Efficacy of a Culturally Traditional, Inexpensive, School day Snack against Anemia and Stunting in Adolescent Schoolgirls in Tamil Nadu, India

(Preliminary Block-level Study and Proposal for Formal Studies)

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Abstract:

Every weekday for 9 months, all the girls (about 3000) in grades 7-12 (aged 12-18) attending 17 government schools in Alathur Block of Perambalur district in Tamil Nadu, India were given a health snack. This was a protein, iron, and folate rich snack with no reported side-effects which was easily prepared from locally abundant, inexpensive ingredients, was suited to local tastes, cost only Rs. 13 (material, labor and transportation), and contained about 400 kcal per serving. The preliminary AGASI (Adolescent Girls Anemia and Stunting Intervention) program was partly funded by the Perambalur district government and was administered by the Payir NGO which prepared, transported, and directly observed consumption of the snack every weekday along with providing nutritional counseling. The control group consisted of girls from 2 government schools in 2 neighboring blocks. Girls exposed to the program exhibited significant differences compared to the control group in the change of height, weight, and blood hemoglobin content. Of the treatment group, 2/3rd attained medically normal hemoglobin content and the median growth showed a “catch up”with the national median (Indian Pediatrics). Formal randomized controlled studies are recommended to assess the effect of the intervention including health education on cognitive ability as well as nutrition and growth status. If the results are positive, a subsequent study with government involvement is recommended, with the government implementing cash transfers contingent on nutritional status tests, and independent AGASI providers providing the snack and nutritional counseling.

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Introduction:

India is home to over 1/6th of the world's adolescents, with 243 million people between the ages of 10 and 19 (Anand). Despite India's strong economic growth over the last 2 decades, childhood malnutrition rates are almost five times that of China, and two times that of Sub-Saharan Africa, causing India's declaration of malnutrition as a medical emergency in mid-2015. This was accompanied by restructuring the long-standing Integrated Child Development Services to consider inter-generational cycles of malnutrition that irreversibly affect not only health but also cognitive ability and education, but future economic productivity ("Helping India Combat Persistently High Rates of Malnutrition"). An astounding 75% of new mothers are anemic which is not only a significant cause of maternal mortality, but also affects the nutritional status of the next generation (Biradar *et al*; Bentley & Griffiths). All too often, new mothers are just past adolescence themselves, and 47% of adolescent girls are underweight, with 56% suffering from Iron or Vitamin B deficiencies (Sivagurunathan).

The southern Indian state of Tamil Nadu (TN), the location of the preliminary and proposed studies, has made impressive progress on human development indices with government sponsored initiatives under the Millennium Development Goals (Dr´eze and Sen; Gupta). TN, the originator of the noon midday meal scheme that was later adopted countrywide, ranks as one of the states that is least plagued by severe malnutrition, with the severely malnourished amounting only to 0.5% of the population, while 26 % of children are severely malnourished in states like Bihar (Hemalathal). TN continues to emphasize the provision of affordable, healthy nutrition, as evidenced by the subsidized eatery chain called Amma Unavagam that provides inexpensive, relatively nutritious meals in urban areas and employs womens' self-help groups in the process. Moreover, Iron and Folic Acid (IFA) supplementation is provided for free to young women and

mothers via Public Health Centers (PHCs) that are relatively numerous and accessible, even in remote rural areas. The PHC's have qualified staff capable of maintaining accurate records, and performing precise assessments of nutritional and growth status.

Despite this, using data collected at TN PHC's, the IFA supplement utilization has been shown to be dismal, *especially among adolescent girls with moderate stunting and anemia remaining highly prevalent (Selvaraj)* with anecdotal evidence suggesting side-effects (indigestion/aftertaste/bloating/diarrhea/constipation) and lack of awareness of the serious consequences of anemia as some of the reasons for the poor utilization.

This existing capacity and nutritional emphasis makes TN a suitable location for the proposed study, not only for logistical reasons but also for comparisons with existing programs.

Preliminary Program

Setting, Sample, Design

The preliminary Adolescent Girls Anemia and Stunting Intervention (AGASI) program was funded by the district collector of Perambalur district in central Tamil Nadu, one of the state's drought-prone and economically less-developed regions. The district collector tasked Payir, an NGO in Thenur, (which is in Alathur block), to execute the intervention. The intervention did not interfere with the noon "midday meal scheme" and was in the form of a nutritious snack during a 15 minute lesson-break in the 2:00pm-4:30pm timeslot, prepared and transported fresh daily by over 30 Payir employees to each of Alathur block's 17 government high schools. The snack fits local tastes and has no unpleasant side effects (unlike IFA supplementation).

