

HONDURAS SOCIAL NETWORK RCT COHORT
Comprehensive Data Set Overview
v3 (June 28, 2024)
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Introduction to the RCT

Our research team impaneled a large, population-based cohort with an initial sample size of 24,860 people in 176 villages located in a remote area in western highlands of Copán, Honduras in 2015, and we followed subjects through 2023, collecting multiple waves of socio-economic, psychological, health, physical, genetic, microbiome, and social-network data.

Our initial, primary objective was to conduct a randomized controlled trial (RCT) of novel social network targeting techniques (utilizing the “friendship paradox”^{1,2,3,4}) in order to explore how social network dynamics affect the uptake, diffusion, and group-level normative reinforcement of key behaviors and attitudes pertaining to maternal and infant health. We deployed and assessed these social network targeting algorithms (in which people were chosen exogenously to receive an educational intervention) in order to maximize social contagion of information and behaviors related to neonatal and maternal health, and also diarrhea and respiratory illness prevention and management.

Study Population

The study region consisted of an area of over 200 square miles of rugged mountainous terrain near the Guatemala border with an estimated total population of 92,000 people. As preparation for this project, we completed geographical mapping of the 238 small towns and villages in the study region (we did not include cities), allowing us to gain a more precise understanding of the study population and field condition (including terrain, rainfall, and distances to health facilities) in order to inform planning and implementation.

We selected 176 villages from these 238 small towns and villages in this area. Factors like population size, accessibility, and safety were considered when selecting the final list of villages. The included 176 villages had an estimated adult population of 32,800, according to local Honduras government census data.

Owing to high adolescent birth rates in this population, all individuals over the age of 12 who lived or worked in the study villages were eligible to enroll at baseline in 2015. Individuals who were cognitively impaired and unable to provide consent at baseline were excluded.

Recruitment

We enrolled participants into the study and conducted a photographic census in the 176 study villages, collecting photographs, location of residence (GPS coordinates), and basic demographics (age, gender, marital status) from all possible residents using Trellis software^{5,6}. Recruitment rates were high. Of the approximately 32,800 eligible individuals in these villages, 93% (N=30,422) agreed to be censused for our study. The total number of respondents surveyed per village ranged between 55 and 620 individuals and the average participating household size was 2.8.

Table 1 : Baseline Census Demographics N=30,422

Mean village size (census)	173 [55 – 627]
Mean household size	2.8 [1 – 13]
Mean age	33 [12 – 94]
Women	54%
Married/Living as married	58%

Table 2 : Baseline Cohort Statistics N=24,812

Mean age	33 [12 – 93]
Women	58%
Married/Living as married	58%
Less than primary education	70%
Catholic religion	51%
Protestant religion	32%
No religion	16%
Indigenous	12%
General health fair/poor (self-reported)	44%
Mental health fair/poor (self-reported)	40%

Study Design

After completing the photographic census (Table 1), we then sociocentrically mapped the complete face-to-face networks of the 24,812 people who agreed to enroll in the RCT in the 176 villages (that is, we attempted to discern all possible social connections among all participant individuals within each village). Included villages were then randomized using a 2x8 factorial design in which (1) the proportion of people targeted per village varied (0, 0.05, 0.1, 0.2, 0.3, 0.5, 0.75, 1), and (2) the algorithm for choosing network targets (or seeds) varied (either random targeting or targeting of random friends of randomly selected people). We assessed how the adoption of the intervention, at both the individual and community levels, varied across the different arms of the trial for all residents of the villages, whether they were given the intervention or not. A CONSORT diagram is at the end of this document, showing enrollment and drop-out at all phases of the initial RCT.

To obtain balance between cells in our randomized design, we first created 11 blocks of 16 villages that minimized the within-block variance in (1) the number of households per village and (2) the average number of subjects within the households. Once the blocks were assigned, we sampled cell assignments without replacement within each block so that each block contained exactly one village in each cell of the 2 x 8 design.

Once villages were assigned to the 2 x 8 treatment arms, in each village, we targeted households for the intervention as follows: For villages in the “random” targeting arm (composed of 8 cells corresponding to the 8 targeting fractions), we sampled without replacement the number of households indicated by the village’s dosage assignment, rounding to the nearest whole number. For example, in a village with 37 households assigned to a dosage of 20%, we randomly chose 7 households for treatment.

For villages in the “friend” nomination arm, as a first stage, we sampled without replacement the number of “seed” households indicated by the village’s dosage assignment, rounding to the nearest whole number. These seed households were not, however, necessarily assigned to treatment. Instead, in a second stage, we randomly chose one person from the household and randomly chose one of that person’s social contacts who did not belong to the same household as the subject. We then assigned that social contact’s household to the intervention. In the event that the first person had no social contacts outside the household (according to three core name generators, shown in Table 3) or the social contact’s household had already been assigned to treatment, we sampled another household without replacement from among those households that have not yet been sampled, and repeated the procedure of choosing a randomly selected subject within the household and randomly choosing one of their social contacts’ households for treatment. This sampling method was repeated until the number of households treated within the village corresponded to the randomly assigned dosage.

The Maternal Neonatal Child Health (MNCH) intervention

Our intervention partner organization in the region was the Inter-American Development Bank (IADB), who contracted with the organization *Vision Mundial* (World Vision International), to deliver the intervention to the study population. IADB worked collaboratively with *Vision Mundial* in designing and implementing a culturally responsive intervention, including input from the Yale research team as appropriate. It is important to emphasize, however that the “treatment,” statistically speaking, in our RCT was the *network targeting algorithm*, not this intervention. We wanted to choose an intervention that had already been demonstrated to have an effect in those to whom it was given.

