Agriculture and Nutrition Linkages: Agriculture, Diet Quality, Climate Change and Child Growth

Looking Beyond a Decade of Accomplishments in Nutrition
NIL Legacy Event | September 16th, 2021

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Insights into the seasonality of diets and food systems from the PoSHAN Community Studies in Nepal

Andrew Thorne-Lyman
Associate Scientist Johns Hopkins University

Photo credit: PoSHAN Study Team
Figure 1.1. Seasonality of acute malnutrition in Bangladesh (for children 0-59 months)

Source: based on data published by Helen Keller International, 1999

Seasonality of Consumption of Nonstaple Nutritious Foods among Young Children from Nepal’s 3 Agroecological Zones

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Abstract

Background: Children’s dietary patterns vary by season, particularly in subsistence agriculture settings like Nepal. The assembly of nutritious nonstaple food consumption is a well-known ecological phenomenon. This study aimed to examine seasonal differences in children’s consumption of fruits, vegetables, dairy, eggs, and nuts, and how these vary between Nepal’s three agroecological zones.

Aim: To analyze monthly seasonal data for the 2016-2017 period to identify and examine seasonal differences in children’s consumption of fruits, vegetables, dairy, eggs, and nuts.

Methods: Children’s dietary patterns were evaluated using a household food frequency questionnaire. Food enrollment was conducted between May 2016 and April 2017 among 206 households in three agroecological zones: high, middle, and low.

Results: Children’s dietary patterns varied significantly by season and by agroecological zone. Children in the high and middle zones consumed more vegetables, fruit, and dairy products than those in the low zone. Children in the high zone consumed more vegetables, fruit, and dairy products than those in the middle and low zones. Children in the low zone consumed more dairy products than those in the high and middle zones.

Conclusions: Children’s dietary patterns vary by season and by agroecological zone. Changes in the availability and consumption of foods may help explain seasonal variability in children’s dietary patterns.

Keywords: Children’s dietary patterns, seasonality, agroecological zones, Nepal.
THE IMPORTANCE OF NON-STAPLE FOODS

- Poor diet quality is linked to impaired child growth and development.
- Child diets consist primarily of staple grains and increasingly highly processed foods.
- Increasing household access to nutrient dense foods could help improve growth and development.
HIGH QUALITY FOODS ARE OFTEN SEASONAL
THE POSHAN STUDY IN NEPAL

Crops, Gardens and Markets lead to

... Household Food Security & Wealth

... Dietary Intake, Quality of Life & Services

... Nutritional Status of Women & Children

Inform Policies and Programs
PoSHAN Study

- National Surveys from 2013-2016 in 21 VDC’s
- 7 per agro-ecological zone
- N~5000 households per year
  - 3 sentinel sites (1 per zone)

SENTINEL SITE SEASONAL SURVEYS

Monsoon 1
June '13 → July '13 → Aug '13 → Sept '13 → Oct '13 → Nov '13 → Dec '13 → Jan '14 → Feb '14 → March '14 → April '14 → May '14

Postmonsoon Harvest 1

Winter Lean 1

Monsoon 2
June '14 → July '14 → Aug '14 → Sept '14 → Oct '14 → Nov '14 → Dec '14 → Jan '15 → Feb '15 → March '15 → April '15 → May '15

Postmonsoon Harvest 2

Winter Lean 2
Background

• Seasonal patterns in child diets are not well understood
• Systematic review identified only 1 paper on seasonality of child diets in South Asia (Madan, 2018)

Research questions

• What seasonal patterns exist in child consumption of non-staple nutritious foods in different regions of Nepal?
• Does household wealth buffer seasonality of child consumption of nutritious foods?
Non-Staple Foods: Pro-vitamin A-Rich Fruits & Vegetables

Mango

Pumpkin

Papaya

Leafy Greens

Non-Staple Foods: Animal Source Foods

Dairy

Eggs

Meat


*Photo credit: Elena Broaddus*
1. CONSUMPTION OF ALL FOOD GROUPS IS LOW

- Average consumption of all foods less than once/day (except for dairy in the hills)

- ~Consumed once per day
2. VARIABILITY IN SEASONAL PATTERNS BY REGION

- Seasonal variation in fruit and vegetable consumption frequency in the mountains and Terai.
2. Variability in Seasonal Patterns by Region

- **Fruits & Vegetables**
- **Eggs**
- **Dairy**
- **Meat & Fish**
Wealth disparities are greater in the winter than other times of the year.

