Prevention of Linear Growth Faltering in Infants and Young Children With Lipid-based Nutrient Supplements (iLiNS-DOSE)

Statistical Analysis Plan

Appendix 06: Hypothetical Willingness-to-Pay for LNS and Likuni Phala at Baseline

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) product formulated for consumption during early childhood, from approximately 6-24 months. Using contingent valuation methods, we elicited hypothetical WTP for a week's supply of LNS from households participating in the iLiNS-DOSE randomized control nutrition trial in Malawi. As a comparator, we also elicited hypothetical WTP for a week's supply of Likuni Phala (LP), a familiar, locally-available product commonly in this iLiNS study area. For both LNS and LP, after eliciting WTP for a week's supply of the product, we used a set of follow-up questions to assess hypothetical WTP in the long-term (i.e., WTP for a week's supply regularly over the coming year).

Preventative LNS products are intended to be consumed daily for many months as a supplement to breast milk and 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 benefit 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.

In this hybrid setting, in addition to the opportunity costs associated with procuring and consuming preventative LNS products, some households may also be required to pay for them. Our estimates of willingness-to-pay (WTP) for LNS will shed light on household valuation of LNS and the factors that influence WTP.[1] Moreover, our data on WTP for LP 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 a targeting mechanism to distribute LNS.

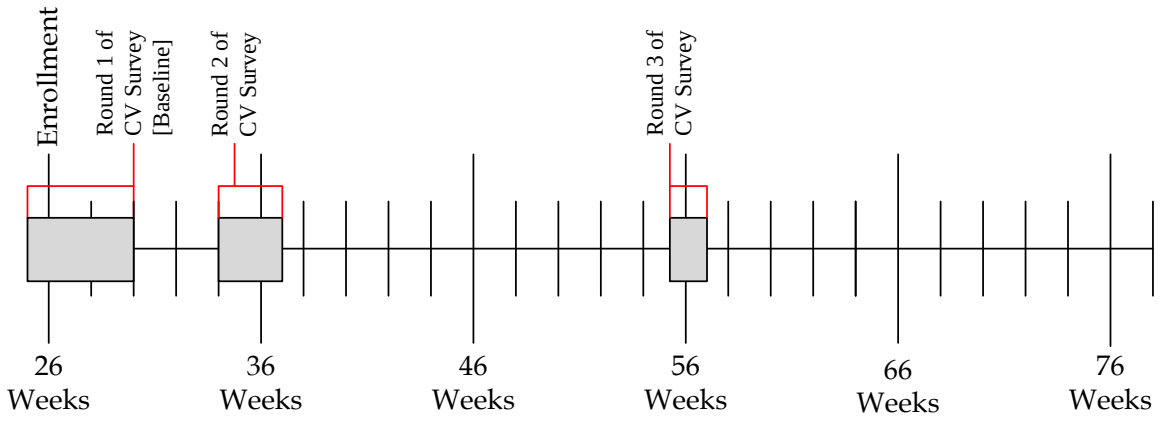
2. Description of Variables

The following sections describe the dependent and explanatory variables that will be used to model WTP. Note that the baseline contingent valuation survey was to be administered within a

[1] The randomized trial is evaluating the efficacy of LNS for childhood consumption.

few weeks of enrollment.[2] Figure 1 depicts the relationship between infant enrollment into the randomized trial and the actual timing of each round of the contingent valuation survey.[3] Time is measured in weeks from the birth of the child. The grey boxes indicate the approximate range of time when enrollment and contingent valuation surveys were administered.

FIGURE 1: TIMELINE OF iLiNS-DOSE INTERVENTION AND CONTINGENT VALUATION (CV) SURVEY



2.1 Dependent Variables

- WTP for a week's supply of LNS at baseline in 4th quarter 2011 US dollars.
- WTP for a week's supply of LP at baseline in 4th quarter 2011 US dollars.
- Difference in WTP for a week's supply of LNS and LP at baseline in 4th quarter 2011 US dollars.
- Long-term (i.e., one year) WTP for a week's supply of LNS at baseline in 4th quarter 2011 US dollars.
- Long-term (i.e., one year) WTP for a week's supply of LP at baseline in 4th quarter 2011 US dollars.
- Difference in long-term (i.e., one year) WTP for a week's supply of LNS and LP at baseline in 4th quarter 2011 US dollars.

Note: The distributions of WTP for LNS and LP are right-skewed. To account for this in our models, we may transform WTP to ln(WTP).[4]

[2] In some instances, contingent valuation surveys were administered a few weeks past the planned enumeration date due to logistical reasons and difficulty locating respondents.
[3] The focus of this manuscript will be baseline hWTP only.
[4] 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).