The snack was given to all girls grades 7-12 in each of these 17 schools. The snack was provided every school day (except on exam days) between June 15, 2016 and March 16, 2017, for a total of 173 days. Due to the daily frequency with which Payir employees met with the girls for a few minutes, consumption of the snack was directly observed by Payir employees who delivered the snack. In addition, as the snack was distributed, both Payir employees and the school teachers repeatedly counseled the group about why adolescent girls need more iron and folic acid than boys; and why they are more susceptible than boys to the effects of anemia; how anemia and stunting affect current and future physical and mental capability and performance in school; as well as its effect on pregnant and nursing mothers and their infants.

The control group, who did not receive the snack, consisted of girls, in the same age-range, and in similar socioeconomic and nutritional status, in 2 high schools in the immediately neighboring (confusingly named) Perambalur and Veppur blocks. The number of girls exposed to the program was 3200, while the control group was 500. Height (wall-rod), weight (digital step-on scale) and hemoglobin (fingerprick) of both groups were measured by Payir's trained health workers using the same portable instruments before and after the program. Both groups had continued access to the noon midday meals (through 10th grade) and to the Iron and Folic Acid (IFA) supplementation that was available at their local PHCs before commencement and throughout the duration of the study.

Nutritional Content and Preparation

The preliminary AGASI used a traditional, unfortified, protein, iron, and folate rich cooked afternoon snack: varied boiled lentils (*Sundal*) and a nut, seed, lentil, and date whole

grain ball (*Satthu Urundai*). The average calorific value of each portion was about 400 kcal, containing about 28 mg protein, 12 mg iron (60% adult daily value), 80% folic acid daily value, and at least 35% DV of all other B-vitamins and minerals. Payir's self-help groups and Thenur villagers prepared the snack fresh every day in hygienically controlled and supervised conditions on Payir campus and transported it to the schools in the afternoon.

Cost Comparison:

The preliminary AGASI (including material, labor, transportation, nutritional counseling, and measurement) cost an average of Rs. 13 per child per day. The district collector's office funded Rs. 10 per child per day, and Payir's donors funded the rest. By comparison, *Amma Unavagam* (a heavily state-subsidized, urban eatery chain also staffed by self-help groups) provided the equivalent of 13 steamed rice-lentil buns with lentil soup (*idli-sambar*, the highest nutritional value on offer), for the same Rs. 13, but the estimated cost was Rs. 35 (Madhavan). On a cost-adjusted basis, Amma Unavagam's meal provides 160% of the calories, but only 85% of the protein and 40% of the iron, folic acid, and other B-vitamins and minerals as the AGASI snack. Furthermore, AGASI's cost per child per year of $73 compares favorably with the exhaustively researched *Scaled up India Plus* proposal in *Estimating the Cost of Delivering Direct Nutrition Interventions at Scale: National and Subnational Level Insights From India* for treating moderate malnutrition with nutritionally-dense food, counseling and micronutrient supplementation (Menon).

Theory of Change for the Intervention

We lay out the goals, and the obstacles addressed by the preliminary AGASI program, whose results are presented in the next section.

The goals are: first, achieve "catch-up" growth rate and hemoglobin content in government-school-going adolescent girls within a year; and second, enable them to easily self-sustain this healthy state throughout their lives.

The current obstacle to both of these goals are: the girls' and their mothers' lack of precise awareness of the multi-generational ill effects of stunting and anemia and the significantly higher propensity for girls and women to suffer from it and propagate it; how to quickly correct it (proven by measurements); and how to thereafter prevent it using a practical and convenient, inexpensive, weekday nutritional regime.

Comparison to Similar Studies

There are many previous related studies in many parts of India with somewhat similar goals, which study the efficacy of supplementation (Vir *et al*; Kotecha *et al*), fortification of grains and salt (Berry *et al*, Banerjee *et al*), and nutritional counseling (Bhanushali *et al*; Pareek *et al*). The primary distinguishing features of AGASI are that one: it addresses both stunting and anemia; two: it focuses on the efficacy of inexpensive snacks that have no reported side-effects, suited to local tastes, and are easy to prepare using locally available ingredients; and three: it recognizes the need for hand-holding and direct observation in the first year: a hands-on and practical demonstration of a viable nutritional recipe and routine, along with face-to-face, repetitive counseling.