Wealth does help buffer against seasonal decreases in consumption, but does not prevent them entirely.
Implications

→ Interventions to ensure adequate intake of quality foods around the year and/or micronutrients for children are needed.
→ Need a better understanding of what drives different seasonal pattern of household access to non-staple nutritious foods
Background

- Increasing evidence that ASF are important for child growth and development
- Many donor investments in small-scale poultry and animal production

How strong is the association between livestock and poultry ownership and consumption of different ASF by children (6-72 months)?
• Three relationships were explored:
  o Cow/buffalo ownership ➔ Child dairy consumption
  o Chicken ownership ➔ Child egg consumption
  o Meat animals ➔ Child meat consumption

• Estimated direct effects of livestock ownership on consumption (independent of food purchases)
ANALYSIS 2: LIVESTOCK & ASF CONSUMPTION
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Take-aways and implications

1. Findings provide empirical support for programs promoting small scale animal production.
2. Increasing meat consumption may require a strong income-generation emphasis to enable households to increase expenditure.
Background

• Child minimum dietary diversity is an important indicator of child dietary quality in many countries and projects

• Surveys are not always conducted in the same season over time and can take 3 months+ to complete

Research questions

• Could seasonality lead to incorrect conclusions about longer term (~5 year) time trends in MDD if surveys are collected in different seasons?

(National continuous DHS data from Peru, Senegal and PoSHAN Nepal)
SEASONAL DIFFERENCES WERE PRESENT BUT SMALLER THAN EXPECTED ~2-4%

- Compared with 5 year changes of 4.2% and 4.4% for Peru and Senegal, if surveys are done in different seasons, incorrect conclusions could be reached! Even more so for rural areas…
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THANK YOU!
Understanding the role of isolation in nutritional risk: past, present, and future
Rewind the tape to 2010

- DHS paradox: rich data set, but 50%+ of variation in $z$-scores is hidden/missing. Is it just noise?

- DHS data lacking in agricultural and environmental details. Can we combine data?

- A tricky data matching problem presenting both conceptual and empirical challenges.

- Proof-of-concept in a series of early papers adding NDVI, yields, rainfall, temperature, etc. to DHS.
Research story circa 2015

- By merging data, portions of “hidden” variation in z-scores “discovered” in features of communities, landscapes, and local environments.

- Isolation matters to U5 growth in Nepal and Uganda
  - Environmental risks mitigated by infrastructure
  - Agricultural prices buffered by roads and bridges
  - Access to markets and services is key

Circa 2018-19: a puzzle emerges

- Even after controlling for a broad set of child, household, community, and environmental factors, child growth seems to be strongly and negatively associated with altitude in Nepal.

- Is isolation alone driving this pattern?
  - wealth and access to markets mitigate

- Is this pattern unique to Nepal?

- What might “altitude” be telling us?

2021: New results, bigger picture, new avenues

- Findings for 47 countries and 600,000+ U5s
- Pernicious effect of elevation: is it just isolation?
- Three hypotheses: hypoxia, health/disease, soils
- Soil hypothesis especially intriguing
  - iron/zinc/selenium/iodine deficiencies in upland soils could translate into deficiencies in locally-sourced diets
  - markets may be “importing” elements from lowlands, and those who can afford to purchase staples may benefit
- New research avenue? testing/tagging/tracing

Related NIL open-access USAID-supported publications

Climate shocks and child growth: What have we learned about when and how to intervene?

William A. Masters, Tufts University
https://sites.tufts.edu/willmasters
Climate shocks are big recurrent threats to child growth, especially in remote rural areas with poor sanitation

Climate affects all aspects of family life and child growth: livelihoods, markets, disease

- To guide intervention, we need data on child growth over wide variation in time and space
- Early NIL studies used existing DHS surveys to identify protective effects of intervention
- We found that child height is linked to climate in pregnancy for boys, and early infancy for girls, but only at survey sites with less use of food markets and less household sanitation

**Weekly variation in vegetation across Nepal, Jan-Dec 2010**


Data shown are NDVI from [http://www.star.nesdis.noaa.gov/smcd/emb/vci](http://www.star.nesdis.noaa.gov/smcd/emb/vci).

A household’s own farm production has only limited potential to overcome agroclimatic constraints

The first two rounds of PoSHAN data revealed how a household’s own production diversity has limited links to child dietary diversity

• only in poorer households (who cannot buy from markets)

• only for older children (who eat the family diet, not special foods)

• particularly for F&V, dairy and eggs (which were less easily purchased)


With four rounds of PoSHAN data, we could test for the degree to which households recover after a negative shock:

- We found statistically significant recovery in 7-day dietary recall data, but not in the noisier 24-hr recall or body weight.
- We found suggestive evidence of more recovery in places with more market activity, but small sample size limits statistical power to measure differences in degree of recovery.

