Hypothetical Willingness-to-Pay for Lipid-based Nutrient Supplements During Pregnancy (LNS-P&L)

Statistical Analysis Plan

Table of Contents

1. Introduction and Context

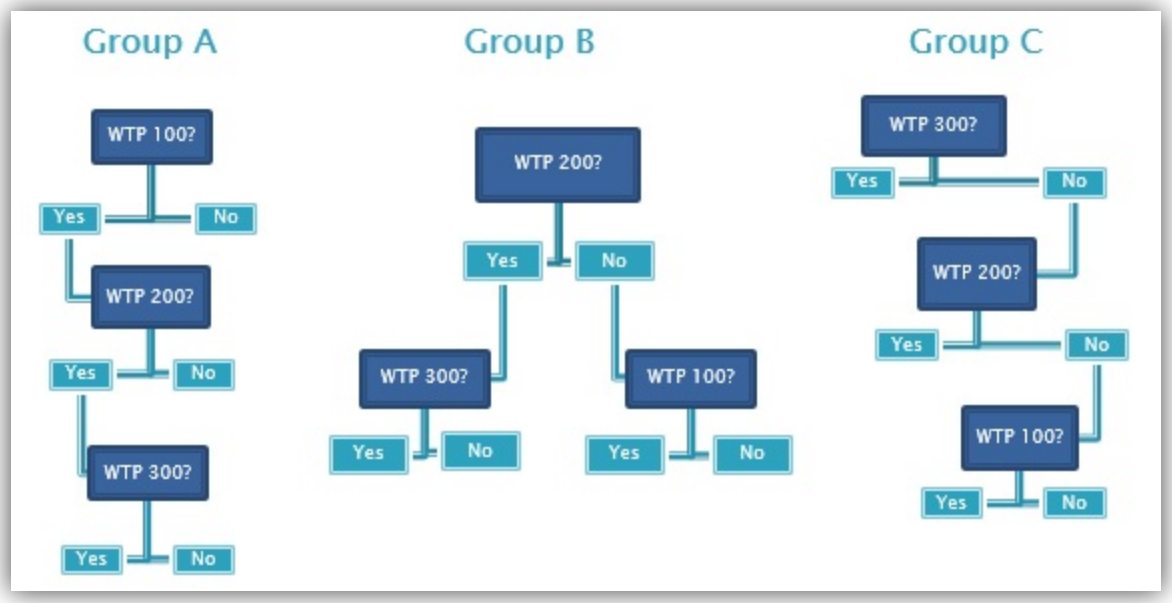
The proposed paper studies individual hypothetical willingness-to-pay (WTP) for lipid-based nutritient supplements for pregnant and lactating women (LNS-P&L) as distributed by the iLiNS study in Malawi. These supplements are designed for the prevention of malnutrition in pregnant mothers and their babies, and thus far have been provided for free to randomly selected

pregnant and lactating women participating in the project.[1] The viability of a self-sustaining, non-experimental distribution of LNS, however, depends on the WTP for LNS in the target population. Specifically, the introduction of LNS into the market, where it can reach more people and be available well beyond an experimental timeframe, is contingent not only on identifying its potential health and nutritional benefits, but also on gauging the demand curve for LNS. Measuring individual hypothetical WTP and identifying its determinants is the first step in this direction.

We use the term "hypothetical", however, because the WTP measurement used in this analysis is based on individual statements only, as opposed to one elicited through an experiment or observed in a real market. Specifically, interviewees are first encouraged to think about their WTP through a contingent valuation tree, through which they are asked about their WTP for LNS at three different price points, as depicted in Figure 1. With this frame of reference, they are then asked the maximum price they would be willing to pay for a week's worth of LNS-P&L; this is recorded as their hypothetical WTP. Because respondents may have different timeframes when giving this value – some considering the purchase of only one week's worth of LNS while others considering the price they would be willing to pay for various months, for instance, – follow-up questions ask for the maximum they would be willing to pay every week for the duration of the pregnancy. This measurement is the long-term hypothetical WTP. In our analysis, we will use both measurements.

Figure 1. Contingent Valuation Tree for Eliciting Hypothetical WTP

[1] Within this study, the treatment arm receiving LNS is given both LNS-P&L during pregnancy and lactation and child LNS once the focal child is six months of age. The current paper focuses on LNS-P&L; child LNS will be studied in future work.



To benchmark the hypothetical WTP measurements, respondents are also asked about their WTP for 147 grams of *bonya*, a small dried local fish.[2] This information is elicited through the same contingent valuation tree, and is also collected for both short and long timeframes.

