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Statistical Analysis Plan:
iLiNS ZINC Hypothetical Willingness-to-Pay for LNS and Herbal Teas

Contents

1) Brief Introduction and Motivation

In this paper we will present baseline estimates of hypothetical willingness-to-pay (WTP) for a small-quantity preventative lipid-based nutrient supplement (LNS, hereafter) product formulated for consumption during early childhood. The iLiNS study in Burkina Faso (iLiNS-ZINC) is a community-based, partially double-blind, placebo-controlled randomized clinical trial for zinc-contained LNS. Using contingent valuation methods, we elicited hypothetical WTP for one week's supply of LNS from households participating in the iLiNS ZINC trial. As a comparator, we also elicited hypothetical WTP for one week's supply of herbal teas. For both LNS and herbal teas, after eliciting WTP for one week's supply of the product, we used a set of follow-up questions to assess hypothetical WTP in the long-term (continuous payment for 9 months).

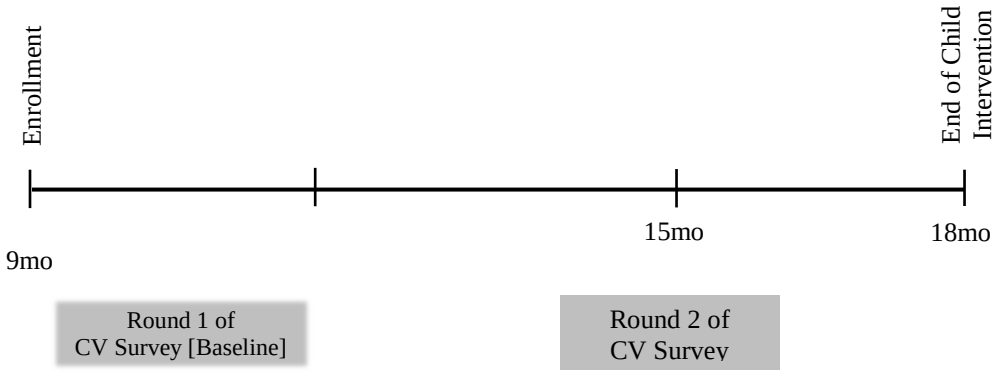
Preventative LNS products are intended to be consumed daily for many months as a supplement to traditional foods (Dewey and Arimond 2012; Nutriset 2011). This is in contrast to ready-to-use therapeutic foods such as Plumpy'Nut©, which are primarily used in emergency settings and are administered in relatively large doses over a short period of time to treat children with severe acute malnutrition. While the international donor community has historically purchased and distributed therapeutic nutritional products for severely malnourished children for free via public channels, the differences in usage of preventative LNS products coupled with the potentially large and heterogeneous population of women and children who may benefits from them will make full subsidization of preventative LNS products much more expensive and less likely (Lybbert 2012). Thus, a hybrid distribution system that reaches target consumers through both public channels and retail markets may be recommended.

Our estimates of baseline[1] willingness-to-pay (WTP) for LNS will shed light on household valuation of LNS and the factors that influence WTP. Moreover, our data on WTP for herbal teas will provide a benchmark from which we can evaluate WTP for LNS relative to a familiar, locally-available product. This collection of results will provide a starting point for characterizing demand for LNS, which in turn may guide policy decisions regarding the price LNS consumers might be expected to pay as well as help establish targeting mechanisms to distribute LNS.

2) Description of Variables

The following sections describe the dependent and explanatory variables that will be used to model WTP. The timeline in the figure below, where time is measured in months from enrollment into the randomized trial, shows the relationship between child enrollment into and progression through the randomized trial relative to the timing of each round of the contingent valuation survey.

[1] Data on hypothetical WTP was collected when the child was approximately 9 months old (baseline) and again at 15 months. WTP at 15 months will be analyzed in a separate study.



Timeline: Child Intervention and Contingent Valuation (CV) Survey

2.1 Dependent Variables

- WTP for a day's supply of LNS at baseline in 4th quarter 2011 US dollars.
- WTP for a day's supply of herbal teas at baseline in 4th quarter 2011 US dollars.
- Difference in WTP for a day's supply of LNS and herbal teas at baseline in 4th quarter 2011 US dollars.
- Long-term (i.e. continuous 9 months in early childhood) WTP for a day's supply of LNS at baseline in 4th quarter 2011 US dollars.
- Long-term (i.e. continuous 9 months in early childhood) WTP for a day's supply of herbal teas at baseline in 4th quarter 2011 US dollars.
- Difference in Long-term (i.e. continuous 9 months in early childhood) WTP for a day's supply of LNS and herbal teas at baseline in 4th quarter 2011 US dollars.