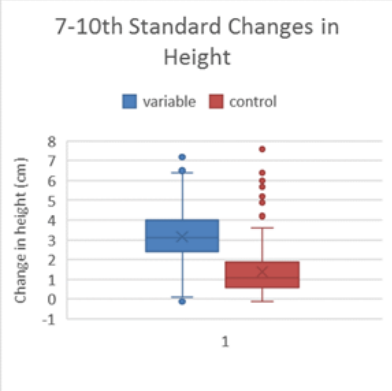
Preliminary Program Results

Although the sample size that was exposed to the AGASI program (*labeled as the blue "variable" group in the plots below*) is almost 5 times that of the control (*red*) sample size, the two groups began in the same general height, weight, and hemoglobin levels as can be seen in table 1a. The whisker plots below show a significant improvement in height and weight for the AGASI group, in relation to control, in the pivotal 7-9th standards (ages 12-15) showed greater levels of growth.

The improvements in hemoglobin levels last through the 12th grade and approximately 2/3 of the AGASI group achieves normal levels of hemoglobin (12g/dL) in comparison to only about 1/2 the control group.

The comparison to the Indian Pediatric Association (IPA) height and growth charts shows another key finding: although both the AGASI and control median started out and remained on the low end, over the 9 months of the study, the *rate* of change of height and weight of the AGASI group in the lower grades significantly exceeded that of the IPA chart, thus indicating a "catch-up" was in progress that was not observed in the controls.