2. Objective of Analysis

The objective of this particular analysis is to estimate the distribution of individual willingness-to-pay for LNS-P&L and determine whether it is affected by exposure to LNS. In addition, it aims to identify other individual and household characteristics that may also influence WTP.

3. Description of Variables

The planned analysis for this paper focuses on WTP for LNS-P&L during pregnancy only and will use data collected at baseline. The principal pre-requisite for participating in this iLiNS study was to be pregnant during the enrollment period and live within the catchment area encompassing Mangochi, Malindi, Lungwena, and Namwera. In enrolling, participants were each assigned into one of three study arms: a group receiving LNS-P&L during pregnancy and

[2] A reasonable and comparable daily serving of *bonya* is estimated to be around 21 grams (market price about U$0.25).

lactation and child LNS at 6-18 months; a second receiving micronutrient tablets only during pregnancy and lactation; and a control group.

The data to be used in this paper was collected around five weeks after enrollment, and collectively belongs to what we refer to as baseline or "round one" data. There may be some variation in the exact number of weeks elapsed between enrollment and subsequent interviews, however, with some baseline data collected as much as nine weeks after enrollment. The following subsections list the variables of interest, all from baseline.

3.1 Dependent Variables

The dependent variables in our analysis are the WTP measurements, converted into 4th quarter 2011 US dollars for ease of analysis and comparability with other studies. For the same reasons, while the questionnaire asks for WTP for a week's supply of the product, we divide the stated responses by seven to get individual WTP for a day's worth of LNS or *bonya*. Specifically, the dependent variables are the natural logarithms of:

- Hypothetical WTP for LNS: stated maximum price willing to pay for LNS
- Hypothetical WTP for *bonya* : stated maximum price willing to pay for *bony*a
- Long-term hypothetical WTP for LNS: stated maximum price willing to pay for LNS for the duration of the pregnancy
- Long-term hypothetical WTP for *bonya*: stated maximum price willing to pay for *bonya* for the duration of the pregnancy.

The logarithmic form of the variables above are used because of the skewness of the distribution, a standard adjustment made when studying prices. Additionally, we also consider:

- Difference in hypothetical WTP for LNS and *bonya*
- Difference in long-term hypothetical WTP for LNS and *bonya.*

3.2 Explanatory and Control Variables

We propose the following reduced-form model for estimating the determinants of WTP:

$$WTP_i = \beta_0 + \beta_1 iLiNS\ treatment_i + \beta_2 iLiNS\ mother\ characteristics_i + \beta_3 (iLiNS\ mother\ characteristics)_i * (i\ not\ iLiNS\ mother)_i + \beta_4 i\ is\ not\ iLiNS\ mother_i + \beta_5 household\ characteristics_i + \beta_6 X_i + \epsilon_i \quad ,$$

where WTP_i is each one of the six dependent variables listed in the previous subsection. Explanatory variables are indicators of the treatment arm, characteristics of the iLiNS mother, and household characteristics. Control variables are included in X_i.

iLiNS treatment

- Study arm: participants are assigned into one of three study arms, only one of which receives LNS-P&L. In this paper, we are interested in measuring whether even a short exposure to LNS-P&L affects individual WTP for LNS.

iLiNS mother characteristics

- Gestational weeks at enrollment: number of weeks of pregnancy at the time the mother enrolled in the iLiNS study
- Mother's age: age in years
- Mother's education: number of years of education
- Mother's BMI: calculated using the mother's height and weight at enrollment, and adjusted for weeks of gestation; may be normalized for the sample
- Mother's HIV status: HIV status as recorded at enrollment
- Baby is mother's first child: whether, at enrollment, the mother has other children or not
- Mother's tribe: the tribe of the iLiNS mother
- Risk aversion: final bet amount in the risk aversion experiment
- Discount rate: amount of rice added in the final round of the discount rate experiment

Note that the last two measurements are technically from experiments applied to the iLiNS mother or the father of the iLiNS baby and to the iLiNS mother or the male head of household, respectively, but over 97% of respondents to the risk aversion questions are iLiNS mothers. This share is closer to 90% for the discount rate questionnaire.

i not iLiNS mother

In about 10% of observations, the respondent for the WTP questionnaire at baseline was the household head rather than the pregnant women enrolled in the iLiNS study, and data collection limitations prevent us from identifying individual characteristics for respondents who are not the iLiNS mother. Given this restriction, we allow for possible systematic differences in WTP for household heads relative to iLiNS mothers, both with respect to its level (β_4) and to how the iLiNS mother's characteristics affect WTP (β_3).

household characteristics

- Household size: number of people that are part of the iLiNS mother's household at baseline
- Number of children under 5: number of children below the age of five who are part of the iLiNS mother's household at baseline
- Household Asset Index: principal components score based on baseline ownership of a set of assets and household quality. A higher score is associated with better living conditions.