2.2 Explanatory Variables

Childhood consumption of LNS may have private benefits that accrue to the iLiNS child and her household at different points along the lifecycle. The immediate- and short-term benefits potentially include reduced child morbidity (Martorell 1999; Allen and Gillespie 2001), which may decrease household expenditures on health care and ease the household's time and, perhaps, budget constraints by freeing up maternal time spent caring for a sick child. In the long-term, the household may benefit from improvements in the child's physical capacity, cognitive ability, and accumulation of human capital, leading to productivity gains in adulthood (Alderman 2010), thus increasing the household's incentive to invest in early childhood health.

There may also be costs associated with childhood consumption of LNS, such as the time spent procuring and consuming LNS or any unpleasant side-effects associated with its consumption. Given households' 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 child and maternal health) coupled with the costs associated with consuming LNS will influence the private value (WTP) for LNS. The expected relationship between WTP and the following respondent, household, maternal characteristics, and child characteristics will be tested using Ordinary Least Squares (OLS) models and described in Section 3 below.[5]

Respondent Baseline Characteristics:

- Head of Household: Indicator variable that = 1 if the respondent is the iLiNS head of household and = 0 if respondent is the primary caregiver for the iLiNS child.[6]
- Age: Respondent's age in years.
- Education: Number of completed years of formal education by the respondent.

Household Baseline Characteristics:

- Children Under Five: The number of children under five years of age who are household members at baseline.[7]

[5] 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 an inverted u-shaped relationship with WTP, where WTP is lower at the tails of the covariate distribution. To account for this potential non-linearity, we will also include squared terms.
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.

[6] The respondent to the contingent valuation survey was determined randomly (by tossing a coin) to be either the head of the household or the iLiNS child's primary caregiver. In cases where the caregiver is also the head of household, this variable is coded as = 1 (head of household).

[7] Household members are defined as people who have been regularly sleeping in the same dwelling and sharing food from the same cooking pots for at least the last three months.

- Percent Under Five: The percentage of household members who are under five years of age at baseline, defined as (children under five/household size)*100.
- HFIA Score: The Household Food Insecurity Access (HFIA) Score is a continuous measure of the degree of food insecurity in the household. 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 the 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, '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 ownership of a set of assets (radio, television, refrigerator, cell phone, and stove), lighting source, drinking water supply in the dry season, sanitation facilities, and flooring materials. Household ownership of this set of assets is combined into an index (with a mean of zero and a standard deviation of one) using principal components analysis. Higher asset index scores indicate relatively 'better-off' households.
- Household Per Capita Expenditures: Total daily per capita (PC) expenditures, composed of non-food expenditures plus food expenditures (which includes the value of purchased and home-produced foods) in 4th quarter 2011 US dollars.
- Percent Food Expenditures: The percentage of total daily per capita expenditures that go toward food, defined as (PC daily food expenditures/PC total daily expenditures)*100.
- Discount Rate: Relative measure of the household's discount rate determined by playing a game at baseline in which a respondent was shown two equal-sized tins of rice and was then asked to measure out the quantity (from 0-10) of rice into a third tin that would make him/her indifferent between receiving the first tin of rice alone in a week and the second tin plus the additional amount measured into the third tin in one month.[8]
- Risk Behavior: The measure of relative household risk aversion was generated by playing a game at baseline in which a respondent was given 150 Malawian Kwacha (approximately 0.38 USD) and allowed to bet a portion of the mount flipping a coin. If the coin landed on heads, the respondent lost half of the amount bet. If the coin landed on tails, the respondent gained the amount bet.

[8] To determine whether the respondent received rice in a week or a month, s/he rolled a 10-sided die. If the number rolled was smaller than the amount of rice measured, the first tine of rice alone was delivered to the respondent in a week, and if the number rolled was equal to or greater than the amount of rice measured, the second tin of rice plus the amount measured into the third tin was delivered to the respondent in a month. The quantity of additional rice measured into the third tin by the respondent serves as his/her individual discount rate relative to the rest of the sample.

Maternal Baseline Characteristics

- Maternal Height: Mother's height in meters measured at enrollment.[9]
- Maternal BMI: Mother's body mass index at enrollment.
- Age: Mother's age in years.
- Education: Number of completed years of formal education by the iLiNS child's mother.

Child Baseline Characteristics

- LNS: Dummy variable = 1 if iLiNS child randomized to receive LNS and = 0 if iLiNS child randomized to receive delayed intervention.[10]
- Child's Height-for-Age Z-score: Child's height-for-age Z-score measured at enrollment.[11]
- Primiparity: Dummy variable = 1 if iLiNS child is mother's first child.
- Male: Dummy variable = 1 if iLiNS child is male and = 0 if iLiNS child is female.