The apparent levelling off in AGASI group's height improvements in 11th and 12th grades (ages 17-18), is consistent with the IPA growth charts. However, we are unable to explain the relative weight improvements in 12th grade other than attribute it to the much smaller (1/5th) size of the control population.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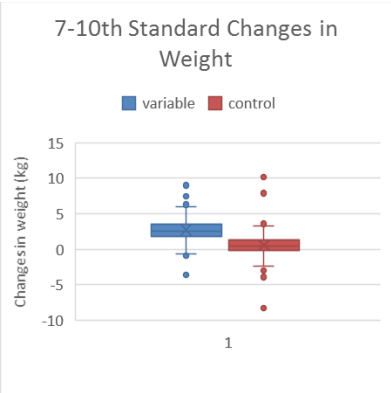
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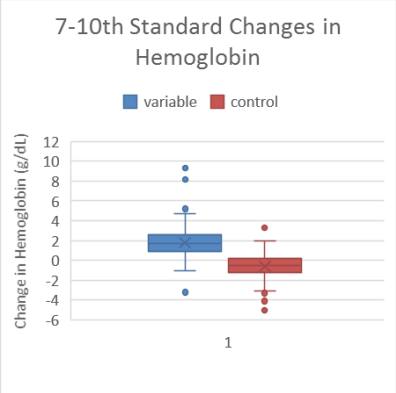
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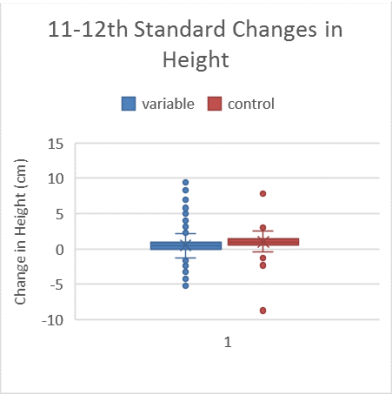
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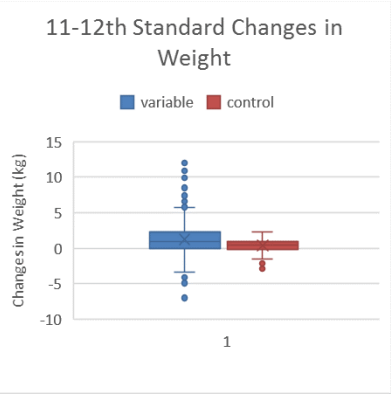
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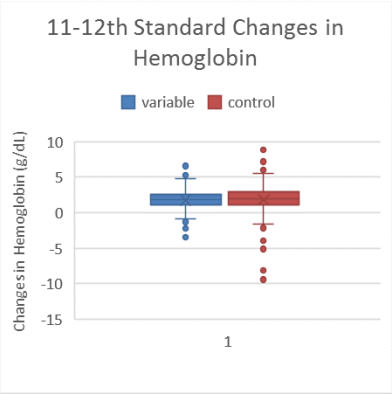
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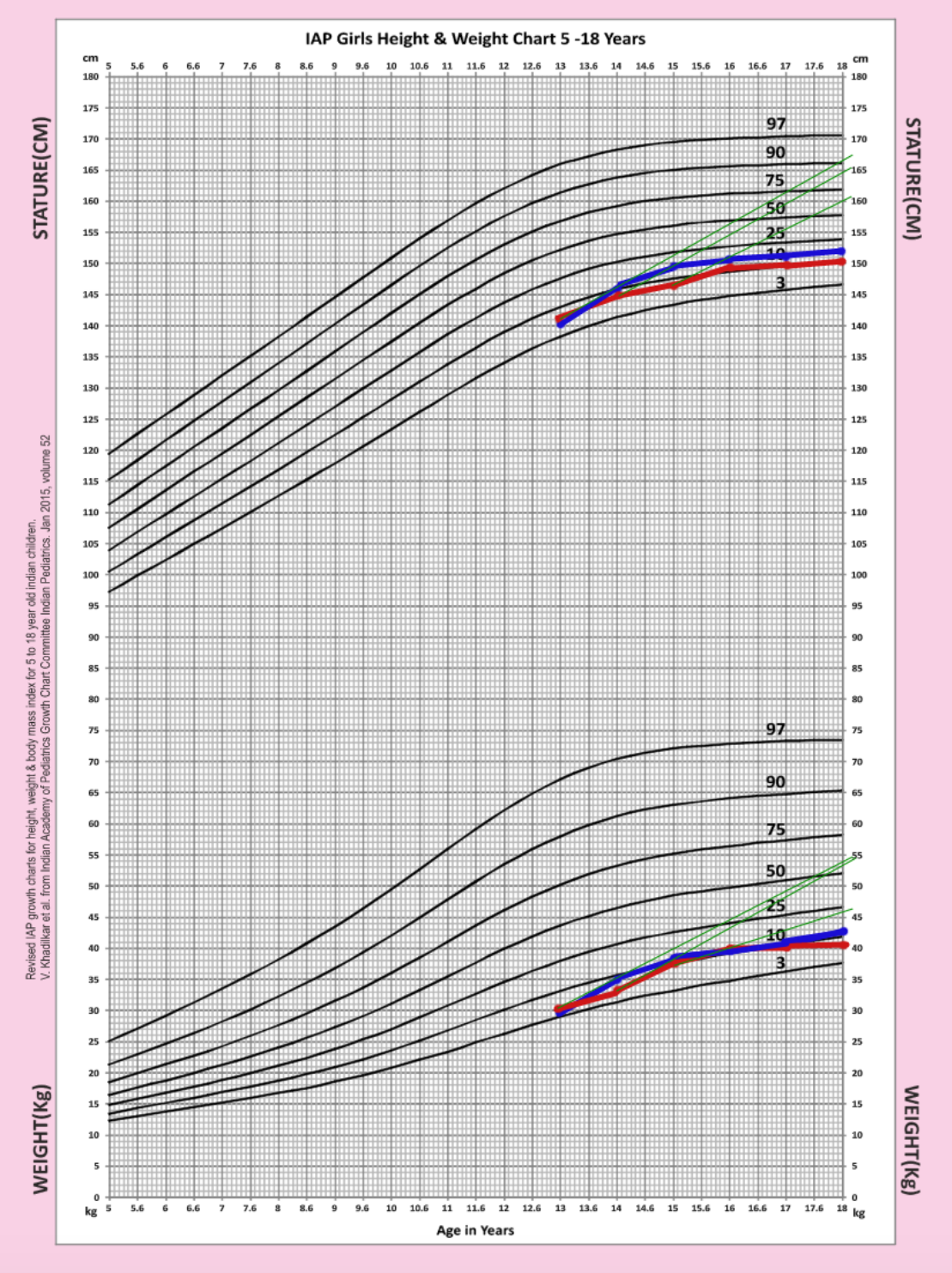


VISUAL COMPARISON of **Table 1a** Each blue (resp. red) dot represents the median of a different AGASI (resp. control) cohort at the end of the 9 months, so the blue/red/green lines are no more than a visual aid. Since the IPA curve is clearly nonlinear, *the linear extrapolation of the median growth rate* (line connecting Age X control red point to Age X+1 AGASI blue point) in the pivotal grades is merely for visual comparison to a *linear extrapolation of the IPA curve's slope at the corresponding point* (not shown), indicating a significant AGASI catch up (and this comparison is strengthened by the more accurate whisker plots).