Note: The distributions of WTP for LNS and herbal teas are right-skewed. To account for this in our models, we may transform WTP to natural logarithm of WTP.[2] We may also separate WTP values into two groups, household head and the mother of the iLiNS child for further regression tests.

2.2 Explanatory Variables

[2] Because the natural log of zero is undefined, we will set all zero WTP values to a value slightly smaller than the minimum non-zero value of ln(WTP).

Preliminary results of the iLiNS-ZINC randomized trial have shown that LNS along with selected healthcare services improve the linear growth and selected indicators of cognitive development of children who received the supplement daily from 9-18 months of age (Hess et al. 2013). There may also be costs associated with consumption of LNS, such as the time spent procuring and consuming LNS or any unpleasant physical side-effects associated with its consumption. Given household preferences and constraints, a household's expected stream of benefits (which may be shaped by characteristics such as level of education, demographic composition of the household, discount rate, and maternal health) coupled with costs associated with consuming LNS will influence the private value (or willingness-to-pay) for LNS. The expected relationship[3] between WTP and the following respondent, household, child, and maternal characteristics will be tested using Ordinary Least Squares (OLS) models as described in Section 3 below.[4]

Respondent Baseline Characteristics:

- Household Head: Indicator variable that = 1 if the respondent is the iLiNS household head and = 0 if respondent is the mother of the iLiNS child.[5]

- Age: Respondent's age in years.

- Education: Number of completed years of formal or informal education by the respondent.

- Weekly Income[6]: Self-reported measure of the amount typically earned per week by the respondent in his/her primary work in 4th quarter 2011 US dollars.

Maternal Characteristics:

- Maternal BMI: Maternal body mass index at enrollment.

- Risk Behavior: Relative risk aversion score was an indicator of the iLiNS mother/ caregiver's willingness to take on risk as measured by the amount she risked in a game

[3] In some cases, the relationship between WTP and a covariate may be non-linear. In particular, respondent age, respondent income, household food security, and household expenditures may have a u-shaped relationship with WTP, where WTP is lower at the tails of the covariate distribution. To account for this potential non-linearity, we may also include squared terms.

[4] Note that some of the variables included in this list (and any variant of them, including squared terms and interactions) may be too highly correlated to include both in the model. We will test all independent variables for correlation and omit those deemed to be too highly correlated.

[5] The respondent to the contingent valuation survey was determined randomly (by the tossing a coin) to be either the iLiNS child's mother or the head of household.

[6] The distribution of weekly income is right-skewed. To account for this in our models, we transform weekly income to natural logarithm of weekly income, written as ln(weekly income) in the regression

of chance. In the game, the mother of the child was given 10 coins of 50 Francs CFA and asked how much she would like to bet, with a 50% chance to double the amount she bet and a 50% chance to lose half of the bet amount.

- Discount rate: Relative discount rate was generated by playing a money game in which the mother/caregiver of the studied child was asked to measure out the amounts of money that would make her indifferent between receiving the smaller amount of money in one week or the larger amount four weeks later.

Child Characteristics:

- Height for Age: The Height for Age z-score is an indicator to show the iLiNS child's nutritional status at the time when he/she was 9 months of age.

- Child Gender: Indicator variable that = 1 if the iLiNS child is male and = 0 if the child is female.

- Only child: Indicator variable that = 1 if the iLiNS child is the only child (age under 5 years old) in the household when he/she was 9 months old (at baseline). Indicator variable that = 0 if there is more than one child in the household at baseline.

- Child Ratio: The ratio between household members who are under five years of age and household size at baseline, defined as (children under five/household size).

Household Characteristics:

- HFIA Score: The Household Food Insecurity Access (HFIA) Score is a continuous measure of the degree of food insecurity in the household at baseline. For each of nine questions, the survey respondent, who is the person primarily responsible for food preparation and meals in the household, indicates whether anyone in her household experienced the food insecurity condition in the previous four weeks. If yes, the respondent indicates how frequently the specific condition was experienced, where 'rarely' = 1-2 times in the past four weeks, 'sometimes' = 3-10 times in the past four weeks, and 'often' = more than 10 times in the past four weeks. Each household receives a score from 0-27 based on a simple sum of the frequency of occurrence of each food insecurity condition, where 'never' = 0 points, 'rarely' = 1 point, 'sometimes' = 2 points, and 'often' = 3 points. The higher the score, the higher the degree of household food insecurity experienced in the previous four weeks.