- Household Food Insecurity Access (HFIA) Score: indicator of the household's food insecurity, generated by adding the value of responses to nine questions regarding food insecurity. The higher the score, the higher degree of food insecurity in the last four weeks.
- Household per capita expenditures: total daily per capita expenditures by the household, calculated as a sum of all food and non-food expenditures and converted into 4^{th} quarter 2011 US dollars
- Share of food expenditures: the portion of total expenditures that were used for the purchase of food, calculated as the ratio of food expenditures to total expenditures for the household

Control Variables in X

- Month: month in which the baseline WTP questionnaire was administered, as there may be systematic variation across seasons
- Year: year in which the baseline WTP questionnaire was administered
- Enumerator: code of the enumerator who administered the baseline WTP questionnaire
- Contingent valuation group: a set of dummy variables indicating to which group the respondent to the WTP questionnaire was assigned and, consequently, the order in which the framing questions were posed, as detailed in Figure 1
- Weeks from enrollment to enumeration: the number of weeks elapsed between when the woman enrolled in the study and when the baseline WTP questionnaire was applied.

4. Statistical Methods

4.1 Data Cleaning

Cleaning of the SES variables, including the WTP data, will follow standard protocol and on-going practice, with Maira Reimao identifying issues, verifying discrepancies, and submitting corrections and/or verification requests through Form 99 (copying Steve Vosti and Per Ashorn). These are then processed by the data management team in Malawi or verified by Robert Mataya if further investigation is required.

Non-SES variables will be received from the nutrition team in Finland. They will be verified for cleanliness, but no changes will be made without authorization from the nutrition team.

4.2 Software

All of the analysis will be done using Stata 13 (student edition), and the final draft will be prepared using Latex.

4.3 Analysis

The statistical analysis in the proposed paper will be based on various regressions, using the reduced-form model described in the previous section of this document. Results will be presented in a series of tables. The interpretation of results related to non-SES indicators will be done in collaboration with the scientific teams responsible for those data.

4.3.1 Descriptive Statistics

Summary statistics for the explanatory variables will be shown on Table 1. The next two tables will focus on the short-term WTP for LNS, first giving summary statistics for the entire sample (Table 2) and then divided by each of the study arms (Table 3). Similarly, Table 4 will display the summary statistics for the entire sample while Table 5 will distinguish between study arms.

4.3.2 Regression Results

The regressions for the proposed paper will use ordinary least squares (OLS) with robust standard errors, following the model described in sub-section 2.2. In total, six regressions will be run, each with one of the variables described in sub-section 2.1 as the dependent variable. Table 6 will present the results for the initially stated hypothetical WTP and Table 7 will detail the results for long-term WTP. While the control variables will be included in the regressions used to generate the two tables, their respective estimates will not be reported as they are not of interest for the study at hand.

5. Tables

Table 1: Summary Statistics for Explanatory Variables
Baseline Mother and Household Characteristics, Full Sample

	Variable	Mean/Count	Std Dev/ Percent	Min	Max
Mother characteristics	**Gestational weeks**				
	Age				
	Education				
	BMI				
	HIV status				
	Baby is first child				
	Tribe				
	Risk aversion				
	Discount rate				
Household characteristics	**Household size**				
	# of children under 5				
	Asset index				
	HFIA score				
	Per capita expenditures				
	Share of food expenditures				

Table 2. Summary Statistics on Short-Term WTP, Full Sample
Baseline Short-Term WTP

Variable	N	Mean/Count	Std Dev/ Percent	Min	Max

WTP for LNS
WTP for *bonya*
Difference between WTP for LNS and *bonya*

Values pertain to WTP for a day's serving, converted into 4th quarter 2011 US dollars.

