NARAYANA MEDICAL COLLEGE

Narayana Translational Research Centre
Invites you for a Seminar on

"Micronutrient Deficiencies – Hidden Hunger"

Monday, 25th January, 2021; 11 am to 12 noon

by

Dr. Malavika Vinod Kumar, Ph.D.

Managing Trustee, Sundar Serendipity Foundation

&

The Micronutrient Research Foundation, Chennai.

Patron

Dr. Surya Prakasa Rao, MD
Professor and Dean,
Narayana Medical College,
Andhra Pradesh, India.

Convenor

Dr. Sivakumar Vijayaraghavalu, Ph.D.
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The guest speaker **Dr. Malavika**, Managing Trustee, Sundar Serendipity Foundation & The Micronutrient Research Foundation, Chennai; was received by our honorable Dean Dr. SP Rao in his chamber. He welcomed her and briefed about our institution. She also explained about her Trust and its activities.

Left – Dr. Sivakumar Vijayaraghavalu, Head of NTRC, Center – Dr. Malavika (guest speaker) & Right Dr. SP Rao, Dean, Narayana Medical College.

The guest speaker met our academic coordinator in his office and briefed him about her organization and its services for the past 20 years and discussed about possible collaborations between our institution and her organization.

Inaugural Speech by our honorable Dean – Dr. SP Rao

Dr. Sivakumar Vijayaraghavalu, Convenor, introduced the speaker to audience

Dr. Sivakumar Vijayaraghavalu – Convenor of the seminar, welcomed the audience and introduced the guest speaker as follows to the audience.

Good morning and greetings to all present - physically in this lecture gallery and digitally via zoom portal. I, welcome you all with an immense pleasure on behalf of our Institution – Narayana Medical College, our honorable Academic coordinator – Dr. Sarvapalli Vijayakumar and our respected Dean Dr. Surya Prakasa Rao to this seminar entitled – *Micronutrient deficiencies – hidden hunger*.

Recently in our forum professor LS Ganesh from IIT Madras pointed out statistically that 600 million Indians are living under extreme poverty and majority are malnourished; with this say – he invited all of us as a citizen of this country to address this issue in this same dias few weeks ago. The relevance for referring that incident here is – today's speaker is an exemplary figure in addressing the issue of malnourishment; she is doing it as service for the past 20 years without any monetary benefit.

She already taken up one of the nation's biggest challenge – the hidden hunger; and served more than 30,000 families – more than 1,20,000 individuals without any political ideology/backup. Let's give her a big round of applause. Since our Dr. Vijayakumar sir also has similar interest and wants to address the malnourishment in the tribal population in AP. We invited Dr. Malavika to highlight about her service and research to us.

She had completed her Masters in Biochemistry from Dr. AL PG Institute of Basic Medical Sciences (IBMS), Univ. of Madras; and PhD under Dr. MS Swaminathan, world renowned green revolutionist in M.S Swaminathan Research Foundation (MSSRF), University of Madras, Chennai, Tamil Nadu, India. We are honored to welcome you ma'am; I humbly request you to take over the session and deliver your talk. The power point presentation of the talk is given below.