- Household Asset Index: A proxy measure of household socioeconomic status based on baseline ownership of a set of assets (radio, television, refrigerator, cell phone, and stove), lighting source, drinking water supply, sanitation facilities, and flooring materials. Household ownership of this set of assets is combined into an index (with a mean of

zero and standard deviation of one) using principal components analysis. Higher asset index scores indicate relatively 'better-off' households.

- PC Daily Expenditures[7]: Per capita (PC) total daily expenditure composed of non-food expenditures plus food expenditures (which includes the value of purchased and home-produced foods) in 4th quarter 2011 US dollars.

- Food Ratio: The ratio of per capita daily food expenditure to per capita total daily expenditure, defined as (PC daily food expenditures/PC total daily expenditures).

Intervention Group:

- Treatment Group: Set of dummy variables indicating randomized group assignment. To assess zinc-related biochemical and functional responses among young Burkinabe children, the studied children were randomly assigned to receive one of the following interventions from 9 to 18 months of age: 1) LNS without zinc and placebo tablet (LNS-Zn0), 2) LNS with 5mg zinc and placebo tablet (LNS-Zn5), 3) LNS with 10mg zinc and placebo tablet (LNS-Zn10), 4) LNS without zinc and 5mg Zinc tablet (Suppl-Zn5) and 5) Non-intervention group (NI).

Other Covariates/Controls:

- Version of Questionnaire: Control variables for different versions of the contingent valuation survey to control for starting 'bid' pricing (version A: 100CFA; version B : 500CFA; version C: 1000CFA)

- Language: Set of dummy variables to indicate language of enumeration, including French, Dioula, Moore, Bobo and Bolon.

- Month: Dummy variables indicating the month when the contingent valuation survey was administered.

- Enumerator: Set of enumerator control variables.

3) Statistical Methods

3.1 Data Cleaning

Cleaning of the SES data follows the same procedure outlined in the main analysis plan (iLiNS-ZINC Statistical Analysis Plan Version 1, 2013-08-20).

[7] The distribution of PC daily expenditure is right-skewed. To account for this in our models, we transform it to natural logarithm of per capita daily expenditure, written as ln(daily expenditure) in the regression.

3.2 Outliers

Identification and treatment of outliers in the SES data and maternal nutrition variables will follow the treatment described in the main statistical analysis plan (iLiNS-ZINC Statistical Analysis Plan Version 1, 2013-08-20).

3.3 Software

All statistical analyses will be performed with Stata 13 statistical package.

3.4 Analysis

3.4.1 Summary Baseline Characteristics

Summary statistics, including mean (count for dichotomous variables), standard deviation (percentage for dichotomous variables), minimum, and maximum for all explanatory variables will be presented in Table 1.

3.4.2 Summary of Short- and Long-Term WTP

Summary statistics, including mean, standard deviation, minimum, and maximum for short-term (i.e., a day's supply) WTP for LNS and herbal teas, the difference in short-term WTP between the two products and across rounds will be presented in Table 2.

Tables 3 will present the same summary statistics but for long-term (i.e., continuous 9 months in early childhood) WTP for LNS and herbal teas, the difference between the two products and across rounds.

Tables 4 will present summary statistics for short- and long-term WTP, respectively, across treatment groups (i.e., different nutritional treatments in iLiNS study).

3.4.3 Factors Associated with WTP

Regression results will be presented in Table 5 (baseline short-term WTP for a day's supply) and Table 7 (baseline short-term WTP for a day's supply across respondents). Parallel sets of regression results will be presented in Tables 6 and 8 for long-term (i.e., continuous 9 months in early childhood) WTP at baseline. We will use ordinary least squares (OLS)[8] to estimate the relationship between baseline[9] WTP for LNS and a set of characteristics that, based on theory and previous empirical work, we expect to be associated with WTP.

[8] If WTP is censored at zero - that is, WTP is actually negative (and unobserved) for some respondents who would require payment to take LNS /herbal teas - OLS may lead to inconsistent estimates (Cameron and Trivedi 2005). A tobit model can be used to account for censoring but is not without tradeoffs. The tobit model relies on normally distributed and homoscedastic errors for consistency, and since we observe only a small proportion of zeros in our data (1.4% of WTP for LNS and 1.9% for herbal teas), we opt for OLS over a tobit specification.

[9] Data on WTP was also collected at approximately 6 months later after the first round (baseline) WTP survey.

