	Phase I	44
	Screening of Primitive Tribal Children for VAD and IDA	
	A. Selection of Area and children	44
	B. Screening for Clinical Symptoms of VAD and IDA	47
	Phase II	48
	Assessment of Socioeconomic and Nutritional Status	
	A. Formulation of Tools and Selection of children	48
	B. Conduct of Socioeconomic and Dietary Survey	48
	C. Assessment of Nutritional Status	52
	1. Age of Children	52
	2. Nutritional Anthropometry	52
	3. Serum Retinol and Blood Haemoglobin	56
	4. Dietary Survey	56

Chapter No.	Title	Page No.
	Phase III	57
	Formulation, Acceptability, Nutrient Analysis and Storage Stability of Spirulina Supplement	
	A. Selection of Spirulina as Supplement	57
	B. Formulation of Spirulina incorporated Food Supplement (SIFS)	59
	C. Assessment of Acceptability	60
	D. Nutrient Content of Supplements	61
	E. Storage Stability of Spirulina incorporated Food Supplement	64
	Phase IV	65
	Nutrition Interventions to the Target Groups	
	A. Selection of PTG Children	65
	B. Conduct of Supplementation	65
	1. Spirulina Candies (SC)	65
	2. Spirulina Incorporated Food Supplement (SIFS)	66
	C. Imparting Nutrition Education	68
	1. Audio - Visual Aids	68
	2. Nutrition Exhibition	68
	3. Positive Deviance Hearth	69
	D. Raising Kitchen Garden	70
	1. Procuring Seeds	72
	2. Developing a Model Kitchen Garden	72
	3. Laying Kitchen Gardens	72
	Phase V	72
	Impact Evaluation	
	A. Nutritional Supplementation on	72
	1. Nutritional Anthropometry	72
	2. Biochemical Analysis	72
	3. Clinical Examination	73
	4. Dietary Pattern	73
	B. Nutrition Education and Kitchen Garden on	73
	1. Knowledge, Attitude and Practice Scores	73

Chapter No.	Title	Page No.
IV	RESULTS AND DISCUSSION	77
	Phase I	77
	Prevalence of VAD and IDA among PTG Children in Nilgiris District	
	A. Clinical Symptoms of VAD and IDA among PTG Children	77
	B. Socio Economic Background of PTG Children	83
	1. Background information on Children	83
	2. Monthly Income and Expenditure of the families	86
	C. Nutritional Anthropometry of PTG Children	89
	1. Mean Height of Children	89
	2. Mean Weight of Children	91
	3. Mean MUAC, Chest Circumference and Head Circumference of Children	93
	4. Grading of Children according to Height for Age	98
	5. Grading of Children according to Weight for Age	100
	6. Grading of Children according to Weight for Height	102
	7. Percentage Prevalence of Under nutrition, Stunting and Wasting among Children	104
	8. Grading of Children according to MUAC for Age	105
	9. Grading of Children according to BMI for Age	106
	10. Morbidity Pattern over three months	107
	D. Dietary Pattern of PTG Children	108
	1. Dietary Habits	108
	2. Frequency of Black Tea Consumption	110
	3. Cooking Methods	110
	4. Frequency of Consumption of Food Items	111
	5. Mean Food Intake	115
	6. Mean Nutrient Intake	119
	7. Correlation between Energy intake and BMI	122
	Phase II	123
	Background Information and Nutritional Status of PTG Children included for Supplementation	
	A. Socio Economic Background of Supplementation Group Children	123
	1. Background information of the Supplementation Group Children	123
	2. Monthly Income and Expenditure of the Supplementation Group families	124

Chapter No.	Title	Page No.
	B. Nutritional status of Children	126
	1. Nutritional Anthropometry	126
	2. Biochemical Picture	131
	3. Clinical Picture of the Children	137
	4. Dietary Pattern	138
	Phase III	140
	Acceptability and Nutritive Value of Spirulina Supplement	
	A. Acceptability Trials	140
	B. Nutritive Value of Spirulina Supplements	140
	C. Storage Stability of Spirulina Incorporated Food Supplement	141
	Phase IV	143
	Impact of Interventions on Nutritional status and KAP	
	A. Impact of Supplementation	143
	1. Nutritional Anthropometry	143
	2. Biochemical Picture	159
	3. Clinical Examination	164
	4. Dietary Pattern	167
	B. Impact of Kitchen garden and Nutrition Education	171
V	SUMMARY AND CONCLUSION	175
	REFERENCES	187
	APPENDICES	210