Dr. Malavika, delivered her talk in the Gray's lecture gallery

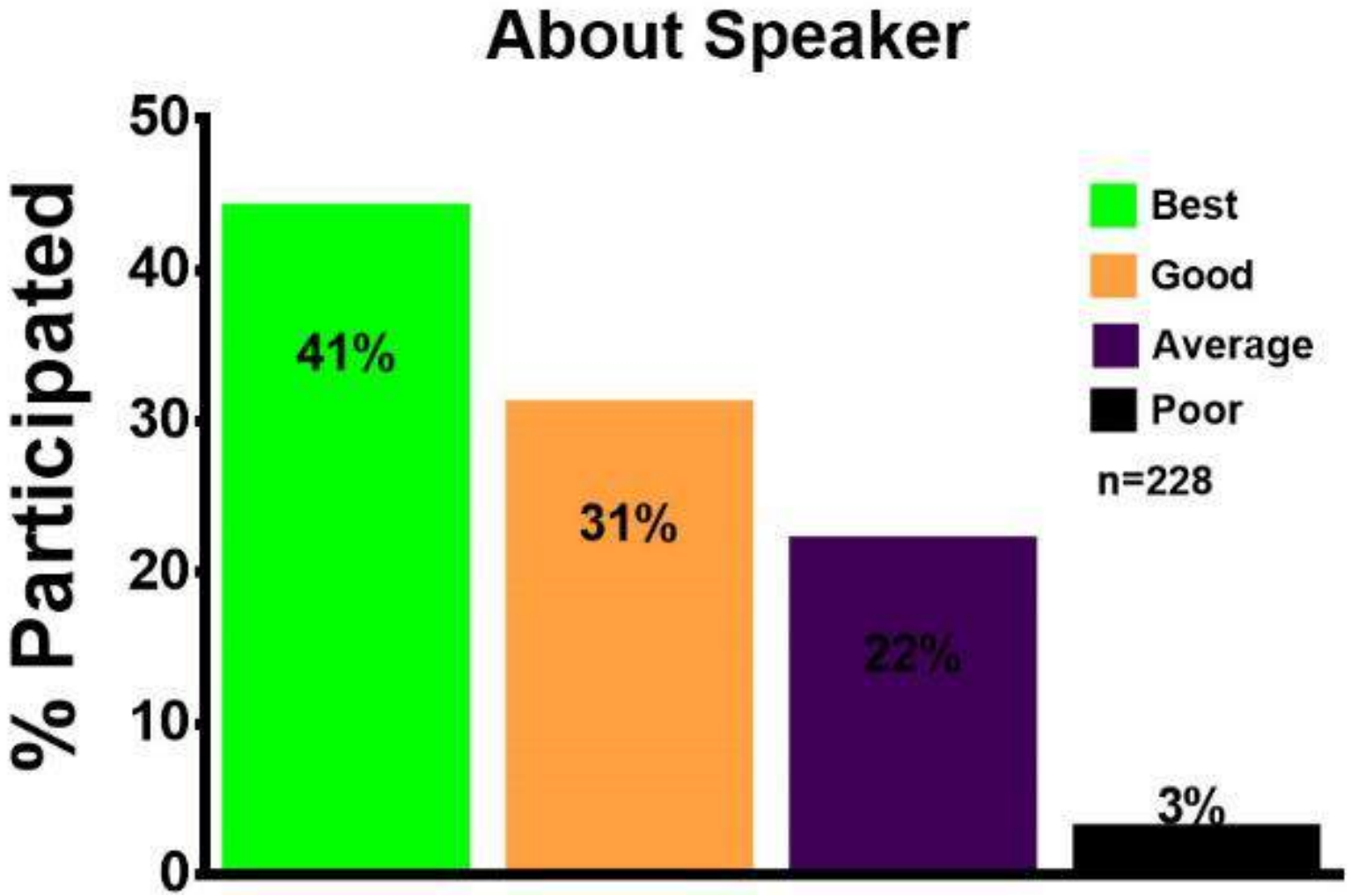

Inflammation corrections:
When you test serum ferritin, soluble transferrin receptor, serum retinol, you have to test for CRP and AGP also
This is for correction for inflammation
When there is inflammation, serum ferritin increases, serum retinol decreases
Divide your subjects into 4 groups: when no AGP and CRP increase is there (CRP ≤5 mg/L and AGP ≤1 g/L), it is the reference group. This group is not affected by inflammation. Incubation group is when CRP is high AGP is normal. Early convalescence is when both CRP and AGP is high. Late convalescence is when CRP is low and AGP is high.
You have to make adjustments for all groups except reference group.
In our studies inflammation was seen in 25% of the children & in 40% of pregnant women