Table 1a

Standard (measured at the end)	IPA median weight (kg)	AGASI "variable" median weight (kg)	Control median weight (kg)	IPA median height (cm)	AGASI "variable" median height (cm)	Control median height(cm)
7th	43.5	29.9	30.7	152.5	140.4	141.1
8th	46.5	35.4	33.1	155.0	145.9	145.8
9th	48.5	37.9	36.9	156.5	149.2	146.7
10th	50.0	39.9	40.7	157.0	150.5	149.6
11th	51.0	40.8	40.8	157.5	151.0	150.1
12th	52.0	42.8	40.8	158.0	152.1	150.6

Hemoglobin levels (g/dL) AGASI	Percent of AGASI	Percent of control
>12	65.99	51.21
>12.5	55.14	38.06
>13	40.83	22.06

Proposed Next Steps

First, we propose an enhanced AGASI study including a robust health-education component for the students and parents, accompanied by a measurement of cognitive and learning rate indicators and how they correlate with Hb and other health indicators. If at all possible, this would be a formal randomized controlled trial study of the enhanced AGASI program by qualified researchers, sampling ideally from a more diverse population (2 blocks, or involving other like-minded NGOs in other geographical locations, or district-wide). As in the case of the preliminary study, a combination of Government and Non-Government funding could be viable.

Payir (including temporary) staff, given their experience with the preliminary study, can be trained to carry out the logistics of the trials precisely.

If the results of the study are positive, as a follow-up project, we subsequently propose direct engagement with the TN Government for a futher study of the following nature. To reduce the potential for (or perceptions of) waste and corruption from a scaled-up AGASI program, we propose direct cash transfers by the Government, to mothers of adolescent girls who are directed to purchase the snack (not mandatorily but with strong recommendation) from independent AGASI providers. In particular, although the snack used by the preliminary AGASI is a traditional preparation made with locally freely available ingredients, the unit cost of AGASI (especially if scaled up) would be significantly less than the material, fuel and preparation cost incurred single household. The cash transfers would use Aadhar identity card verification, contingent on initial and subsequently positive growth/hemoglobin tests at Government PHCs.

We believe that such a government-run cash transfer and measurement program is likely to be much more successful if the testing/certification for BMI/Hb, cognitive/learning, as well as knowledge and adoption of Health-improving nutrition and lifestyle is performed by an entity (presumably a PHC) that is separate from the cash-transfer institution and also separate from the AGASI providers.

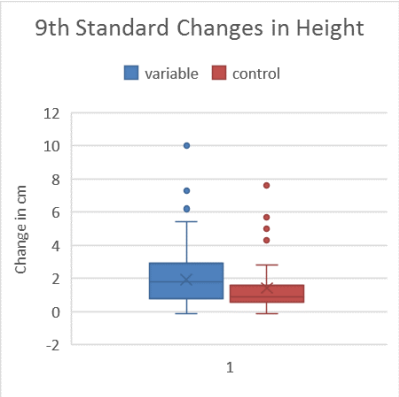
These independent providers would not only sell nutritionally-dense, traditional, inexpensive snacks, but would have an incentive to also provide direct counseling on nutrition and daily-routine maintenance, as well and lessons on preparation - through face-to-face and regular contact with their own staff. The employment generation for local self-help groups, who are highly competitive due to lower margins, is an added plus.

Tamil Nadu (TN) has relatively good PHC coverage with trained staff capable of periodic growth and anemia status measurements, and relative ease and reliability of cash-transfer implementation, due to 83% statewide Aadhar identity card coverage, even 98% in Perambalur district, the location of the preliminary study ("TN Aadhar Drive Covers 83%, but Chennai Lags"). Hence TN and specifically Perambalur district would serve as a viable location to focus on the nutritional impact of the proposed scaled-up, study with cash-transfers, without interference from extraneous, logistical factors such as distribution and measurement.