List of Tables

Table. No	Title	Page No.
I	Screening of Primitive Tribal Children	45
II	Classification of Anaemia as a Problem of Public Health Significance	56
III	Composition of Spirulina Incorporated Food Supplement	60
IV	Nutrient content of Spirulina Candies	62
V	Percentage of Energy provided by the candy	63
VI	Nutrient content of Food Supplement	63
VII	Clinical symptoms among PTG children	78
VIII	Clinical symptoms of VAD and IDA among PTG children	79
IX	Background Information on PTG Children	84
X	Monthly Income and Expenditure of the Families	86
XI	Mean Height (cm) of Children	90
XII	Mean Weight (kg) of Children	92
XIII	Mean MUAC, Chest Circumference and Head Circumference (cm) of Children	94
XIV	Grading of Children according to Height for Age	98
XV	Grading of Children according to Weight for Age	101
XVI	Grading of Children according to Weight for Height	102
XVII	Percentage prevalence of underweight stunting and wasting among children	104
XVIII	Grading of Children according to MUAC for Age	105
XIX	Grading of Children according to BMI for Age	107
XX	Morbidity Pattern over three months	107
XXI	Frequency of Black Tea Consumption	110
XXII	Cooking Methods	110
XXIII	Frequency of consumption of Food Items	111
XXIV	Mean food intake (1-9 years)	116

Table No	Title	Page No.
XXV	Mean food intake (10-14 years)	117
XXVI	Mean nutrient intake (1-9 years)	120
XXVII	Mean nutrient intake (10-14 years)	121
XXVIII	Correlation between Energy intake and BMI	122
XXIX	Background Information of the Children included for Supplementation	123
XXX	Monthly Income and Expenditure of the Supplementation Group Families	125
XXXI	Mean Anthropometry of E I Children	127
XXXII	Mean Anthropometry of E II Children	128
XXXIII	Mean Anthropometry of P I Children	129
XXXIV	Mean Anthropometry of P II Children	130
XXXV	Mean Hemoglobin (g/dl) of Children	131
XXXVI	Grouping of Children according to Degree of Anemia	132
XXXVII	Correlation between Iron intake and Haemoglobin	134
XXXVIII	Mean Serum Retinol (mg/L) of Children	135
XXXIX	Correlation between beta- carotene intake and Serum Retinol	136
XL	Correlation between Haemoglobin and Serum Retinol level	136
XLI	Clinical Picture of the Children	137
XLII	Consumption of Beverages	139
XLIII	Cooking Methods	139
XLIV	Acceptability Trials	140
XLV	Nutrient Content of Spirulina incorporated Food Supplement	141
XLVI	Storage stability of Spirulina incorporated Food Supplement	141
XLVII	Mean Height (cm) of Boys Before and After Supplementation	144
XLVIII	Mean Height (cm) of Girls Before and After Supplementation	146
XLIX	Mean Weight (kg) of Boys Before and After Supplementation	149
L	Mean Weight (kg) of Girls Before and After Supplementation	151
LI	Mean MUAC (cm) of Boys Before and After Supplementation	154
LII	Mean MUAC (cm) of Girls Before and After Supplementation	157

Table. No	Title	Page No.
LIII	Mean Hemoglobin of Children Before and After Supplementation	159
LIV	Categorization of Children According to Degree of Anemia	162
LV	Mean Serum Retinol of Children Before and After Supplementation	163
LVI	Clinical Symptoms Before and after Supplementation	165
LVII	Mean food intake Before and after Supplementation	168
LVIII	Mean nutrient intake Before and after Supplementation	170
LIX	Impact of Kitchen Garden and Nutrition Education on KAP	172
LX	Percentage of mothers with correct KAP before and after Intervention	174

List of Figures

Figure No.	Title	Page No.
1	Tribal Population in the Country	11
2	Global Prevalence of Vitamin A Deficiency	23
3	Global Prevalence of Iron Deficiency Anemia	24
4	Map showing Primitive Tribal settlements in Nilgiris District	46
5	Experimental design of the study	74
6	Clinical symptoms among PTG children	80
7	Clinical symptoms among PTG children- Tribewise	80
8	Clinical symptoms observed among the PTG children	81
9	Type of Family	84
10	Number of Children per Household	85
11	Monthly Expenditure Pattern	87
12	Mean Height of Boys	91
13	Mean Height of Girls	91
14	Mean Weight of Boys	93
15	Mean Weight of Girls	93
16	Mean MUAC of Children	95
17	Mean Chest Circumference of Children	95
18	Mean Head Circumference of children	95
19	Head and Chest Crossing Over	97
20	Percentage Adequacy of Mean Food Intake	118
21	Percentage Adequacy of Mean Nutrient Intake	122
22	Grouping of Children according to degree of Anemia	133
23	Mean Height of Boys Before and After Supplementation	145
24	Mean Height of Boys in E I and P I before and after supplementation	145
25	Mean Height of Boys in E II and P II before and after supplementation	145
26	Mean Height of Girls Before and After Supplementation	147