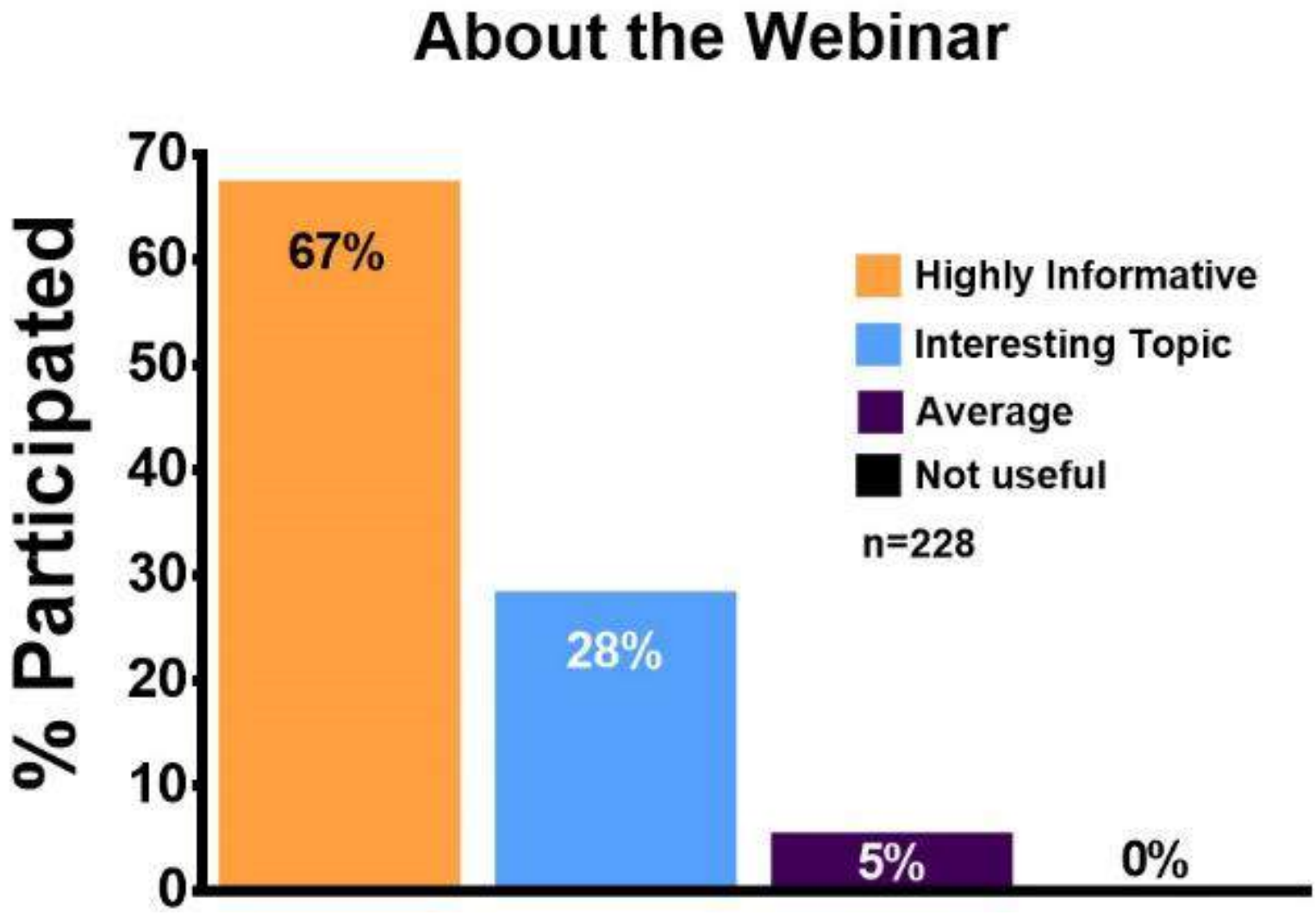
Dr. Agil, Post graduate student, Dept. of Community Medicine asking question in the Q & A Session of the talk

Vote of thanks by Dr. Sivakumar

The speaker – Dr. Malavika thanked our organization, academic coordinator and dean for giving this opportunity to interact with the medical students. She also thanked students and staff listening to her in the Gray's lecture gallery and via zoom portal.

