UNIVERSIDAD DE COSTA RICA
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CRELES-RC

Costa Rican Longevity and Healthy Aging Study, Retirement Cohort
Methods, Wave 1

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Coverage: Costa Rica, population cohorts born 1945-1955
Funding: U.S. National Institute on Aging (grant R01AG031716)

Suggested citation:
Dow, William H., Gilbert Brenes, and Luis Rosero-Bixby (2013). CRELES: Costa Rican Longevity and Healthy Aging Study, Retirement Cohort. Methods, Wave 1. Berkeley, CA: Department of Demography, University of California, Berkeley. Electronic Document, http://www.creles.berkeley.edu.

DATA AND METHODS

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The Costa Rican Longevity and Healthy Aging Study (CRELES, or Costa Rica Estudio de Longevidad y Envejecimiento Saludable) is a set of nationally representative longitudinal surveys of health and lifecourse experiences among older Costa Ricans. CRELES is part of the growing set of Health and Retirement Surveys being conducted around the world. Costa Rica is of particular interest to study given its high longevity: life expectancy is greater than that of the United States, despite being a middle income country with about one-fifth the per capita income and one-tenth the per capita health spending.

CRELES is now composed of multiple waves of data from two cohorts: the original CRELES pre-1945 birth cohort is a nationally representative sample of nearly 3000 Costa Rica residents born in 1945 or before, first interviewed in 2005. This document describes data and methods for a new CRELES Retirement Cohort, born 1945-1955 and interviewed starting in 2010. Referred to as the 2010 CRELES-RC, this new sample includes 2798 baseline long-form interviews with targeted age-eligibles plus 1338 interviews with their spouses (regardless of age), conducted between January 2010 and December 2011. The new CRELES-RC also includes a supplemental sample of short-form interviews conducted between January 2012 and January 2013 with 491 initial non-responding target individuals so as to study response-rate patterns which may be especially systematic in working age populations.

CRELES data are well-suited for studying longevity determinants, relationships between socioeconomic status and health, stress and health, patterns of health behaviors, and the effects of Costa Rica's rapid 1960s fertility decline. The CRELES surveys are distinguished by extensive measurement of health indicators as well as biomarkers. The 2005 wave of the CRELES Pre-1945 cohort included fasting blood and overnight urine collection, with blood collection repeated in 2007. The 2010 CRELES-RC drew (non-fasting) venous blood to measure cholesterol, C-reactive protein, and HbA1c. DNA has been extracted for both cohorts. Other objective health indicators include anthropometrics and observed mobility. The CRELES surveys are also distinguished by linkages with the Costa Rican National Death Index, which has allowed on-going monitoring and follow-up of mortality events, which are also studied through a surviving family interview. CRELES public use data files contain information on a broad range of topics including self-reported physical health, psychological health, living conditions, health behaviors, health care utilization, social support, work, and socioeconomic status. A second wave of CRELES-RC interviews began in 2012.

CRELES-RC was conducted by the University of California, Berkeley and University of Costa Rica's *Centro Centroamericano de Población* (CCP) with funding from the United States National Institute on Aging (NIH grant R01 AG031716). The Principal Investigator is William H. Dow (University of California, Berkeley), with Co-Principal Investigators Luis Rosero-Bixby and Gilbert Brenes (University of Costa Rica).

Design of the sample[1]

The study employed a multi-stage probabilistic sampling design with four stages. In the first stage, a simple random sample of 60 Health Areas was selected out of 102 Health Areas in which Costa Rica is divided. In the second stage, 222 pseudo-census tracts were drawn from a sampling frame based on a corrected version of the 2000 Census; in general, each pseudo-census tract was composed of two actual census tracts contiguous to each other, although in rural areas, some pseudo-census tracts had 3 or 4 actual census tracts; pseudo-census tracts were created in order to have at least 15 houses with persons born between 1945 and 1955 in each of these areas. In every pseudo-census tracts, all residences with at least one target individual were selected with complete certainty (probability one) in the third stage; the decision of visiting all residences with at least one target respondent was made in order to have enough sample size. Finally, in the fourth stage, among all people born between 1945 and 1955 in each of these residences, we selected randomly only one person as the main informant; the main respondent's spouse was interviewed if the target individual was married.

The non-response rate is different if the supplemental short-form sample is taken into account. The complete sample has an estimated non-response rate of 34%, but if only the long-form respondents are considered, the non-response rate increases to 43%. The short-form interviews were used to compute sampling weights that corrected the potential selection bias of the long-form subsample. The spouses' questionnaire was only used for the spouses of long-form respondents; among them, only 76% of the total eligible spouses could be interviewed (a non-response rate of 24% among contacted spouses). Additionally, the fieldwork team interviewed 51 spouses whose target individuals could not be interviewed because of late refusals or problems to contact them. There is a separate dataset with these 51 spouses.