The MNCH intervention was delivered at the household level using Time and Targeting Counseling⁷, which has been proven to be an effective delivery method in other similar settings. The intervention included several, diverse outcomes involving knowledge, attitudes, and practices related to a range of health-related variables, such as: 1) use of folic acid in women of reproductive age to prevent birth defects; 2) receipt of prenatal care in the first trimester; 3) preparation of a birth plan for seeking timely prenatal care, institutional birth, post-partum care, and help in emergencies; 4) immediate breastfeeding after birth; 5) proper thermal and cord care for newborn infants; 6) exclusive breastfeeding for infants under 6 months; 7) proper

treatment of diarrhea in children (including the use of zinc) and the use of handwashing and other means to prevent diarrheal, respiratory, and other infections; 8) paternal involvement in child care, particularly for newborns; 9) use of modern family planning methods; and 10) delaying pregnancy until 18 years of age. These themes were worked into 15 modules to be delivered over the course of 22 visits.

A total of 117 core measures related to these outcomes were assessed at both baseline (wave 1, in 2016) and follow-up, after the MNCH intervention was delivered in all included villages (wave 3, in 2019).

The objectives chosen for intervention and other features of this trial were guided by stakeholder engagement and formative research with the local community. Furthermore, to work within the constraints of this study, the intervention messaging and delivery methodology had to meet specific requirements including: (1) alignment with priorities of the Ministry of Health (MOH) of Honduras, the Bill and Melinda Gates Foundation, and the needs of the local population; (2) inclusion of new messages for the targeted population to allow for detection of *changes* in knowledge, attitudes and practices; (3) inclusion of tracers or identifiers which could be detected during follow-up surveys; (4) avoidance of mass-media communication techniques, including radio spots, flyers, posters, etc., as these would contaminate the network effects of the study; (5) having a strong monitoring component; and (6) be based on interventions with demonstrated effectiveness in similar settings in order to test the spread of behavior from person to person.

The intervention also had to adapt to the targeting strategy, focusing delivery based on network position as defined by our targeting algorithm, as opposed to a delivery based on a primary audience for the behavior change of interest. For example, the targeting algorithm could hypothetically identify a household with an elderly couple and therefore be selected to receive the intervention. Typically, this household would not be selected for an intervention on prenatal care or neonatal practices, given that there are no women of reproductive age living there. However, since the intervention was designed to deliver specific modules most relevant to the household's life circumstances, the members of this household may be counseled on issues surrounding respiratory disease education, violence prevention counseling, or an intervention about the benefits of young people delaying marriage instead.

Trained study community health workers (CHWs) counseled families (mothers, fathers, grandparents – whoever was in the household) regarding several health topics, depending on current life circumstances, based on the “Timed and Targeted Counseling” methodology complemented with other methods of face-to-face communication including songs, rhymes, and riddles. The social and behavior change communication strategy for the intervention was designed using the “P-Process.” This methodology uses narrative and negotiation in a 1–2 hour visit with families to discuss positive and negative scenarios and create a list of agreements with families to try out new practices. This method provides counseling to all members of selected households whether or not there were young children or a pregnant woman living in the household. Because of this tailored approach, some intervention households may have received different modules at different times and at different frequencies. All of this was done entirely consistently across all sixteen arms of the RCT.

Overall, 83% of target households received at least one counseling visit (across targeting methods and dosages). Out of a maximum of 22 counseling visits, there was a median of 18 completed visits and a mean of 14 completed visits per target household.

To consider a household as intervened-upon (regardless of treatment assignment), we established a minimum completion of 15 visits per household. This means that while 10% of households in a particular village may have been selected to receive the intervention, it may be possible for only 8% of them may have received 15 or more visits.

Timeline of Data Collection Waves

After initiation, RCT census and survey data collection occurred in several different waves, as follows (see Figure 2):

Wave 0: Jun 2015 to Dec 2015

Upon enrollment in the study, participants participated in a photographic census in the 176 study villages, which involved an estimated 93% of all residents ages 12 and older. (N = 30,422)

Wave 1: Oct 2015 to July 2015

Baseline survey completed with 81% censused individuals ages 12 and older. Sociocentric network, health attitudes, and behavioral data were collected. (N = 24,702)

Wave 2: Jan 2018 to Aug 2018

Interim follow-up survey completed in 176 villages with 81% of eligible individuals at Wave 2, 12 months into the behavioral intervention. Health and behavioral data collected. (N = 21,485)
No village-level census was conducted at Wave 2, but updated location and status (whether they moved, died, etc.) for respondents since Wave 1 survey was coded. There was no sociocentric network mapping at Wave 2.

Wave 3: Jan 2019 to Dec 2019

New census completed in 176 villages with approximately 90% of all study village residents ages 15 and older, enrolling anyone who was currently living in the village (including those who may not have completed the Wave 1 census). (N = 28,420)

Final RCT follow-up and baseline surveys completed with 79% of censused population (survey implementation began within 6 weeks of census being completed, 24 months after the initiation of the behavioral intervention and within a few months of its completion).

Sociocentric network, health, and behavior data collected. (N = 22,512)