Participants Poll

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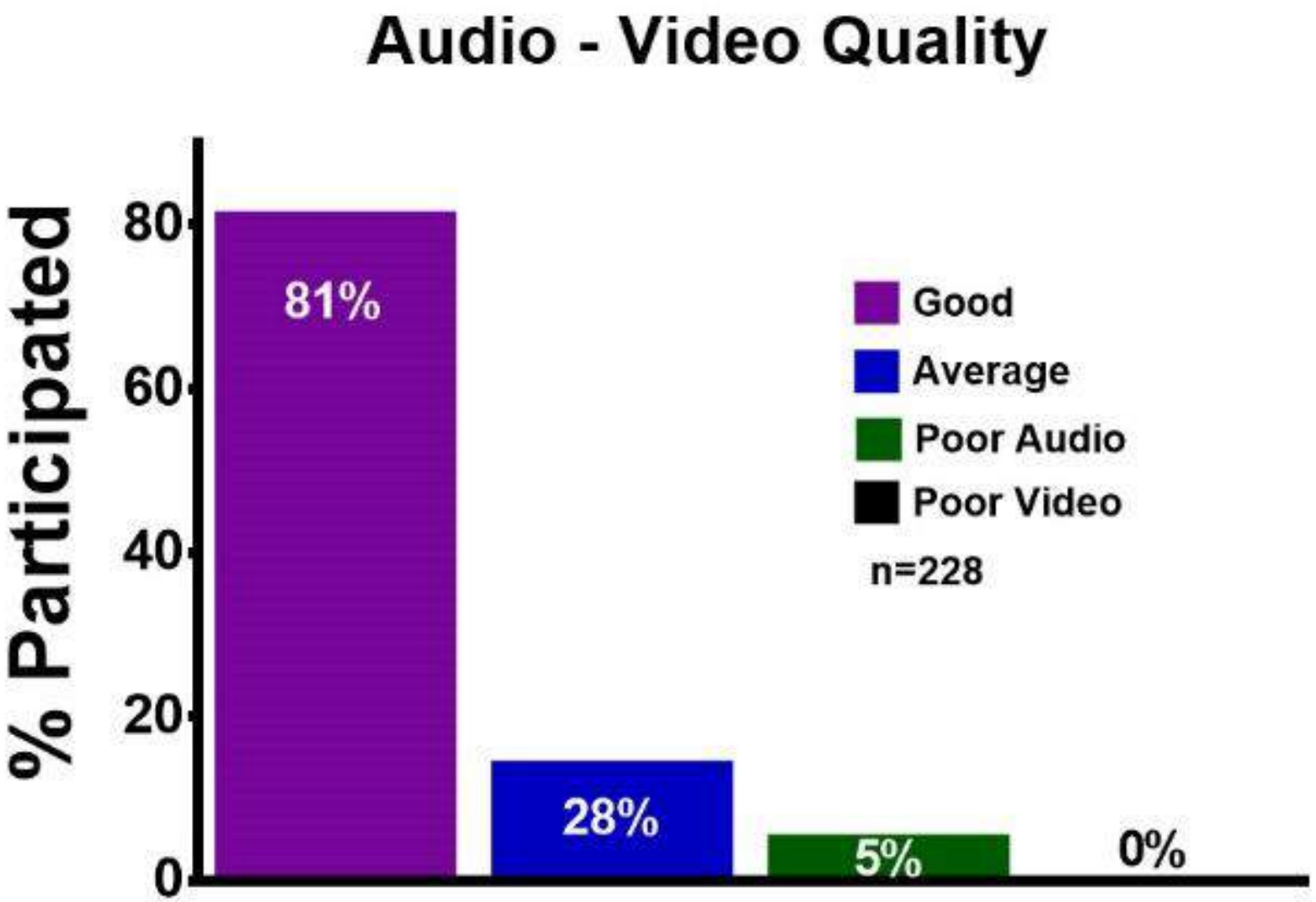
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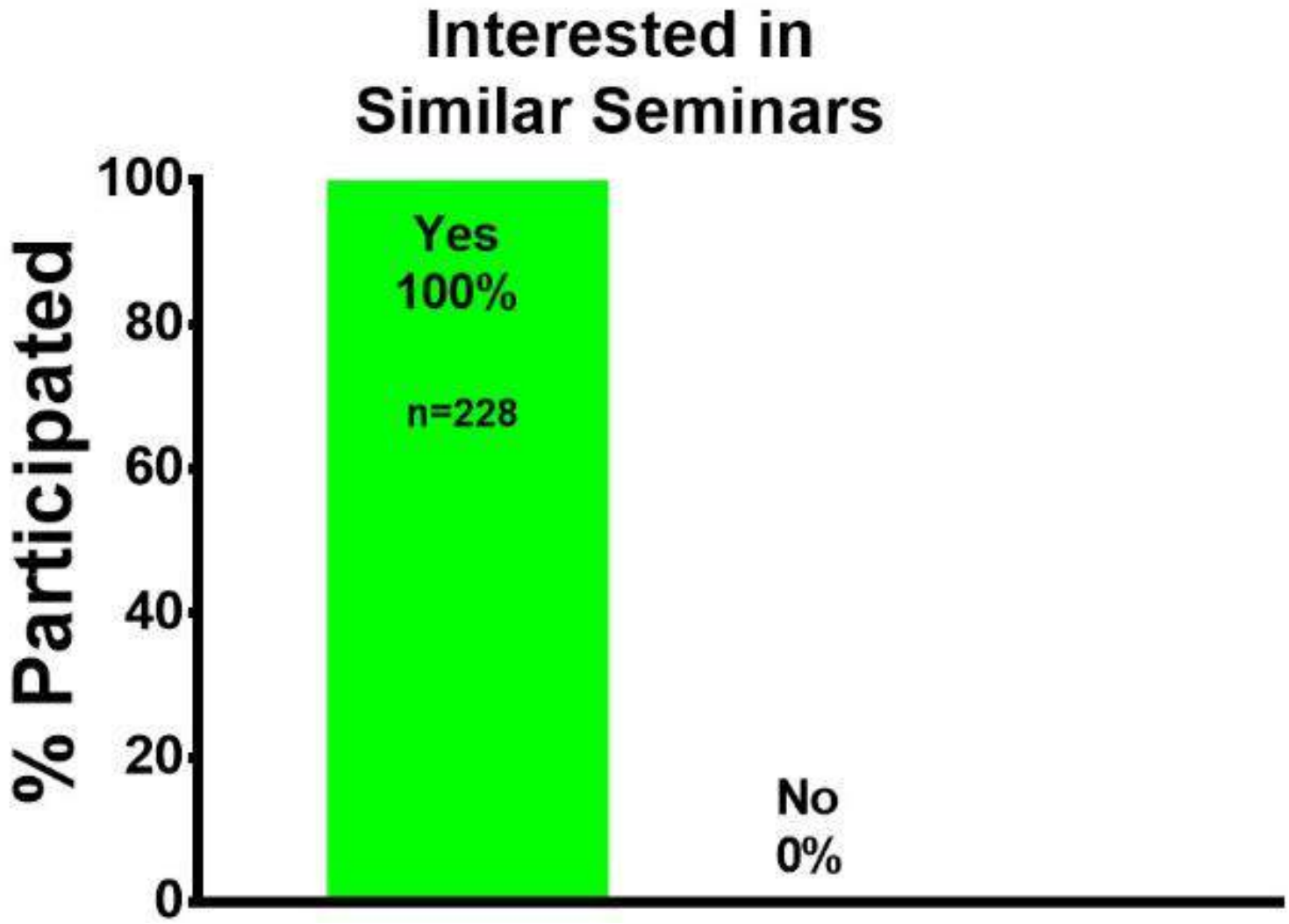
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Micronutrient deficiencies : Hidden Hunger