Nutritional resilience varies by type of outcome: Not all variables bounce back after decline

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Reversion after decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women’s weekly DDS</td>
<td>-0.36*** Resilience</td>
</tr>
<tr>
<td>Children’s weekly DDS</td>
<td>-0.54*** Resilience</td>
</tr>
<tr>
<td>Women’s daily DDS</td>
<td>-0.03 Random walk</td>
</tr>
<tr>
<td>Children’s daily DDS</td>
<td>-0.03 Random walk</td>
</tr>
<tr>
<td>Women’s BMI</td>
<td>0.40*** Momentum</td>
</tr>
<tr>
<td>Children’s WHZ</td>
<td>0.19*** Momentum</td>
</tr>
</tbody>
</table>

Degree of resilience as measured by recovery after decline from year to year in Nepal, 2013-16

OLS regressions, corrected for bias. *p<0.1, ** p<0.05, ***p<0.01.
Nepal: n=3,752 (women) & 2,203 (children)

Market prices for nutrient-rich foods fluctuate greatly

New food composition data for Malawi, together with market price data reveals fluctuating cost of meeting nutrient requirements

Interventions to lower and stabilize prices differ by food group

The timing and magnitude of seasonal fluctuations varies by food group:
- Animal-source and packaged foods have little or no seasonality in price.
- Cereals and legumes have synchronized price peaks in December-March.
- Fruits and vegetables have diverse price peaks throughout the year.

=> Interventions should target production and distribution of each food group.

It is particularly difficult to meet all nutrient requirements when household meals are shared by members with diverse needs

- Fluctuations in price and availability of each food imply need for frequent substitution between items to meet each person’s nutrient requirements
- People of diverse age and sex have different needs, and meeting them all with a single shared meal is particularly expensive

=> Interventions should target needs of each population group

For agriculture and food systems, the biggest challenge remains for early childhood in lower-income households

- As we acquire and analyze more data, we find more opportunities to prevent malnutrition by intervening earlier in life, in more targeted ways.

- Many interventions are needed, but for agriculture and food systems much improvement is needed for infant and child diets!

=> New work focuses on key foods needed at each place and time.

Conclusions:
What have we learned about when and how to intervene?

- Climate shocks are multidimensional and complex, with interacting roles of temperature, precipitation, wind and evaporation over time and space
  -- Vegetative growth (NDVI) used in our Nepal study is just one aspect of climate,
    new frontiers include role of heat waves and thermal stress indexes
  -- Studying how climate shocks relate to outcomes reveals mechanisms and
    informs interventions to protect against shocks and help at normal times too

- Lessons to guide interventions are context-dependent, but:
  -- Access to long-distance trade is key to stability and diversity of diets, complementing
    local farm production at each place
  -- Sanitation and health services are key to maternal and child development, building
    resilience to cycles of poor diets and high disease burdens
  -- Newer data and analysis permits targeting of interventions earlier in life
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• POSHAN community studies – Nepal:
  • Led by Johns Hopkins University with in-country partners; National Agriculture Research Council (NARC), Nepal Technical Assistance Group (NTAG), New Era, Tribhuvan University Institute of Medicine (TUTH IOM), and Tufts University

• Food composition and diet costs -- Malawi:
  • Collaboration between the Feed the Future Innovation Lab for Nutrition, the Lilongwe University of Agriculture & Natural Resources (LUANAR) and the South African Medical Research Council (SAMRC) for Malawi’s first food composition table

• “First foods” study of child diet diversity – Worldwide:
  • Collaboration between the Feed the Future Innovation Lab for Nutrition with the Feed the Future Policy Impact Study Consortium (TA-CA-15-008), and the International Food Policy Research Institute (IFPRI)
Women’s diet quality: Measurement, role of food systems and implications for child health outcomes

Isabel Madzorera, ScD
Department of Global Health, Harvard School of Public Health
MATERNAL DIET QUALITY – STATUS 6 YEARS AGO

• Women & children have poor diets (LMICs):
  • monotonous, plant-based, limited animal foods, seasonal fruits and vegetables

• MDDW - Correlated with micronutrient adequacy:
  • Vit A, thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, vit C, calcium, iron, zinc

• Gap: Does not capture global dietary transition and consumption of unhealthy foods in LMICs

Minimum Diet Diversity Index - Women (MDD-W)
sum out of 10 food groups

- Starchy staple foods
- Beans and peas
- Nuts and seeds
- Dairy
- Eggs
- Flesh foods
- Vitamin A-rich dark green leafy vegetables
- Other vitamin A-rich vegetables and Fruits
- Other vegetables
- Other fruits

MDD-W
NO GLOBALLY ACCEPTED MEASURES OF DIET QUALITY FOR WOMEN?