Wave 4: Aug 2022 to Jul 2023

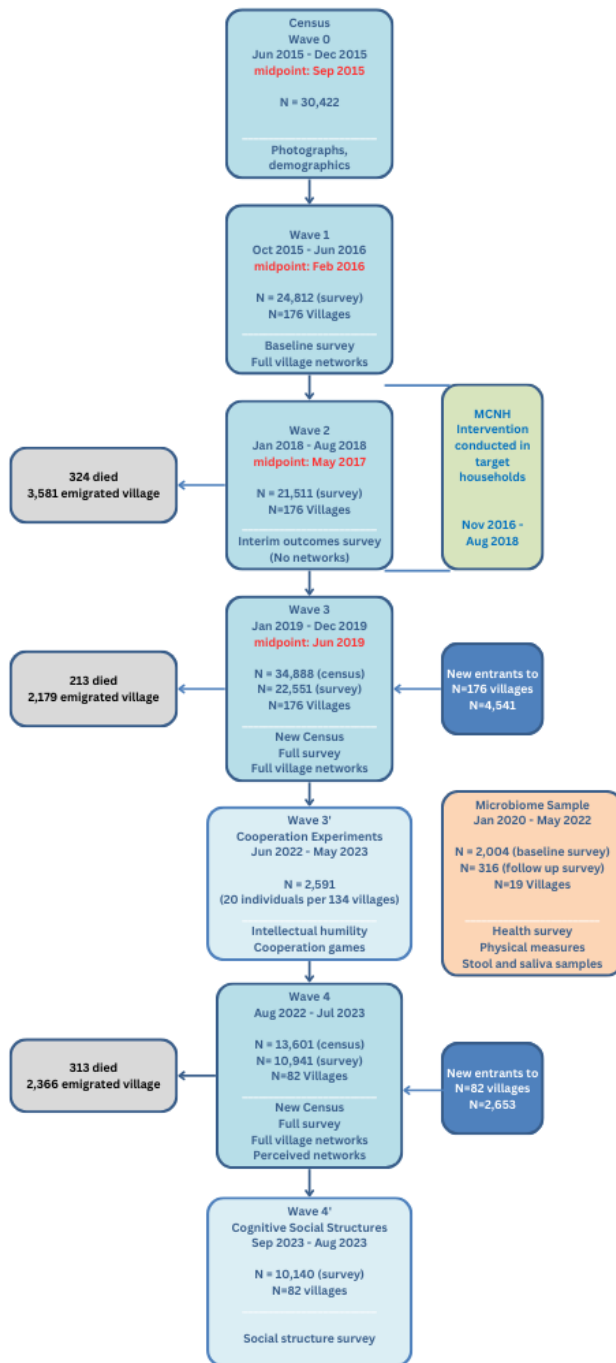
New census completed in 82 villages (chosen from the 176 based on the exclusion procedure described below) with approximately 98% of all study village residents ages 15 and older, enrolling anyone who was currently living the village but had not completed the Wave 1 or Wave 3 census. (N = 13,601) Survey completed with 80% of censused individuals. Sociocentric network, health, and behavior data collected. (N = 10,941)

In addition to serving as a follow up to the RCT, several new domains were included at Wave 4, including a flourishing index, ego network change questions, and a mobility assessment for older participants.

For Wave 4, from the 176 villages, we removed villages in this order to get to 82 villages:

- All 22 villages in the 75% RCT arms
- all villages in the San Jeronimo and Santa Rita municipalities
- all villages with survey response rate of < 70%
- add back any villages from our microbiome project (see below) that may have been removed in the process
- due to safety concerns in two of the villages chosen by the above method, they were replaced with villages of a similar profile with completion rates between 60 and 70%

Figure 1: Waves of data collection



Additional data collection

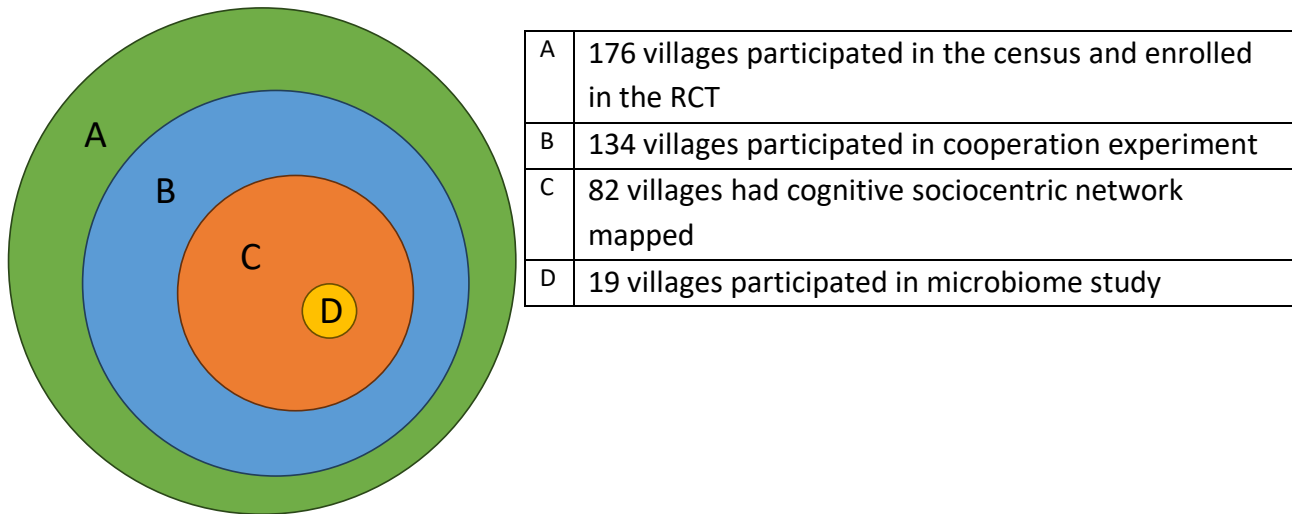
Additional subsets of data were collected as part of new research studies that began after the primary RCT was completed (Wave 3):

- 1) Human Microbiome and Social Networks Study (19 villages),
- 2) Human Cooperation and Intellectual Humility Study (134 villages), and

3) Cognitive Representation of Social Networks studies (82 villages).

A rendering of these different, overlapping projects can be seen below in Figure 2. More information on each of these studies follows below on page 16.