By

Dr. Malavika Vinod Kumar

Managing Trustee, Sundar Serendipity Foundation

&

The Micronutrient Research Foundation, Chennai.

Power point presentation

What is Hidden Hunger?

Hidden hunger is due to the deficiency of micro nutrients- vitamins and minerals.

Micronutrients = Vitamins & Minerals

Vitamins and minerals are called micro nutrients. Yet their deficiencies causes a catastrophe which is hidden hunger.

Hidden Hunger 

- Anaemia,
- Vitamin A deficiency
- Zinc deficiency
- Iodine deficiency
- Vitamin B12 and folic acid deficiency
- Deficiencies of many other vitamins & minerals

Why is it called Hidden Hunger?

It is called Hidden Hunger because the affected individual is not aware of it.

Some of the deleterious effects of Hidden Hunger are:

· Anaemia
· Night blindness
· Low Birth weight
· Poor productivity
· Impaired Immune functions and therefore susceptibility to diseases.
· Deficits in attention, memory, concentration and cognition
· Stunted growth
· Birth defects like Neural tube defects and Cleft palate.

National family health Survey 5: 2019-20

- **Anaemia prevalence in Nellore, Andhra Pradesh**
- Children <5years:67.5%
- Non pregnant women:59.6%
- Pregnant women:53.7%
- Men :16.2%

Is this acceptable??

NO

Our Journey to fight anemia in the last 25 years

A Multiple Micronutrient Fortified Salt Enriched with

Iron
Iodine
Vitamin B12
Folic Acid
Zinc
Vitamin A

Powder salt **Crystal salt**

Our Journey to fight anaemia in the last 25 years:

A multiple micronutrient food supplement:

A powder enriched with 10 micronutrients, added to food during cooking.

Unlike fortified salt, the use of this involves behavior change: you have to remember to add it during cooking.

Very useful in noon meal schemes to improve the nutrition of school children.

Evolution of fortified salt

- Iron fortified salt in the 80's
- Double fortified salt enriched with iron and iodine in early 90's
- Multiple micronutrient fortified salt from 1998

Clinical trials: Double fortified salt

- **Tea plantation study** (Double blind, randomised, placebo controlled study)
- **Multi center study** (Randomised controlled study) in Gujarat, Madhya Pradesh and Karnataka
- The experimental households were given the fortified salt, the control households got iodised salt
- Hemoglobin (cyanmethhemoglobin method) and urinary iodine analysed
- Deworming in all subjects periodically with albendazole
- Study period:1 year
- ~800 subjects, 400 in experimental group, 400 in control

Results: Multicenter study

TABLE 3. Changes in hemoglobin concentration in groups receiving double-fortified salt (experimental group) and iodized salt (control group) according to cluster[a]

	Experimental group				Control group			
Cluster	*N*	Baseline	Endpoint (1 yr)	Change	*N*	Baseline	Endpoint (1 yr)	Change
Uttar Kanada	28	9.23 ± 2.30[b]	10.08 ± 2.26[b]	0.85 ± 0.40[c]	47	9.34 ± 2.26	9.32 ± 2.46	−0.02 ± 0.60[c]
Dharwad	59	10.63 ± 2.96[b,d]	11.55 ± 2.65[b,e]	0.93 ± 0.43[c]	81	9.35 ± 3.10[d]	9.40 ± 3.13[e]	0.05 ± 0.47[c]
Tumkur	90	9.47 ± 2.74[b]	13.04 ± 1.21[b,e]	3.58 ± 2.73[c]	99	9.44 ± 2.31[f]	11.97 ± 2.08[e,f]	2.53 ± 1.86[c]
Pratapgad	81	12.49 ± 1.40[b]	13.68 ± 1.03[b,e]	1.19 ± 0.67[c]	106	12.39 ± 1.38[f]	12.64 ± 1.33[e,f]	0.25 ± 0.62[c]
Gonda	88	9.77 ± 2.02[b,d]	11.91 ± 1.40[b]	2.13 ± 1.10[c]	69	11.06 ± 1.98[d,f]	11.57 ± 1.57[f]	0.51 ± 0.84[c]
Surat and Bharuch	47	9.31 ± 1.75[b,d]	11.13 ± 1.36[b,e]	1.82 ± 1.10[c]	34	7.94 ± 1.90[d,f]	8.34 ± 1.84[e,f]	0.40 ± 0.47[c]
Total	393				436			