For $i = 1, 2, \ldots, N$ contingent valuation survey respondents and $m = 1, 2, \ldots M$ iLiNS children, we will estimate $WTP_i = \alpha + X_i'\beta_x + H_i'\beta_h + N_m'\beta_n + I_m'\beta_j + C_i'\beta_c + u_i$, where WTP_i is respondent $i's$ stated maximum WTP for a day's supply of LNS, X_i is a vector of respondent baseline socioeconomic characteristics, H_i is a vector of respondent $i's$ household baseline socioeconomic characteristics, N_m is a vector of maternal and child baseline characteristics including indicators of maternal BMI and child's height for age z-score, I_m is a vector of treatment group dummy variables, C_i is a vector of other control variables, and u_i is the error term. We will estimate a parallel model for baseline WTP for herbal teas.

We will also use OLS to estimate the factors associated with the difference in WTP for LNS and herbal teas at baseline, defined as $WTP(LNS)_i - WTP(Herbal\ Teas)_i$. This will be modeled as $WTP(LNS)_i - WTP(Herbal\ Teas)_i = \alpha + X_i'\beta_x + H_i'\beta_h + N_m'\beta_n + I_m'\beta_j + C_i'\beta_c + u_i$.

4) Design of Tables

Table 1. Baseline Respondent, Maternal, Child and Household Characteristics

	Variable	Definition	Mean/ Count	Std Dev/ Percent	Min	Max
Respondent	Household Head	=1 if the respondent is head of household (= 0 if the iLiNS child's mother)	xxx xx.xx	xx.xx xx.xx	xx	xx
	Age	Respondent's age in years				
	Education	Respondent's years of formal/informal education				
	Weekly Income	Respondent's weekly income in fourth quarter 2011 USD				
Maternal	Maternal BMI	Body mass index of iLiNS child's mother				
	Risk Behavior	Relative measure of Mother's risk-seeking behavior				
	Discount Rate	Relative measure of Mother's discount rate				
The iLiNS Child	Height for Age	Child height for age z-score				
	Only Child	=1 if the iLiNS child is the only child (age under 5) in the household				
	Child Gender	= 1 if iLiNS child is male = 0 if iLiNS child is female				
	Child Ratio	The ratio of children (under 5) to total household members				
Household	HFIA	Household Food Insecurity Access Score				
	Asset Index	Proxy measure of socioeconomic status based on asset ownership				
	PC Daily Expenditures	Per capita total daily expenditures in fourth quarter 2011 USD				
	Food Ratio	The ratio of PC daily food expenditures to PC total daily expenditures				

N=XXX

Table 2. Short-term Hypothetical WTP† for a Day's Supply of LNS and Herbal Teas

	Product	Mean (Std Error)	Std Deviation	Min, Max	Zero Max WTP
9 Months (Baseline)	LNS	xxx (x.xx)	x.xx	x.xx x.xx	xx(x.x%)
	Herbal Teas				

†In 4th Quarter 2011 US Dollars.
Significance codes: *** (p < .01), ** (p < .05), * (p < .1) indicate different mean in WTP across products.
Omit Outliers by *5 standard deviation.

Table 3. Long-term Hypothetical WTP† for a Day's Supply of LNS and Herbal Teas

	Product	Mean (Std Error)	Std Deviation	Min, Max	Zero Max WTP
9 Months (Baseline)	LNS	xxx (x.xx)	x.xx	x.xx x.xx	xx(x.x%)
	Herbal Teas				

†In 4th Quarter 2011 US Dollars.
Significance codes: *** (p < .01), ** (p < .05), * (p < .1) indicate different mean in WTP across products.
Omit Outliers by *5 standard deviation.

Table 4. Average WTP† for LNS by Nutritional Treatment Group

	Treatment Group	Short-Term Payment		Long-Term Payment	
		Count	WTP for LNS	Count	WTP for LNS
9 Months (Baseline)	Non-intervention	xxx	x.xx (x.xx)	xxx	x.xx (x.xx)
	A: LNS-Zn0				
	B: LNS-Zn5				
	C: LNS-Zn10				
	D: Suppl-Zn5				

†In 4th Quarter 2011 US Dollars.
***(p < .01), ** (p < .05), * (p < .1) indicates significantly lower than the rest of the sample.
###(p < .01), ## (p < .05), # (p < .1) indicates significantly higher than the rest of the sample.