Other Covariates/Controls

- Month: Dummy variables indicating the month the baseline contingent valuation survey was administered.
- Year: Dummy variables indicating the year the baseline contingent valuation survey was administered.
- Enumerator: Set of enumerator control variables.
- Language of Enumeration: Dummy variable = 1 if language of enumeration is Chewa and = 0 if language of enumeration is Yao.

3. Statistical Methods

3.1 Data Cleaning

Cleaning of the SES data follows the same procedure outlined in the main analysis plan with the research assistant generating queries and the SES Coordinator resolving the queries.

[9] The perceived importance of maternal height may be relative to the height of other women in the iLiNS study catchment area. As such, we may also normalize height by the average height of other women in the iLiNS-DOSE trial.

[10] We may also estimate the models using a set of LNS treatment group dummy variables to assess whether there is any statistically significant difference in WTP, all else equal, across the treatment arms.

[11] The perceived importance of child height-for-age may be relative to the height-for-age of other children in the iLiNS study catchment area. As such, we may also normalize child height-for-age by the average height-for-age of children in the iLiNS-DOSE trial.

3.2 Outliers

Identification and treatment of outliers in the SES data and maternal and child nutrition variables will follow the treatment described in the main statistical plan.

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. As a check for the success of randomization, we will report differences in mean explanatory variables across treatment groups.

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 week's supply) WTP for LNS, LP, and the difference in short-term WTP between the two products will be presented in Table 2. Table 3 will presented short-term WTP across treatment groups and respondents.

Tables 4 and 5 will present the same summary statistics but for long-term (i.e., one year) WTP for LNS, LP, and the differences in long-term WTP between the two products.

3.4.3 Factors Associated with WTP

Regression results will be presented in Table 6 (short-term WTP) and Table 7 (long-term WTP). We will use ordinary least squares (OLS) to estimate the relationship between baseline WTP for LNS and a set of characteristics that, based on theory and previous empirical work, we expect to be associated with WTP.[12]

For i = 1, 2, …, N contingent valuation survey respondents and m = 1, 2, …, M iLiNS children, we will estimate $WTP_i = \alpha + x_i'\beta_x + H_i'\beta_h + N_m'\beta_n + C_i'\beta_c + u_i$,[13] where WTP_i is respondent i's stated maximum WTP for a week's supply of LNS, x_i, is a vector of respondent baseline

[12] If WTP is censored at zero—that is, WTP is actually negative (and unobserved) for some respondents who would require payment to take LNS/LP—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 zeroes in our data, we opt for OLS over a tobit specification.

[13] In cases where the iLiNS mother was the respondent to the valuation survey, the respondent denoted j, is alsot the iLiNS woman, denoted m.

socioeconomic characteristics, H_i is a vector of respondent i's household baseline characteristics, N_m, is a vector of maternal and child baseline characteristics including indicators of maternal and child nutritional status, 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 LP.

We will also use OLS to estimate the factors associated with the difference in WTP for LSN and LP at baseline, defined as $WTP^{LNS}_i - WTP^{LP}_i$. This will be modeled as $WTP^{LNS}_i - WTP^{LP}_i = \alpha + x_i'\beta_x + H_i'\beta_h + N_m'\beta_n + C_i'\beta_c + u_i$.

4. References

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5. Tables

Table 1: Baseline Respondent, Household, and Maternal Characteristics

	Variable	Definition	Mean/ Count	Std Dev/ Percent	Min	Max
Respondent	Head of Household	*= 1 if respondent is head of household (=0 if primary caregiver)*	xxx	xx.xx		
	Age	*Age in years*	xx.xx	xx.xx	xx	xx
	Education	*Years of Education*				
Household	Children U5	*Number of household members who are children under five years*				
	Percent Children U5	*Percent of children under five years in household*				
	HFIA Score	*Household Food Insecurity Access Score*				
	Asset Index	*Proxy for socioeconomic status*				
	Per Capita Total Expenditures	*Per capita daily total expenditures (4th Quarter 2011 USD)*				
	Percent Food Expenditures	*Percent of total household expenditures on food*				
	Discount Rate	*Relative measure of time discounting*				
	Risk Behavior	*Relative measure of willingness to take a risk*				

Child	First Child	*= 1 if iLiNS child's mother has no other children*
	LNS	*= 0 if child in delayed intervention group =1 otherwise*
	Male	*=1 if iLiNS child is male (= 0 if iLiNS child is female)*
	Height-for-Age	*Height-for-Age Z-score*
Mother	Age	*Age in years*
	Education	*Years of Education*
	Height	*Height in meters*
	BMI	*Body mass index*

N=xxx

Significance codes: ***(p<.01), **(p<.05), *(p<.1) indicate difference in means between LNS and the delayed intervention groups.