a. Hemoglobin concentrations are expressed as means ± SD (g/dL). A difference is considered significant if $p < .05$.
b. Endpoint hemoglobin significantly higher than baseline hemoglobin in experimental group.
c. Change in hemoglobin at endpoint significantly more in experimental group than in control group.
d. Baseline hemoglobin significantly different in experimental and control groups.
e. Endpoint hemoglobin significantly higher in experimental group than in control group.
f. Endpoint hemoglobin significantly higher than baseline hemoglobin in control group.

Results: Tea plantation study:

Significant improvement in productivity (kilos of tea picked by the experimental group) from 24.8 kgs to 26.2 kgs: 330 tonnes increase in annual tea production

TABLE 3. Mean ± SD haemoglobin levels (g/dl)

Sex of subjects and stage of study	Experimental (fortified salt)	Control	*p*
Male	($n = 155$)	($n = 158$)	NS[a] ($Z = 1.08$)
Baseline	9.57 ± 0.140	9.71 ± 0.137	
Middle	9.63 ± 0.135	9.75 ± 0.120	
End	10.42 ± 0.153	10.30 ± 0.146	
Female	($n = 230$)	($n = 250$)	< .05 ($Z = 2.55$)
Baseline	8.48 ± 0.132	8.92 ± 0.159	
Middle	8.61 ± 0.099	8.68 ± 0.093	
End	10.031 ± 0.134	9.75 ± 0.132	

a. Not significant.

Multiple micronutrient fortified salt: clinical study 1

- The multiple micronutrient fortified salt contained Iron, vitamins A, B1, B2, B6, B12, folic acid, niacin, calcium pantothenate and iodine.
- Pretest post test design with experimental and control groups. There were 119 children in the experimental group and 126 in the control
- Study period: 1 year, age: 5-15 year olds
- Experimental group was residential school children where the fortified salt was used to cook all their meals
- Control group was day scholars who studied in the same school, but who did not reside there.
- Hemoglobin, red blood cell count, hematocrit, serum vitamin A and urinary iodine were measured at baseline and at the end of the study
- In a subsample tests for cognition, attention and memory given (N=63 in experimental and N=66 in control)

Results: Biochemical parameters

Table 6 Change in the biochemical parameters during the study over 12 months

Biochemical parameters	*Experimental group*		*Control group*	
	N	*Change (end point value minus baseline value)*	N	*change (end point value minus baseline value)*
Hemoglobin (g/dl)	119	0.550 ± 1.04[a]	126	−0.226 ± 0.728[a]
Hematocrit (l/l)	119	0.001134 ± 0.0308[a]	126	−0.01787 ± 0.0244[a]
Red blood cells (million/mm^3)	119	0.470 ± 0.475[a]	126	−0.290 ± 0.567[a]
Serum vitamin A (µg/dl)	85	5.56 ± 19.6	71	2.82 ± 19.34
Urinary iodine (µg/l)	119	212.2 ± 178.7[a]	126	−166.94 ± 167.5[a]

Data given as mean ± s.d.

[a]Group mean significantly higher in the experimental group than the control group ($P < 0.05$).

Results: Cognitive tests

Table 3. Cognitive tests: Increment in Scores

Name of the test	Test measures	Experiment n=63	Control n=66
Benton Visual Retention Test (BVRT)	memory	15.5 ± 20.9[a]	8.48 ± 19.4[a]
Cattells retentivity test.	memory	8.73 ± 19.2[a]	2.57 ± 16.1[a]
Mann-Suiter Visual memory screen for objects (picture recall test)	memory	21.2 ± 29.6[a]	7.27 ± 16.1[a]
Delayed Response Learning test	memory	22.2 ± 33.7[a]	5.90 ± 20.4[a]
Personal Information test	memory	31.6 ± 42.5	24.7 ± 35.8
Digit Forward test	memory	0.95 ± 11.0	1.6 ± 12.5
Digit Backward test	memory	2.38 ± 21.8	4.24 ± 19.1
Letter cancellation test	Attention and concentration	4.70 ± 8.43[a]	1.53 ± 8.83[a]
Ravens coloured progressive matrices	intelligence	5 ± 21.7	4.6 ± 18.8

[a]: significant improvement of the experimental group ($p<0.05$) over the control. Data given as mean ± SD