Figure 2: Overlap in Villages Across Component Studies



Additional resources to provide an overview of the study design

- Videos providing a description of the Social Network Targeting RCT can be found:
8-minute version: <https://www.youtube.com/watch?v=Yzy4NzBtq6Q>
20-minute version: <https://www.youtube.com/watch?v=7M1618Crypl&t=3s>
- ClinicaTrials.gov registry :
<https://clinicaltrials.gov/ct2/show/NCT02694679?term=christakis>
- A publication detailing the original study protocol and cohort strategy, which can be found: Shakya HB, Stafford D, Hughes DA, Keegan T, Negron R, Broome J, McKnight M, Nicoll L, Nelson J, Iriarte E, Ordonez M, Airoidi E, Fowler JH, Christakis NA. Exploiting social influence to magnify population-level behaviour change in maternal and child health: study protocol for a randomized controlled trial of network targeting algorithms in rural Honduras. *BMJ Open*. 2017; 7: e012996.

Community-Engagement Efforts

Our first approach to Honduran stakeholders was the national authorities. We established an ongoing collaboration with the Ministry of Health (MOH) of Honduras. After we secured approvals for the conduct of the research, we centered our efforts in our population of study. Following principles of community-engaged research, we worked closely with local communities and stakeholders on the implementation and dissemination processes of the RCT

and subsequent studies. To engage the local population of Copan, we invited regional health leadership, local providers (i.e., nurses, physicians, health promoters), indigenous leaders, and community members to design locally appropriate research processes at all research stages. Beyond seeking insight and feedback for our instrument designs, we actively engaged with the local communities to better understand socio-cultural and environmental dynamics in the context of our study objectives.

We also collaborated with the local authorities and communities in the design of various strategies to improve wellbeing at the village level, through social projects that responded to their priorities and needs, as delineated by them (when possible). Here, we briefly summarize this history of these community engagement efforts and outline some of our principles of equitable research practices and actions in this regard.

Collaboration with Local Partners

When we began designing this cohort project in 2013, the Bill and Melinda Gates Foundation (BMGF) introduced us to IADB, an organization that had previously received funding from BMGF and was currently leading efforts for Salud Mesoamerica Initiative 2020⁸ in Honduras and other countries in the region. IADB in turn introduced us to the Honduras MOH, and we then worked together toward the goal of conducting research that was not only of scientific importance, but also aligned with country-level health priorities as well as potentially implementable within the established health system to improve health of the people of Honduras. After the cohort was established, we obtained additional funding from other sources as well. Given the pathway in which these partnerships came about, we worked primarily with government-funded local and regional health system providers rather than with academic institutions in the country.

Working in partnership with the participating communities was a guiding principle of our Community Engaged Research efforts (CeNR). From the outset, when the original underlying cohort for this study was impaneled (in 2015), we sought extensive local involvement, beginning with a needs assessment where local village residents told us about topics of concern to them in a series of meetings in villages throughout the Copan region as well as focus groups to address some of these topics more in depth. In addition to extensive community input, we sought input from the MOH and the regional health authority, known as MANCOSARIC, which was responsible of coordinating government sponsored health care for all the villages impacted by our studies. We periodically co-designed dissemination research sessions, guided both MANCOSARIC and the MOH about our findings (though we did not reveal the actual RCT results to the community until after completion of the trial).

Research Workforce

Over the years, we have grown our collaboration with our local research workforce composed of Honduras-based research assistants and project management personnel, most of whom are native to the Copan region and who have supported large-scale research operations in different capacities. Staff included site managers, data managers, surveyors, administrators, transportation specialists, nurses (for the Microbiome study), as well as community liaisons to

assist with recruitment efforts. Overall, we estimate we have impacted over 100 local individuals, most of whom have acquired specialized scientific knowledge over the past years.

Led by experienced Yale-based program managers and research coordinators, the Honduras-based team developed and executed protocols that comply with international research standards, Yale University, and the Honduran MOH human subjects' guidelines. Our local collaborators have actively guided and co-created our strategies to design culturally responsive research efforts and expectations on community participation. Our international research collaboration has included diverse levels of cooperation, including co-authorship of peer-reviewed publications, participation in all phases of the study implementation, and participation in joint conferences.

Through the engagement of our Honduran collaborators, we have co-designed training programs in quantitative methods (survey design, software), qualitative methods (focus groups, usability testing, cognitive interviewing), clinical research data collection, and project management. Our preparation sessions have also included professional development opportunities, including use of MS Office programs, workshops to develop effective communication, public speaking, team building, organizational evaluations, and strategies for conflict resolution, among others. Many of the trained data collectors have gone on to work for other public health and development entities.

Our local team had established deep ties to the communities we work in, including village leaders, indigenous organizations, health clinics, and transportation and infrastructure providers. Because of these relationships and our commitment to the villagers in Copan, we presented our results directly to these constituencies regularly. We also held two annual joint implementation and dissemination science conferences with our Honduras and Yale teams (involving approximately 90 people).

Community Impact Beyond Research

We secured funding to conduct community engagement activities and to provided support to the local communities' priorities as a way to show commitment to partnership beyond study participation. First, we conducted an assessment with local health units to better understand their needs. We also engaged with other stakeholders, such as indigenous communities, educators, religious organizations (from all denominations), civic leaders, and village authorities. We prioritized six areas of intervention: Health Center (19 projects); Schools (26 projects); Community Centers and Municipalities (9 projects); Social projects lead by religious charities (14 projects); Indigenous Communities wellbeing; and Infrastructure (6 projects).

Our Social Community Projects were guided by CeNR principles. Of their own initiative, most of the communities actively participated in most efforts. Improvements in health centers included repairs to roofing and bathrooms to benefit patients, new equipment such as stoscopes, scales, and personal protective equipment (PPE) during the height of the COVID-19 pandemic. We painted and repaired 26 schools and sponsored annual children's day celebrations at almost all local schools in the villages in which we worked (ranging from 20-150). Additionally, other

ideas from the local community stakeholder included repairing playgrounds, community centers, and churches, and installation of potable water tanks.