Figure No.	Title	Page No.
27	Mean Height of Girls in E I and P I before and after supplementation	147
28	Mean Height of Girls in E II and P II before and after supplementation	147
29	Mean Weight of Boys Before and After Supplementation	150
30	Mean Weight of Boys in E I and P I before and after supplementation	150
31	Mean Weight of Boys in E II and P II before and after supplementation	150
32	Mean Weight of Girls Before and After Supplementation	152
33	Mean Weight of Girls in E I and P I before and after supplementation	152
34	Mean Weight of Girls of E II and P II before and after supplementation	152
35	Mean MUAC of Boys Before and After Supplementation	155
36	Mean MUAC of Boys in EI and P I before and after supplementation	155
37	Mean MUAC of Boys in E II and P II before and after supplementation	155
38	Mean MUAC of Girls Before and After Supplementation	158
39	Mean MUAC of Girls in E I and P I before and after supplementation	158
40	Mean MUAC of Girls in E II and P II before and after supplementation	158
41	Mean Hemoglobin Values (g/dl) of Children Before And After Supplementation	160
42	Categorization of Children According to Degree of Anemia	161
43	Mean Serum Retinol (mg/L) of Children Before and After Supplementation	164
44	Impact of Supplementation on Clinical Picture	166
45	Mean Food Intake of children before and after supplementation	167
46	Mean Nutrient Intake of children before and after supplementation	169
47	Impact of Kitchen Garden and Nutrition Education on KAP	171

List of Plates

Plate No.	Title	Page No.
1	Primitive Tribal Groups in Nilgiris District	15
2	Examination for Clinical Symptoms	47
3	Scenic view of the remote Tribal Hamlets and Houses	49
4	Open and Highly Vulnerable Sources and storage of Drinking Water	50
5	Socio Economic Survey	51
6	Nutritional Assessment of the Primitive Tribal Children	53
7	Formulation and preparation of SIFS	61
8	Conduct of supplementation	67
9	Nutrition Exhibition	69
10	Positive Deviance Hearth	70
11	Kitchen Garden	71
12	Crippling Effect of the limbs	109
13	Consumption of black tea in feeding bottle by a four year old	109
14	Microbial Count	142

List of Appendices

Appendix No.	Title	Page No.
I	Institutional Ethical Clearance Letter	210
II	Clinical Examination Schedule	211
III	Interview schedule to elicit information from the tribal participants	212
IV	Description of Procedures for Anthropometric Measurements	216
V	Procedure for Biochemical Analysis	217
VI	24 Hour Recall Method	219
VII	Formulation and Preparation of the Spirulina Incorporated Food Supplement (SIFS)	219
VIII	A Child Friendly Five Point Scale	220
IX	Estimation of Total Microbial Count	220
X	The Kitchen Garden Model	221
XI	KAP Schedule	222

Abbreviations

FAO	- Food and Agriculture Organization
PTG	- Primitive Tribal Group
GLA	- Gamma Linolenic Acid
FDA	- Food and Drug Administration
ACC/ SCN	- Administrative Committee on Coordination/ Subcommittee on Nutrition
GRAS	- Generally Recognized As Safe
KAP	- Knowledge Attitude and Practice
UT	- Union Territory
RDA	- Recommended Dietary Allowances
SD	- Standard Deviation
DSHEA	- Dietary Supplement Health and Education Act
UNICEF	- United Nations International Children's Emergency Fund
WHO	- World Health Organisation
CED	- Chronic Energy Deficiency
BMI	- Body Mass Index
USD	- US Dollars
DFID	- Department For International Development
SAFO	- Strategic Alliance for the Fortification of Oil and Other Staple Foods
NGO	- Non Governmental Organisation
KFI	- Indonesian Nutrition Foundation For Food Fortification
BMZ	- Federal Ministry for Economic Cooperation and Development

Abbreviations

DMBA	- DiMethyl Benzantracine
AIDS	- Acquired Immuno Deficiency Syndrome
HIV+	- Human Immuno Virus
IU	- International Unit
NK	- Natural Killer
DHS	- Demographic and Health Surveys
PD HEARTH	- Positive Deviance Hearth
FNA	- Fine Needle Aspiration
VAD	- Vitamin A Deficiency
IDA	- Iron Deficiency Anemia
TRC	- Tribal Research Centre
NNMB	- National Nutrition Monitoring Bureau
NIN	- National Institute of Nutrition
NCHS	- National Centre for Health Statistics
IAP	- Indian Academy of Pediatrics
ICMR	- Indian Council of Medical Research
LA	- Linoleic Acid
ICDS	- Integrated Child Development Services
AOAC	- Association of Official Analytical Chemists
NAWA	- Nilgiris Adivasi Welfare Association
MUAC	- Mid Upper Arm Circumference
HUDCO	- Housing and Urban Development Corporation
RMRC	- Regional Medical Research Centre
HAZ	- Height for Age