Multiple micronutrient fortified salt: clinical study 2

- Randomised control trial in residential schools, with pre and post test design
- Age: 5-18 years, Period: 9 months
- Experimental schools received salt fortified with A, B1, B2, B6, B12, as well as folic acid, niacin, iron, iodine, and zinc.
- Control schools received iodised salt
- Measured Hb, ferritin, transferrin receptor, CRP, AGP, retinol, serum B12, folic acid ,zinc, Urinary iodine at baseline and endline. Hb in all, rest subsample. Calculate BIS.
- Cognitive tests for 11-18 year olds
- Result: Significant improvement in memory test scores in experimental group

Result : Biochemical parameters

Table II: Biochemical parameters in the experimental and control group over 9 months

	Experimental group				Control group				
	N	Baseline	Post Intervention	p value Paired t-test	N	Baseline	Post Intervention	p value Paired t-test	p value Group x time ANOVA
Hemoglobin g/dL *	213	11.94 ±1.4	12.61 ±1.3	0.0001	189	12.22 ±0.99	12.12 ±0.96	0.099	0.0001
Ferritin µg/L*+	45	8.43 ±18.06	8.31 ±42.12	0.889	43	12.17 ±19.3	8.13 ±15.75	0.001	0.013
sTfR mg/L*	45	12.86 ±5.9	11.74 ±5.25	0.005	43	9.77 ±2.48	10.31 ±3.27	0.226	0.005
Body iron stores mg/Kg*	45	-2.68 ±5	-2.4 ±5.23	0.489	43	-0.55 ±4.7	-2.14 ±4.5	0.002	0.004
CRP mg/L	45	0.47 ±0.92	0.41 ±0.72	0.620	43	0.66 ±1.24	0.57 ±1.1	0.707	0.913
AGP g/L	45	0.84 ±0.18	0.84 ±0.23	0.987	43	0.82 ±0.23	0.77 ±0.22	0.285	0.447
Serum vitamin A µg/dL *	119	20.68± 8.23	25.34 ±5.74	0.0001	87	19.08 ±6.6	19.21 ±5.24	0.872	0.0001
Serum vitamin B_{12} pg/mL*	45	5612± 7624	15741 ±10979	0.0001	50	4707 ±5950	557 ±366	0.0001	0.0001
Serum folic acid ng/mL*	45	16.4 ±11.6	10.12 ±7.02	0.004	50	17.88 ±11.98	5.08 ±2.46	0.0001	0.018
Serum zinc µg/dL *	45	92.5 ±39.6	142.5 ±132	0.010	50	101.22 ±48.3	102.73 ±88.78	0.916	0.042
Angular stomatitis † Prevalence %	213	12.8	4.2		189	14.8	16.4		0.0228

Data given as mean ±SD; + Geometric mean ±SD; * Significant group x time interaction ANOVA repeat measures; † By Binary logistic regression, there was a significant time x group interaction for angular stomatitis.
Hemoglobin was done 3 times, at baseline, midpoint, and post-intervention. The midpoint values of hemoglobin in the experimental group were 12.27 ±1.42 g/dL and in the control group it was 12.04 ±1.06.

Study 3: Improvement of nutrition in communities

Community based randomized controlled trial in Kariapatty, Virudhnagar District, Tamilnadu, South India.

Blood and urine tests done only in children 5-15years of age.

Arm1: The multiple micronutrient enriched fortified salt N=215

Arm 2: Nutrition Education N=214

Arm3: Control group , no intervention. N=217

Study period : 8 months

Laboratory Analysis

Inflammation corrections:

- When you test serum ferritin, soluble transferrin receptor, serum retinol, you have to test for CRP and AGP also
- This is for correction for inflammation
- When there is inflammation, serum ferritin increases, serum retinol decreases
- Divide your subjects into 4 groups: when no AGP and CRP increase is there (CRP ≤5 mg/L and AGP ≤1 g/L), it is the **reference group**. This group is not affected by inflammation. **Incubation group** is when CRP is high AGP is normal. **Early convalescence** is when both CRP and AGP is high. **Late convalescence** is when CRP is low and AGP is high.
- You have to make adjustments for all groups except reference group.
- In our studies inflammation was seen in 25% of the children & in 40% of pregnant women

Results

Change (post intervention minus baseline) in Biochemical parameters after correction for inflammation in the three arms over 8 months.

	Fortified salt	Significance (fortified salt and control) P value	Education	Significance (Education and control) P value	Control
Hemoglobin (g/dL) Mean ± SD	0.52±1.99	0.0001 Ancova	-0.22±1.75	0.15 Ancova	-0.53±1.81
Serum Retinol(µg/dL) Mean ±SD	8.56±14.6	0.006	1.51±9.15	0.827	1.65±9.98
Serum Ferritin (µg/L) geometric mean ± SD	10.8±22.7	0.0001	9.49±14.9	1.000	1.09±19.2
Transferrin receptor (mg/L) Mean ±SD	-1.04±3.85	0.004	1.14±5.06	1.000	1.83±4.65
Body iron stores(BIS) mg/kg body wt, Mean ± SD	1.27±2.80	0.0001	0.49±4.02	1.000	-0.51±4.05
Urinary iodine (mg/L) median (range)	-65 (-400-300)	0.0001	-175 (-475-265)	0.307	-130 (-385-100)
AGP (g/L) Mean ± SD	0.30±0.38	0.218	0.31±0.30	0.025	0.16±0.31
CRP(mg/L) Mean ± SD	0.51±1.86	0.145	0.59±2.12	0.209	-0.14±1.98