Table 5. Regression Results: Baseline Short-Term WTP for a Day's Supply

		Coefficient (Robust Standard Error)		
	Variable	ln(LNS)	ln(Herbal Teas)	ln(Difference)
Respondent	iLiNS Woman (0/1)	x.xxx (x.xxx)	x.xxx (x.xxx)	x.xxx (x.xxx)
	Age (yrs)			
	Education (yrs)			
	Education^2			
	Weekly Income (USD)			
Household	HFIA			
	Asset Index			
	PC daily Expenditures (USD)			
	Food Ratio			
Maternal	Maternal BMI			
	Risk Behavior			
	Discount Rate (0/10)			
Child	Height for Age			
	Only Child (0/1)			
	Child Gender (0/1)			
	Child Ratio			
Intervention Group	Non Intervention			
	LNS-Zn5			
	LNS-Zn10			
	Suppl-Zn5			
	Constant			
	N	xxx	xxx	xxx
	R^2	x.xxx	x.xxx	x.xxx

Significance codes: *** ($p < .01$), ** ($p < .05$), * ($p < .1$)
Note: Controls for questionnaire version, language of enumeration, month of enumeration and enumerator were also included in the model (unreported).

Table 6. Regression Results: Baseline Long-Term WTP for a Day's Supply

		Coefficient (Robust Standard Error)		
	Variable	ln(LNS)	ln(Herbal Teas)	ln(Difference)
Respondent	iLiNS Woman (0/1)	x.xxx (x.xxx)	x.xxx (x.xxx)	x.xxx (x.xxx)
	Age (yrs)			
	Education (yrs)			
	Education^2			
	Weekly Income (USD)			
Household	HFIA			
	Asset Index			
	PC daily Expenditures (USD)			
	Food Ratio			
Maternal	Maternal BMI			
	Risk Behavior			
	Discount Rate (0/10)			
Child	Height for Age			
	Only Child (0/1)			
	Child Gender (0/1)			
	Child Ratio			
Intervention Group	Non Intervention			
	LNS-Zn5			
	LNS-Zn10			
	Suppl-Zn5			
	Constant			
	N	xxx	xxx	xxx
	R^2	x.xxx	x.xxx	x.xxx

Significance codes: *** (p < .01), ** (p < .05), * (p < .1)
Note: Controls for questionnaire version, language of enumeration, month of enumeration and enumerator were also included in the model (unreported).

Table 7. Regression Results: Baseline Short-Term WTP for a Day's Supply Across Respondents

	Variable	Coefficients (Robust Standard Error)			
		ln(LNS) HH head	ln(Herbal Teas) HH Head	ln(LNS) Child's Mother	ln(Herbal Teas) Child's Mother
Respondent	Age (yrs)	x.xxx	x.xxx	x.xxx	x.xxx
		(x.xxx)	(x.xxx)	(x.xxx)	(x.xxx)
	Education (yrs)				
	Education^2				
	Weekly income (USD)				
Maternal	Maternal BMI				
	Risk Behavior				
	Discount Rate (0/10)				
Child	Height for Age				
	Only Child (0/1)				
	Child Gender (0/1)				
	Child Ratio				
Household	HFIA				
	Asset Index				
	PC daily Expenditures (USD)				
	Food Ratio				
Intervention Group	Non Intervention				
	LNS-Zn5				
	LNS-Zn10				
	Suppl-Zn5				
	Constant				
	Observations	xxx	xxx	xxx	xxx
	R^2	x.xxx	x.xxx	x.xxx	x.xxx

Significance codes: *** (p < .01), ** (p < .05), * (p < .1)
Note: Controls for questionnaire version, language of enumeration, month of enumeration and enumerator were also included in the model (unreported).

Table 8. Regression Results: Baseline Long-Term WTP for a Day's Supply Across Respondents

	Variable	Coefficients (Robust Standard Error)			
		ln(LNS) HH head	ln(Herbal Teas) HH Head	ln(LNS) Child's Mother	ln(Herbal Teas) Child's Mother
Respondent	Age (yrs)	x.xxx	x.xxx	x.xxx	x.xxx
		(x.xxx)	(x.xxx)	(x.xxx)	(x.xxx)
	Education (yrs)				
	Education^2				
	Weekly income (USD)				
Maternal	Maternal BMI				
	Risk Behavior				
	Discount Rate (0/10)				
Child	Height for Age				
	Only Child (0/1)				
	Child Gender (0/1)				
	Child Ratio				
Household	HFIA				
	Asset Index				
	PC daily Expenditures (USD)				
	Food Ratio				
Intervention Group	Non Intervention				
	LNS-Zn5				
	LNS-Zn10				
	Suppl-Zn5				
	Constant				
	Observations	xxx	xxx	xxx	xxx
	R^2	x.xxx	x.xxx	x.xxx	x.xxx

Significance codes: *** (p < .01), ** (p < .05), * (p < .1)
Note: Controls for questionnaire version, language of enumeration, month of enumeration and enumerator were also included in the model (unreported).

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