We arranged for an American company (Butterfly) to provide free portable handheld ultrasound devices to the local health clinics through their global health program, which was much appreciated by local providers.

Ethical Commitment to Research Participants

We have designed our research grounded in principles of Community Engaged Research, showing respect for persons, community well-being, and local priorities. In an area of the world in which most of our participants have extremely limited access to health care and social services, we have been guided by active listening and partnership. We have not only safeguarded all data from threats to privacy or security, but have intentionally engaged in honoring the social and environmental landscape of our participants, actively attempting to avoid stigmatization or discrimination. We also believe that by contributing to closing the historical gap in research in non-WEIRD settings, we can contribute to the knowledge and wellbeing of the villages and region we work in.

Data and Variables Available

The RCT survey instrumentation included validated scales used widely to measure items related to MNCH outcomes. We conducted an extensive review of the MNCH literature and consulted global MNCH experts for their advice on the inclusion of suitable items in the survey. We also did extensive formative research, including detailed qualitative evaluation of our instruments, focus groups, and cognitive interviewing to assess our survey's cultural relevance and consider regional idiomatic variations specific to the study area. In addition, we conducted three rounds of pilot data collection (in villages not included in our study) involving network mapping and sociobehavioural interviews to test the network questions and our collection procedures. A separate detailed codebook regarding all variables collected has been created and is used by all team investigators working with the data.

Data collected during the course of the project include:

Census demographics Prior to wave 1 baseline survey administration, a population census was collected for the 176 study villages. Surveyors visited each study village as well as each dwelling to obtain demographic data and to photograph residents. Updates to census data occurred prior to administration of interim and final surveys. Two additional village-wide censuses were conducted prior to wave 3 and wave 4.

Geographic information Each household has geolocation information (and photos of household facades)

Name generators Data were collected via name generator questions to allow identification of family, friendship, and other ties among community members and are used to map social networks within study villages (see Table 3 below for full list). The full set of name generators was collected at wave 1, 3, and 4 and all baseline surveys (for any new entrants to our cohort at any wave). Additional questions were added at wave 3 to assess types of physical contact (see Table 4) with alters (i.e., an “ego's” social contacts) and to give the option of adding more than 5 alters for certain ties. Shortly after wave 4, a subset of people in each village were also systematically surveyed regarding their perceptions of the existence of ties among other residents of their villages (see below).

Table 3: Name Generators

What is the name of your mother?
What is the name of your father?
What are the names of your siblings over the age of 12 that live or work here?
What are the names of your children who don't live with you, but do live in this village over the age of 12?
What is the name of your partner?
Who do you trust to talk to about something personal or private?*
With whom do you spend free time?*
Who would you feel comfortable asking to borrow 200 lempiras from if you needed them for the day?
Who do you think would be comfortable asking you to borrow 200 lempiras for the day?
Who would you ask for advice about health-related matters?
Who comes to you for health advice?
Besides your partner, parents or siblings, who do you consider to be your closest friends?*
What are the names of this town's leaders?
Who are the people in this town with whom you do not get along well?
What is the name of your patrón/patrona?
In this household, who primarily provides for most of your living expenses such as food and clothing?

*Used to define the network for selection of network targeting nodes.

Table 4: Frequency of contact and physical contact

You mentioned XX as a person who you spend free time with. In the last month, how often did you spend time with XX?	<ul style="list-style-type: none"> ● Every day ● A few days a week ● A few days a month ● Rarely/never
In the last month, how often did you eat a meal with XX?	<ul style="list-style-type: none"> ● Almost every day ● About once a week ● A few times a month ● About once a month or less

<p>Whenever you see XX, how do you usually greet each other? I will read a list of possible greetings. You greet each other with...</p>	<ul style="list-style-type: none"> ● A smile ● A gesture such as a bow, nod or wave ● A verbal salute (like saying hello) ● A handshake or hi-five ● A pat on the back ● A hug ● A kiss on the cheek [option for female participants only] ● Other [Specify:]
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Demographics Additional demographic information not asked at time of census. Collected at all waves.

Photographs Photographs of participants, upon enrollment. These have been processed for facial symmetry and other measures which are available in derivative form.

General health Data related to the physical and mental health status of respondents across study waves as well as access to healthcare. Collected at all waves. Additional mental health measures added at wave 4.

Resources Data to assess food insecurity and financial resources. Collected at all waves.

Reproductive health Data related to reproductive health. Collected at all waves.

Birth history / Postpartum care / Child health Gender-specific data related to reproductive health, birth history, and child health. Complete birth history and postpartum data captured for youngest child or any children born since previous survey. Repeated questions (the “child roster”) capture a shorter set of birth history and postpartum data for up to 3 additional children, reported youngest to oldest. Child health questions asked for children reported to be <=5 years of age. Collected for newly reported children at all waves.

Other Children Birth date, sex and status of additional children beyond four reported in roster at baseline. Collected during baseline surveys only.

Gender dynamics Data to identify gender dynamics in respondent’s decisions regarding healthcare and finances. Collected at waves 1, 2, and 3.

Knowledge / Attitudes / Beliefs regarding MNCH Data collected on personal knowledge, attitudes and beliefs regarding study outcomes. Collected at all waves.

Community norms regarding MNCH Data related to perceptions of community response or norms regarding study outcomes. Collected at waves 1 and 3

Counseling Information on subject and source of any health counseling received by respondent. Collected at waves 1, 2, and 3.

Household inventory Information about household composition, dwelling features, inventory and construction materials. Collected at all waves.

Health cards Photographs were collected of folic acid supplements, pregnancy cards for pregnant women, as well as pregnancy cards and vaccination cards for youngest child 5 years old and younger. Collected at waves 1, 2, and 3.

Child health follow-up Child health information for children reported on in previous wave. Collected at waves 2, 3, and 4.