Results

Prevalence percentage of serum retinol deficiency, anaemia, iron deficiency anaemia and iron deficiency in the three arms at baseline and post-intervention after correction for inflammation

	Arm 1: Micronutrient group-fortified salt			Arm 2: Education group-nutrition education			Arm 3: Control group-no intervention	
	Baseline	**Post intervention**	***p value* Binary logistic regression Group x time interaction (Arm 1 with arm 3)**	**Baseline**	**Post intervention**	***p value* Binary logistic regression Group x time interaction (Arm 2 with arm 3)**	**Baseline**	**Post intervention**
Serum retinol deficiency prevalence (%)	51.6	28.1	0.0192	56.8	51.5	0.781	49.0	39.0
Anaemia prevalence (%)	46.0	32.6	0.0109	36.4	42.1	0.783	42.9	46.5
Iron deficiency prevalence (%)	66.9	51.3	0.0001	56.1	79.6	0.653	58.6	88.6
Iron deficiency anaemia Prevalence%	35.2	31.0	0.0913	22.9	36.3	0.482	30.0	39.3

Study 4: Improvement of nutrition through noon meal scheme in children

- Earlier we had shown improvement of micronutrient status when the fortified salt was used in residential schools and communities
- The normal consumption of salt is about 10 grams per person per day. Our salt contained nutrients such that 10 grams contained about 1 RDA of nutrients
- In a noon meal the quantity of salt consumed per child per day is 2.5-3 grams . Only if you add nutrients so that about 1 RDA of nutrients is delivered through 3 grams of salt, can the nutrition in the children be improved

Methods:

- In the school where children ate the noon meal we provided a multiple micronutrient fortified salt with iron, iodine, B12, folic acid and zinc . The children who did not eat the noon meal formed the control group
- It was a pretest post test design, study period 1 academic year, age group 5-17 years
- 3 grams of salt had about 1 RDA of micronutrients
- Serum Ferritin, soluble transferrin receptor, AGP and CRP were assessed at baseline and endline
- Body iron stores (BIS) was calculated at baseline and endline
- All children periodically dewormed

Results : Biochemical parameters

Table 2. Biochemical parameters, after correction for inflammation, in the two groups over a 1-year study period

	Intervention group: fortified salt					Reference group: no Intervention			
Parameter	N	Baseline	Post intervention	Change (post intervention - baseline)	ANOVA repeat measures (Intervention with reference) *p* value	N	Baseline	Post intervention	Change (post intervention baseline)
Urinary iodine[†] (µg/L)	73	165 (100-270)	175 (110-317)	42 (-80-135)	0.132 [B]	44	265 (195-331)	210 (150-285)	-15 (-139-57)
Soluble transferrin receptor (mg/L)	128	7.90±3.53	7.10±3.25	-0.80±2.33	0.0001[A]	100	6.71±1.62	7.18±2.20	0.47±2.15
Ferritin[‡] (µg/L)	128	24.17±19.56	22.44±22.10	-0.2±14.26	0.625 [B]	100	28.13±21.28	25.34±24.50	-0.7±16.75
Body iron stores (mg/kg body weight)	128	2.84±3.68	2.93±3.91	0.09±1.69	0.028 [A]	100	3.79±2.83	3.21±3.64	-0.58±2.83
CRP (mg/L)	128	0.58±1.27	0.58±1.25	0.01±1.50	0.143 [B]	100	0.91±2.86	2.37±10.84	1.46±11.07
AGP (g/L)	128	0.81±0.26	0.74±0.29	-0.07±0.32	0.001 [A]	100	0.75±0.26	0.84±0.33	0.09±0.36

All data are presented as mean±SD unless otherwise indicated.

[†]Median (range 25th–75th percentile). Wilcoxon signed-ranks test and Mann–Whitney test.

[‡]Geometric mean±SD.

Mann–Whitney test: Intervention and reference, baseline $p=0.001$, endline $p=0.132$.

Wilcoxon-signed ranks test: Intervention $p=0.165$, reference $p=0.150$.

[A]Significant improvement.

[B]Nonsignificant changes.

Movement for freedom from Hidden hunger

- To give the multiple micronutrient fortified salt free of cost to rural communities, urban slums and the deserving poor
- Given free for periods ranging from 6 months to a year
- Past few years, we have given to 30,000 families improving the nutrition of 1,20,000 men, women and children

Thank you