1. Is dietary diversity sufficient as a measure of quality of diets in LMIC? Urban and rural areas in SSA?

2. Definitions, measurement: Varying definitions of diet quality
   1. nutrient adequacy/food variety or food diversity
   2. moderation - saturated fat, sodium, sugar, nutrients associated with excess disease risk
   3. balance - energy-yielding macronutrients

3. Tools not validated in low- and middle-income countries (LMICs)
EXAMPLE 1: MEASUREMENT & IMPLICATIONS FOR CHILD HEALTH

Maternal dietary diversity and dietary quality scores in relation to adverse birth outcomes in Tanzanian women
Isabel Madzorera, Sheila Isanaka, Molin Wang, Gernard I Msamanga, Willy Urassa, Ellen Hertzmark, Christopher Duggan, Wafaie W Fawzi

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Study in Dar es Salaam, Tanzania among 8,428 pregnant women, 12-27 weeks gestation

*Dietary intake:* Repeated 24-hour dietary recalls during pregnancy
Prime diet quality score (PDQS)
21 food groups (score range 0-42)

<table>
<thead>
<tr>
<th>Healthy (14)</th>
<th>Unhealthy (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>dark green leafy vegetables</td>
<td>red meat</td>
</tr>
<tr>
<td>cruciferous vegetables</td>
<td>refined grains and baked goods</td>
</tr>
<tr>
<td>whole citrus fruits</td>
<td>desserts and ice cream</td>
</tr>
<tr>
<td>fish</td>
<td>potatoes</td>
</tr>
<tr>
<td>legumes</td>
<td>processed meats</td>
</tr>
<tr>
<td>low fat dairy</td>
<td>sugar sweetened beverages</td>
</tr>
<tr>
<td>eggs</td>
<td>fried foods away from home</td>
</tr>
<tr>
<td>whole citrus fruits</td>
<td>other fruits</td>
</tr>
<tr>
<td>fish</td>
<td>poultry</td>
</tr>
<tr>
<td>legumes</td>
<td>nuts</td>
</tr>
<tr>
<td>low fat dairy</td>
<td>whole grains</td>
</tr>
<tr>
<td>eggs</td>
<td>liquid vegetable oils</td>
</tr>
</tbody>
</table>

Associations in high income contexts
Cardio-vascular disease
Gestational diabetes, hypertension in pregnancy
FINDINGS

- **Measurement of Diet quality:**
  - **Consumption of unhealthy foods:** ≥4 servings/wk of refined grains, red meats (22%), desserts (13%).
  - **Low consumption of healthy foods:** nuts, whole grains, citrus fruits, and eggs by women.

- **PDQS (diet quality):** inversely associated with preterm, low birth weight and fetal loss.

- **MDD-W (dietary diversity):** inversely associated with small for gestational age (SGA).

- **Implications for child health:**
  - Low maternal dietary diversity and quality may be modifiable risk factors for adverse birth outcomes in Tanzanian mothers.
EXAMPLE 2: ROLE OF FOOD SYSTEMS IN DIET QUALITY

HANU Intervention: homestead production of diverse, nutrient-rich foods - vegetable seed, garden training, behavior change communication, 880 women

Rufiji rural district, Eastern Tanzania, 10 villages from Health and Demographic Surveillance System (HDSS)
DIET QUALITY FINDINGS

BMI for rural women in Rufiji, Tanzania
- Overweight: 24%, obesity: 13%, underweight: 7%

Low median PDQS for women: 19, max 42

- Healthy foods consumed ≤1 serv/week: eggs (97%), poultry (94%), nuts (91%)

Women in salaried employment: 16%, women in non-farm income activities: 29%
FINDINGS

• **Low food crop diversity:** 2 (±2) crops

• **Food crop diversity:** Food crops produced by household
  Positively associated with PDQS, but the association was strengthened by proximity to markets.

• **Distance to markets:**
  Negatively associated with women’s diet quality

• **Women’s employment:**
  Women’s salaried employment positively associated with women’s diet quality
Next Steps

1. We need data on overall diet quality (in addition to diet diversity) in LMICs for all age groups.
   • Track increasing consumption of unhealthy foods – women, children etc

2. Further validation of measures of diet quality e.g. GDQS and other refined tools
   • Associations with disease outcomes

3. Evaluation of complex of pathways from food systems to improved diet quality
   • In rural and urban settings – personal and external food environments, agriculture production

4. Policies and programs to improve diet quality:
   • Consider market access and women’s access to off-farm income in addition to diversifying household crop production.
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