Such a follow-up study would estimate the feasibility and costs of scaling up to a multi-district, or even state-wide program.

Appendix

We include the complete set of plots for all age groups. Raw data is available upon request.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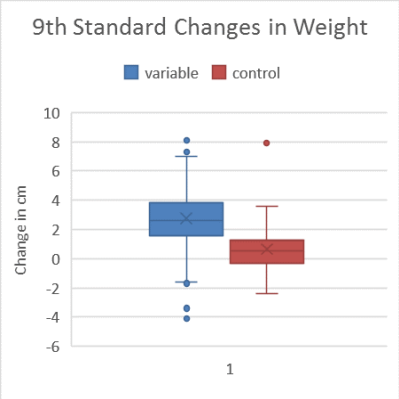
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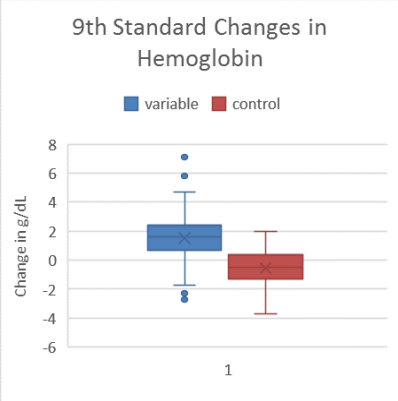
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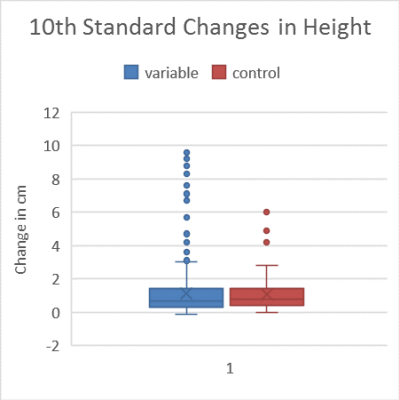
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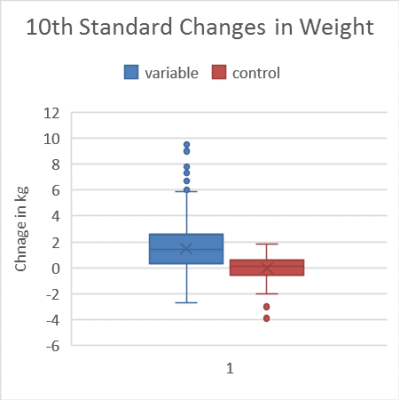
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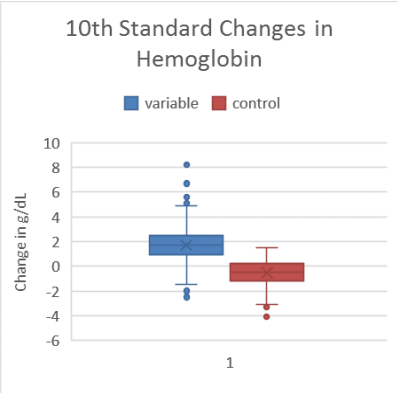
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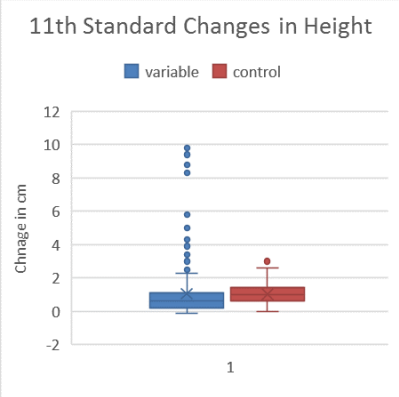
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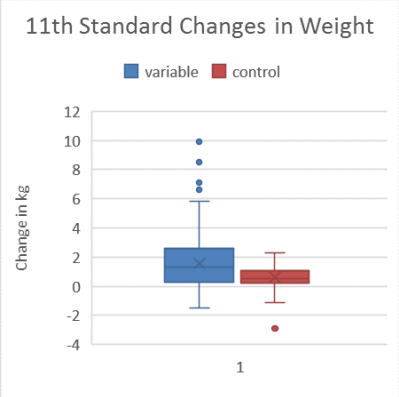
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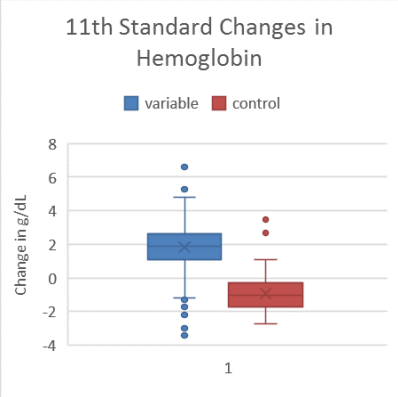
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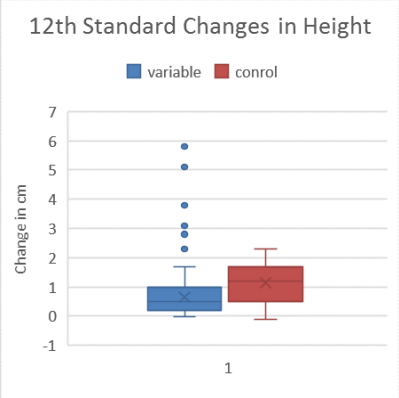
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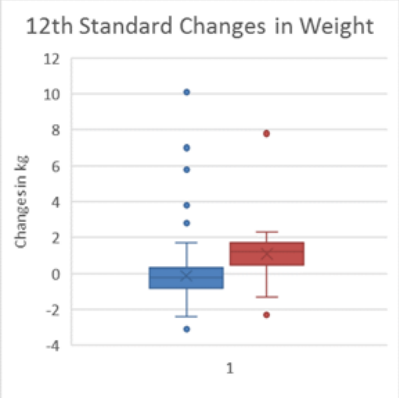
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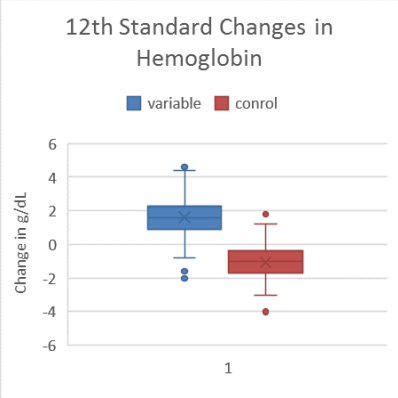
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What is your proposed budget? Please provide a detailed breakdown (Again, links to external documents are welcome). *