Intervention knowledge Intervention-specific responses to riddles. Collected at waves 1, 2, and 3.

Ego network change Data collected to ask participants who changed the composition of their ego networks to report the reasons for dropping or adding alters since our last visit, including friends and antagonistic ties (measures of disliking within the network). Eight reasons related to social network processes, instrument design, or participant error, were considered as possibilities for such a large network change from one wave to the other. Collected at wave 4

Timed Up and Go (TUG) Mobility assessment administered to adults 50 years and older. Collected at wave 4⁹

Flourishing index A measurement approach to human flourishing¹⁰, centered on five central domains: happiness and life satisfaction, physical and mental health, meaning and purpose, character and virtue, and close social relationships. Collected at Wave 4.

Informed consent Verbal informed consent was collected before initiation of data collection in all research—this was a requirement to RCT participation. Consents were obtained separately for additional collection of birth data from local health centers and use of census photos for other research purposes since these were not requirements for participation in the main studies.

Village-level data In addition to individual-level data, we have also prepared a village-level dataset at wave 1 (and thereafter) describing various observed and derived attributes of the main 176 RCT villages. Several key attributes were re-collected in subsequent waves. The village level data includes:

- Geographic location and coordinates
- Distance from main road
- Driving times to main road, health center and maternal clinic
- Village access during the rainy season and by month

- Infrastructure (observed by surveyors, such as local churches, schools, health center, community centers, athletic facilities, stores, water, electricity, cemetery, etc.)
- Presence of community services (NGOs, committees, associations, boards, councils, etc.)
- Presence of agriculture, livestock or coffee cultivation in the village
- Sanitary conditions (trash removal, open defecations)
- Safety rating and historic homicide rates
- Deforestation around villages (coded from satellite photos)
- Price of goods (basket, kerosene, gasoline, firewood, charcoal, etc.)
- Wealth of village (coded from subject responses)
- Wealth inequality of villages (coded from subject responses)
- Network complexity (e.g., chromatic polynomial, network diameter, etc. coded from subject responses)
- Churches present in each village
- A list of NGO activity in each village
- Public buildings present in each village
- Information on village savings programs and loan rates
- Schools present in each village
- Stores present in each village and prices of goods, where available, for up to three stores

Intervention Delivery The World Vision intervention team used a tablet-based platform (CommCare) to facilitate intervention delivery (designating a module based on household-level questionnaire asked at each visit, for example) as well as to capture general implementation information (i.e. module delivered, who was present, who delivered the counseling, counseling visit dates, community meetings, etc.). They transferred this information to our data team. It has been reviewed, summarized and divided by the HNL team into information at the respondent, household, and village levels.

Intervention Modules and Outcomes A table linking intervention modules and the RCT outcomes was created to facilitate work with the intervention delivery data, giving us insight into which outcome topics the survey respondents were directly presented with during intervention visits.

Additional Related Projects

Data collection for several other projects ran concurrently using subsets of the censused population from the RCT. These projects, and the additional variables and data collection procedures they involved, are outlined below.

Honduras Microbiome and Social Networks Project

N=19 Villages and N=2,011 participants (June 2020 to May 2022)

The Human Microbiome and Social Networks project seeks to explore the role of social interactions in the distribution of the oral and gut microbiome in human populations, and how this relates to health and disease within a community. Our objectives are to address a number of important, open questions about the constitution of the human microbiome, its stability over time, and its underlying role in common diseases like diarrhea, respiratory illnesses, and metabolic disorders. We believe investigation in these areas can help us better understand the epidemiology of common causes of morbidity and mortality in the community and therefore help to generate medical and public health solutions that improve health outcomes at a population level.

Microbiome village selection

The village set was initially reduced from 176 to pool of 60, with selection criteria based on:

1. Safety rating
2. Good access to village (even in rainy season)
3. 90-minute (driving) maximum from headquarters located in Copan Ruinas (to facilitate rapid sample collection)
4. Wave 3 completion rate $\geq 70\%$

We then sampled 100000 sets of villages using the reduced set of 60 villages. The sample criteria used were:

1. 10-15 villages with a total number of individuals of around 2000
2. 3-4 large villages (i.e., >300 respondents)
3. good variation of the wealth index
4. if possible: good variation of elevation, isolation index, and time to main road

We then selected the best 12 samples based on the above criteria. From that reduced set, we chose one sample that had a nice distribution of the village size and good variation of wealth, isolation, time to main road, and elevation. This final sample was composed of 12 villages. We repeated this procedure with the remaining villages to extract a second sample of villages with around 1000 individuals. The second sample was composed of 7 villages, to be used if we had adequate resources (which we eventually did).

Data collection

A total of 2,011 participants were enrolled in 19 villages. They completed a baseline survey which captured key information regarding possible factors that might influence microbiome composition, including dietary habits, family history, medications used, contact with animals, and age. These measures are different from those in the baseline RCT survey. Novel physical measures and stool and saliva samples were also collected. Second stool and saliva samples

were collected from 4 villages (N =316) roughly two years later to provide some data to address longitudinal questions.

Saliva We collected two saliva samples in 2 x 15 mL Falcon tubes with 5 mL 1X RNase/DNase/Protease/Nuclease-free sterile PBS. Participants would rinse their mouth with the solution and deposit this rinse into the tubes. Once saliva samples are collected, they are placed immediately into liquid nitrogen dry shippers. DNA from these samples has since been sequenced, expending most of the samples from the first rinse. The tubes with the second rinse remain frozen in storage.