Table 2: Average WTP for a Week's Supply of LNS and LP at Baseline

Product	N	Mean† (Std Error)	Std Dev	Min	Max*	Zero WTP/ Difference
LNS	xxx	x.xx (x.xx)	x.xx	x.xx	x.xx	xx (x.x%)
LP						
LNS - LP						

†In 4th Quarter 2011 US Dollars
*Observations>4 SD above the mean were omitted as outliers.
Significance codes: ***(p<.01), **(p<.05), *(p<.1) indicate different mean WTP across products.

Table 3: Average WTP for a Week's Supply of LNS and Likuni Phala at Baseline by Treatment Group and Respondent

Product		N	Mean	Std Error
LNS	Overall	xxx	x.xx	x.xx
	LNS			
	Non-LNS			
	iLiNS Woman			
	Head of Household			
Likuni Phala	Overall			
	LNS			
	Non-LNS			
	iLiNS Woman			
	Head of Household			
LNS - LP	Overall			
	LNS			
	Non-LNS			
	iLiNS Woman			
	Head of Household			

†In 4th Quarter 2011 US Dollars.
For treatment groups: significant codes ***(p<.01), **(p<.05), *(p<.1) indicate mean WTP for LNS group different than delayed intervention group for same product.
For respondents: significant codes ***(p<.01), **(p<.05), *(p<.1) indicate mean WTP for iLiNS women different than head of households for same product.

Table 4: Average Long-Term WTP for LNS and Likunia Phala at Baseline

Product	N	Mean† (Std Error)	Std Dev	Min	Max*	Zero WTP/ Difference
LNS	xxx	x.xx (x.xx)	x.xx	x.xx	x.xx	xx (x.x%)
Likuni Phala						
LNS - LP						

†In 4th Quarter 2011 US Dollars.
*Observations > 4 SD above the mean were omitted as outliers.
Significance codes: ***(p<.01), **(p<.05), *(p<.1) indicate different mean WTP across products.

Table 5: Average Long-Term WTP for LNS and Likuni Phala at Baseline by Treatment Group and Respondent

Product		N	Mean	Std Error
LNS	Overall	xxx	x.xx	x.xx
	LNS			
	Non-LNS			
	iLiNS Woman			
	Head of Household			
Likuni Phala	Overall			
	LNS			
	Non-LNS			
	iLiNS Woman			
	Head of Household			
LNS - LP	Overall			
	LNS			
	Non-LNS			
	iLiNS Woman			
	Head of Household			

†In 4th Quarter 2011 US Dollars.
For treatment groups: significant codes ***(p<.01), **(p<.05), *(p<.1) indicate mean WTP for LNS group different than delayed intervention group for same product.
For respondents: significant codes ***(p<.01), **(p<.05), *(p<.1) indicate mean WTP for iLiNS women different than head of households for same product.

Table 6: Regression Results - Baseline WTP for a Week's Supply

		Coefficient (Robust Standard Error)		
	Variable	LNS	LP	Difference
Respondent	Head of Household (0/1)	x.xxx (x.xxx)	x.xxx (x.xxx)	x.xxx (x.xxx)
	Age (yrs)			
	Education (yrs)			
Household	Children U5			
	Percent Children U5			
	HFIA Score			
	Asset Index			
	Per Capita Total Expenditures (USD)			
	Percent Food Expenditures			

	Discount Rate			
	Risk Behavior			
Child	First Child (0/1)			
	LNS (0/1)			
	Male (0/1)			
	Height-for-Age			
Mother	Age (yrs)			
	Education (yrs)			
	Height (meters)			
	BMI			
	Constant			
	N	xxx	xxx	xxx
	R^2	x.xxx	x.xxx	x.xxx

Significance codes: ***(p<.01), **(p<.05), *(p<.1)

Note: Controls for month and year of enumeration, enumerator, and language of enumeration were also included in the model (unreported).

Table 7: Regression Results - Long-Term Baseline WTP

		Coefficient (Robust Standard Error)		
	Variable	LNS	LP	Difference
Respondent	Head of Household (0/1)	x.xxx (x.xxx)	x.xxx (x.xxx)	x.xxx (x.xxx)
	Age (yrs)			
	Education (yrs)			
Household	Children U5			
	Percent Children U5			
	HFIA Score			
	Asset Index			
	Per Capita Total Expenditures (USD)			

	Percent Food Expenditures
	Discount Rate
	Risk Behavior
Child	First Child (0/1)
	LNS (0/1)
	Male (0/1)
	Height-for-Age
Mother	Age (yrs)
	Education (yrs)
	Height (meters)
	BMI
	Constant

N	xxx	xxx	xxx
R^2	x.xxx	x.xxx	x.xxx

Significance codes: ***(p<.01), **(p<.05), *(p<.1)

Note: Controls for month and year of enumeration, enumerator, and language of enumeration were also included in the model (unreported).