Step ***No.***	***Objectives***	***Key activities to achieve*** ***objective***	***Asha funding based on 500 children (INR)***
1	Supplementary Nutrition and Education	Supplementary Nutrition at the rate of Rs. 12.5/- for 200 days/year for Adolescent girls for 1 year	12.5 Lakhs
		Health/Nutrition Education to adolescent children, mothers and to community stakeholders through meetings, workshops & street plays	2.5 Lakhs
		Base-line, mid-year and Year end Hb & BMI reading & Learning outcome collection and monitoring. Rs. 50 per child x 3 times/year for 1 year	0.75 Lakhs
		Budget Subtotal:	***15.75 Lakhs***
2	***Skill Building***	Coordinating with Government Skill Mission. 1 coordinator per 500 students each @ Rs. 2.4 lakhs/year	2.4 Lakhs
		Budget Subtotal:	***2.4 Lakhs***
		Total Budget	***18.15 Lakhs***

We believe a minimum of 500 students would be required to run the program in a statistically meaningful manner.

Please provide a detailed timeline of the project implementation and evaluation (External links are welcome). *

We assume that 1 calendar year is a good time for us to show progress on some of the key success metrics discussed later.
Payir will use its existing food-processing unit (used for the pilot AGASI project) which has sufficient capacity to meet the requirements of the proposed project.

In terms of overall plan below are set of activities planned and their schedule

Activities	**Frequency and Start time**
• Discussion with Students (Subjects), Teachers, Parents etc. • Gathering of baseline data on HB, BMI etc. • Preparation of production facilities	First 3 weeks of program
• Nutritional Ladoos administration	Daily in school
• Educational intervention at school for health, nutrition and adolescence.	Starting month 3 – during school hours
• Street play targeted at children and/or adults in villages	Once every month at school/village
• Collection of learning outcomes	Per school time tables
• HB, BMI data collection	Start of program Middle of year End of the program