Gut microbiome data Each subject was asked to donate three stool samples using two 30 mL cryogenic sterile collection tubes with scoops, to be used for microbiome analysis, and one 4 oz sterile container, to be used for parasite and ova testing. The samples were placed into a bubble mailer containing cold packs and then delivered to a central collecting station within the village where the samples were scanned and logged. Once logged, the 4 oz container containing samples intended for parasite and ova testing were delivered to a local laboratory for analysis. The two 30ml tubes intended for microbiome analysis were placed into large liquid nitrogen (LN) dewars (dryshippers). The LN dewars were transported first to the central study office, where they remained stored in an ultra-low freezer in Copan Ruinas and then shipped in dry ice to the United States (Yale University and Cornell University laboratories) for analysis. All shipments were closely monitored and tracked as part of our quality assurance and control protocols.

Microbiome DNA was sequenced for one of the samples by the Yale Center for Genomic Analysis for 1,868 participants from 19 villages, and a second sample was sequenced for 296 of those participants from 4 villages. Parasite presence analysis was done for 1,857 participants in 19 villages. The second sample from each participant remains frozen in storage.

Demographic information Upon enrollment, the following demographic information is verified and updated if needed: name, gender, age, current marital status. Anyone who reports being married/living as married is asked to name their spouse (name generator), so that this information is also updated.

Physical measures

- Height (cm)
- Weight (kg)
- Systolic and diastolic blood pressure. Two readings, 1 minute apart; an average is automatically calculated and recorded (using OMRONN HEM 907XL Intellisense clinical grade BP machines)
- Pulse rate (bpm) (OMRONN HEM 907XL Intellisense clinical grade BP machine)
- Oxygen saturation (Masimo Pronto Pulse Oximeter)
- Hemoglobin (g/dL) (Non-invasive hemoglobin SpHb – Masimo Pronto Pulse Oximeter)
- Hemoglobin A1c (fingerstick – using the A1c Now Professional analyzer)

Ancestry (Family origin) This section intends to record the place of birth and ethnicity of the respondent, and that of all 4 of the respondent's grandparents, in order to analyze it in conjunction with genetic data.

Income (total expenses) The intention of this section is to estimate total household income by capturing total expenditures in one month.

Animal contact/mobility This section records how often a respondent travels outside of the village and how often they may be exposed to people outside their household and with different types of animals. Contact with animals, whether they are domestic, farm, or wild may also have an impact on the human microbiome.

General health, medications, medical conditions We collect information regarding the participant's self-perceived physical and mental health, recent diarrhea or cough, and so on. Questions about COVID-19 diagnosis and testing were also included along with additional diet questions. These questions were not part of data collection for the first wave of the longitudinal sample (pre COVID-19).

Diet We captured dietary frequency of certain food items (adapted from a study in Guatemala using the Food Frequency Questionnaire)¹¹.

Mental health (GAD-7 and PHQ-9) We screened participants for General Anxiety Disorder by implementing the survey instrument called GAD-7¹² and for Generalized Depression by implementing the survey instrument called PHQ-9¹³.

Cognition and memory – 'Fototest' We evaluated cognition (naming, verbal fluidity and recall) by implementing the Fototest, a low-literacy cognitive evaluation tool¹⁴.

"Big Five" inventory The "big five" refers to a set of personality characteristics that have historically proven to be the most robust in psychometric studies. We used an adapted version of the Big Five Inventory with 10 items¹⁵ that had been translated into Spanish and validated by other studies.

Altruism and risk-taking This section measures altruism using a single dictator-game type question. This simple "one shot" game asks participants how much they would donate to a good cause if they unexpectedly received 1000 Lempira, or whether they would keep it all for themselves. Work was done with local communities to ensure that the amount used in this question was appropriate. We also assess risk-taking behavior via a series of 5 questions. The risk game requires participants to decide whether to take a safe payment or to flip a coin to receive a (usually) higher payment. If the participant decides to receive a safe payment, the question is repeated with a lower safe payment. If the participant decides to flip the coin, the question is repeated with a higher safe payment.

Community Health Support

As part of the Microbiome study protocol, we partnered with local governments to amplify opportunities for health care by providing and incentivizing testing and offering or referring for treatment when indicated. We provided results and medications free of charge (standard of care) for all participants who opted to have their parasite test results returned. We also worked in tandem with health clinics and referred participants with elevated blood pressure and blood sugar screenings or moderate to severe mental health symptoms so that they could be connected to care.

Cooperation Experiments and Intellectual Humility Survey

N=134 villages and N=2,591 participants (June 2022 to June 2023)

Two studies were conducted simultaneously: (1) The cooperation study aimed, among other things, to evaluate village-level social capital and social efficacy by conducting cooperation experiments in a representative sample of 134 of our 176 villages, and (2) The intellectual humility study aimed to develop an event-contingent measure of Intellectual Humility (IH) where respondents identify and reflect on three disagreement situations in which they had a different opinion from another person.

Data Collection

Both projects obtained data from 15-20 randomly selected participants per village. Specifically, forty subjects were recruited at random from each village and then either 15 or 20 participated in a public goods game and a novel measure of intellectual humility. (N=2,591)

“Public Goods” game Experiments were conducted in person. Participants were convened at an accessible location large enough to host the group within their village, and randomly divided into groups of five upon arrival and consent. Participants were provided with Android tablets and trained to use the interface by research assistants. Participants was not aware of the group they had been assigned to and did not know who the other people in their group were. They could only see five avatars on a tablet interface, including themselves. Each participant was given an endowment of 12 Lempira and given the option to either keep the units to themselves or to contribute the endowment to a common pool. The participants were not aware of how many rounds would be conducted and could not talk with other participants nor otherwise exert any direct influence on others’ decision-making process. After doing the activity for ten rounds, the total contributed to the common pool was doubled and the sum distributed equally to all five participants. The participants keep their ending endowment plus 50 Lempira for participation (approximately the daily wage for a day laborer) and the game ends.