Table 3. Summary Statistics on Short-Term WTP, by Treatment Arm
Baseline Short-Term WTP

		Treatment Arm		
	Full Sample	**Receiving LNS-P&L**	**Receiving Micronutrient Tablets**	**Control**
WTP for LNS (all)	Mean (std dev)	Mean (std dev)	Mean (std dev)	Mean (std dev)
WTP for LNS (non-zero)				
WTP for *bonya* (all)				
WTP for *bonya* (non-zero)				
Difference in WTP for LNS and *bonya* (all)				

Values pertain to WTP for a day's serving, converted into 4th quarter 2011 US dollars.

Standard deviations are given in parenthesis.

In the last two columns, the following markers *** ($p<0.01$), **($p<0.05$), and *($p<0.10$) indicate a difference in means between the group receiving LNS-P&L and the group in the respective column, significant at the given level.

Table 4. Summary Statistics on Long-Term WTP, Full Sample
Baseline Short-Term WTP

Variable	**N**	**Mean/Count**	**Std Dev/ Percent**	**Min**	**Max**

WTP for LNS
WTP for *bonya*
Difference between WTP for LNS and *bonya*

Values pertain to WTP for a day's serving, converted into 4th quarter 2011 US dollars.

Table 5. Summary Statistics on Long-Term WTP, by Treatment Arm
Baseline Short-Term WTP

		Treatment Arm		
	Full Sample	**Receiving LNS-P&L**	**Receiving Micronutrient Tablets**	**Control**
WTP for LNS (all)	Mean (std dev)	Mean (std dev)	Mean (std dev)	Mean (std dev)
WTP for LNS (non-zero)				
WTP for *bonya* (all)				
WTP for *bonya* (non-zero)				
Difference in WTP for LNS and *bonya* (all)				

Values pertain to WTP for a day's serving, converted into 4th quarter 2011 US dollars.

Standard deviations are given in parenthesis.

In the last two columns, the following markers *** ($p<0.01$), **($p<0.05$), and *($p<0.10$) indicate a difference in means between the group receiving LNS-P&L and the group in the respective column, significant at the given level.

Table 6. Regression Results for Hypothetical WTP for a Day's Supply
Baseline Short-Term WTP

	Dependent Variable

		WTP for LNS (ln)	WTP for *bonya* (ln)	Difference in WTP for LNS and *bonya*†
	Receiving LNS-P&L			
	Receiving micronutrient tablet			
Mother characteristics	**Gestational weeks**	Coefficient (std error)	Coefficient (std error)	Coefficient (std error)
	Age			
	Education			
	BMI			
	HIV status			
	Baby is first child			
	Tribe			
	Risk aversion			
	Discount rate			
Respondent is not iLiNS mother				
Respondent is not iLiNS mother interacted with mother characteristics	**Gestational weeks**			
	Age			
	Education			
	BMI			
	HIV status			
	Baby is first child			
	Tribe			
	Risk aversion			
	Discount rate			
Household characteristics	**Household size**			
	# of children under 5			
	Asset index			
	HFIA score			
	Per capita expenditures			
	Sample size	N	N	N
	R-Squared			

Statistical significance: *** (p<0.01), **(p<0.05), and *(p<0.10)

† For each respondent, the difference between their short-term WTP for LNS and their short-term WTP for *bonya*

The regressions above also included controls for month and year of enumeration, enumerator, contingent valuation group, and time between enrollment and enumeration (estimates not reported).

Table 7. Regression Results for Baseline Hypothetical WTP for a Day's Supply
Baseline Long-Term WTP

	Dependent Variable

		WTP for LNS (ln)	WTP for *bonya* (ln)	Difference in WTP for LNS and *bonya*†
	Receiving LNS-P&L			
	Receiving micronutrient tablet			
Mother characteristics	**Gestational weeks**	Coefficient (std error)	Coefficient (std error)	Coefficient (std error)
	Age			
	Education			
	BMI			
	HIV status			
	Baby is first child			
	Tribe			
	Risk aversion			
	Discount rate			
Respondent is not iLiNS mother				
Respondent is not iLiNS mother interacted with mother characteristics	**Gestational weeks**			
	Age			
	Education			
	BMI			
	HIV status			
	Baby is first child			
	Tribe			
	Risk aversion			
	Discount rate			
Household characteristics	**Household size**			
	# of children under 5			
	Asset index			
	HFIA score			
	Per capita expenditures			
	Sample size	N	N	N
	R-Squared			

Statistical significance: *** (p<0.01), **(p<0.05), and *(p<0.10)

† For each respondent, the difference between their long-term WTP for LNS and their long-term WTP for *bonya*

The regressions above also included controls for month and year of enumeration, enumerator, contingent valuation group, and time between enrollment and enumeration (estimates not reported).