Intellectual humility survey Humility, as a human virtue, has long been a topic of philosophical interest. But empirical research on humility has begun to flourish only in recent years. While

humility is a multifaceted construct, intellectual humility (IH) has garnered particular attention. IH has emerged as a construct in the psychological literature with particular relevance to many aspects of core human virtues, but efforts to study IH in what has been considered non-Western, Educated, Industrialized, Rich, and Democratic (WEIRD) contexts and to explore the relevance of IH to various practical decisions that people make in their everyday lives are still scarce. We developed a novel measure of IH that involved completing 2,589 face-to-face interviews in Copan between September 2022 and May 2023 (two participants did not complete this survey).¹⁶

Other de novo data collected from these participants includes assessing occupation and other income-generating activity.

Cognitive Social Structures

N=82 villages and N=10,042 participants (September 2023 to August 2023)

We collected data on individual *perceptions* of social networks in 82 villages (see Figure 1). This survey is administered, in each village, shortly after the collection of the wave 4 survey and network data.

Social networks are typically mapped by ascertaining connections between people by asking the people to state to whom they are connected. However, individuals not only reason about their own relationships, but also cognize relationships between *others* in their networks. Such information is often the basis for introductions, strategic information disclosure, and accessing social support. Humans are innately interested in the relationships around them and appear to be adept at tracking the relationships in their networks, despite the seemingly high cognitive burden.

Data Collection

We collected novel data regarding how people perceive the social ties of others in their networks. This data can be used to assess the accuracy of such perceptions and how they vary across the life-course and across other attributes of the perceivers and of the perceived ties.

In the first part of the survey (Table 5), subjects were shown a series of candidate faces that constitute the unique set of individuals who appear in the randomly sampled set of no more than 40 dyads for that perceiver, and we asked whether they recognize each of these people. In the second part, we included two relationships that apply to either kin or non-kin: “with whom do you spend free time?”, “with whom do you discuss personal or private matters?” Additionally, we elicited the specific kin tie (e.g., parent, sibling, partner) if the perceiver believes that a kin tie is present. Subsequently, a series of up to 40 dyads based on the set of recognized individuals are shown to the respondents. When each dyad is displayed, the respondent is asked a series of questions designed to elicit the subject’s perceptions of a relationship between the two other individuals in a displayed pair. Note that subjects are asked not only about ties that do exist in the underlying sociocentric network that had been

previously independently mapped, but also about ties that did not exist (i.e., they are shown pairs of individuals who have not reported any ties between themselves).

The sampling procedure is a stratified design, where ties are sampled in equal numbers at increasing distance to the survey respondent. Survey respondents are thus queried about three relationships for 40 pairs of individuals in their social orbit, where roughly half of the ties exist, and half do not in the underlying social network.

Table 5: Survey Questions about Cognized Social Ties

Question	Question text	Response options
1	Do you know [person a]?	Yes No I don't know / I refuse to answer
2	Do you know [person b]?	Yes No I don't know / I refuse to answer
3	Do [person a] and [person b] [photos shown] know each other?	Yes No I don't know / I refuse to answer [not read by the surveyor]
4	Do [person a] and [person b] spend free time together?	Yes No I don't know / I refuse to answer [not read by the surveyor]
5	Does [person a] and [person b] trust each other to talk about something personal or private?	Yes No I don't know / I refuse to answer [not read by the surveyor]
6	Are [person a] and [person b] one of the following?	Parent/child Sibling Partner

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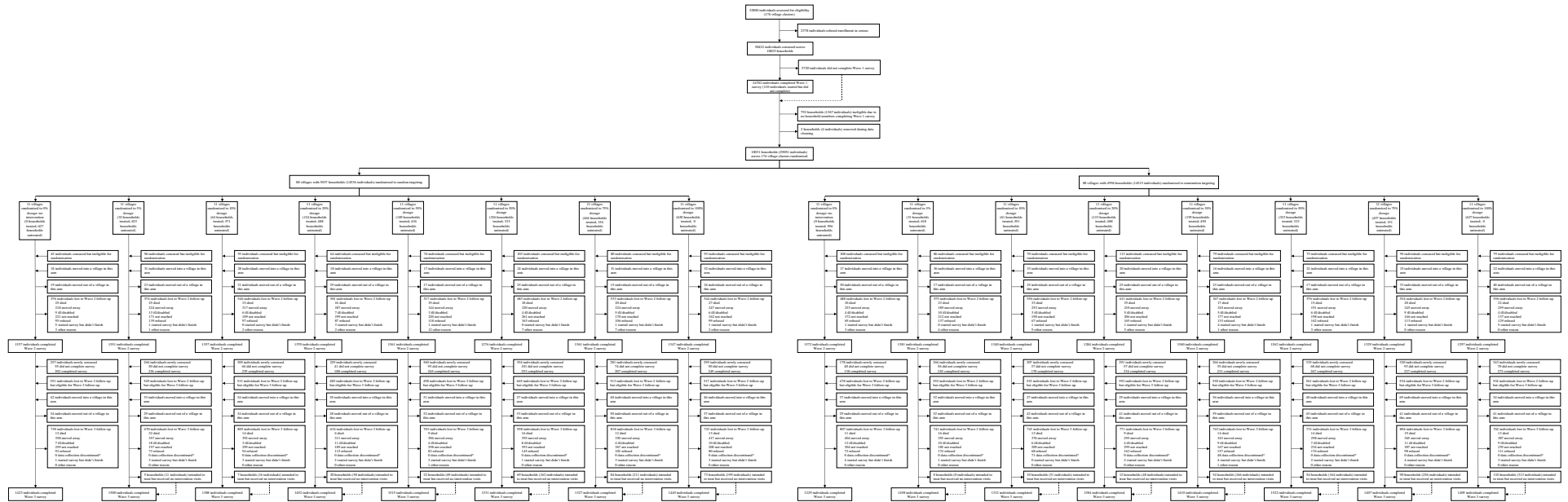


Figure 3: Consort Diagram of RCT