Anthropometric measurements were performed to 97% of the total target sample: 98% of long-form respondents and 86% of short-form interviewees; the latter is relatively low because, among the 67 short-form respondents lacking anthropometric measurements, 63 were interviewed by phone, hence anthropometry was not possible. Among spouses, 99% have anthropometric measurements. Biomarkers were only collected for long-form respondents and for spouses. In each group, 94% have all biomarker information. Among all respondents, only 1% needed another person to respond on his/her behalf ("proxy respondent").

Three sets of sampling weights were computed. The first sampling weight variable corresponds to the long-form subsample and the short-form supplemental subsample joined together (appended one to the other). This variable must be used for estimating basic prevalence measures, particularly for the health and socioeconomic variables that are part of both questionnaires. The other sampling weight variable was computed in order to make inferences to the population based on the long-form subsample; this

[1] A detailed description of the Sampling Design is in the Annex Section.

variable should be used to analyze the variables that are unique to the long-form. Finally, the third sampling weight variable corresponds to the spouses' file. It should be used to infer about the population of spouses and, especially, to perform analysis about couples. This final sampling weight variable takes into account that only 76% of eligible spouses who were actually contacted could be interviewed.

When the sampling weights are used, the frequency distributions of selected variables are similar but not equal to the same distributions observed in the 2011 population census (Table 1). The age distributions in the complete sample (CRELES with short-form interviews) are slightly older than the census and the long-form subsample distributions. Among the selected characteristics, the largest differences between the CRELES estimates and the census frequencies are found in the working status variable. CRELES figures found a higher proportion of people working than the census. This finding is, nevertheless, expected; the census questionnaire uses only one very general question to measure economic participation, while the CRELES questionnaire has several batteries.

Table 1. Comparison of relative frequency distributions of CRELES 1945-1955 Retirement Cohort baseline target interview weighted samples (with and without short form interviews) and the 2011 Costa Rican Population Census for the population 55 to 65 years old, by sex.

Characteristics	Males				Females		
	CRELES with short-form interviews	CRELES without short-form interviews	Census		CRELES with short-form interviews	CRELES without short-form interviews	Census
Age at census date[1/] (Total)	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**
55-58	43.6	43.5	43.6		43.6	43.7	43.7
59-62	34.2	34.3	34.2		34.3	33.8	34.4
63-65 (or older)	22.2	22.2	22.2		22.1	22.5	21.9
Marital status (Total)	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**
Cohabiting	14.3	14.6	15.0		7.7	7.9	8.7
Married	68.2	68.2	63.7		51.3	51.1	50.0
Separated/Divorced	9.3	9.0	9.4		22.4	22.8	16.5
Widowed	2.6	2.6	2.4		10.9	10.6	10.3
Not married	5.6	5.5	9.6		7.7	7.6	14.4
Education	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**
No school/elementary school	56.5	56.3	56.5		58.4	58.1	58.4
Academic secondary school	19.9	19.4	21.8		20.2	21.0	21.7
Post-secondary & technical	23.6	24.3	21.7		21.4	20.9	19.9
Working	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**
Yes	67.0	66.2	61.7		25.0	25.0	21.0
No	33.0	33.8	38.3		75.0	75.0	79.0

Note: [1/]2011 Census date: May 30th, 2011

Field Work

The study, being longitudinal, consists of baseline household data collection and a two-year household follow-up survey. This report presents the results of the baseline round (first wave) which gathered information during 2010 and 2011. It included a structured interview, anthropometric measurements, physical functioning tests and the draw of blood samples. The questionnaire was comprised of questions about marital history, children's characteristics (both alive and deceased children), health and health behaviors,

income from wages and entrepreneurial activities, perceived SES (socio-economic status), housing characteristics, intergenerational transfers, and social support. There were special batteries of questions about perceived stress, physical activity (the IPAQ scale), cognitive status, depression symptoms (a short version of the Geriatric Depression Scale), and friendship. A shorter version of the questionnaire, centered mainly on health and social support questions, is used to interview the main respondent's spouse, when there is one.

Data on the geographical coordinates of the place of each participant's residence, using GPS devices were also recorded in the field. All the data and specimens were gathered at the participants' homes, generally in a single visit. Participants granted their informed consent by means of their signature, they answered a main questionnaire of around 90 minutes, and blood pressure was measured twice during the interview. At the end of the interview, blood samples were drawn, the anthropometric measurements were taken, and the physical functionality tests were performed. The project did not require respondents to be fasting because the chosen biomarkers are not sensitive to whether the subject was fasting or not.

At the beginning of the main interview a cognitive evaluation was included that, together with the interviewer's criteria, established whether or not a "Proxy" informant for the participant was needed to help respond to the survey. Only 36 interviews (1.28% of total interviews) were conducted with the help of a Proxy.

The fieldwork for the supplemental sample of short-form interviews of hard-to-reach individuals who had refused long-form interview was conducted between January 2012 and January 2013. The structured questionnaire for this sample is a short form version of the main questionnaire; it included questions about health, marital history, intergenerational transfers and social support. Anthropometric measurements and physical functioning tests were also performed, except for the 12% of short-form interviews that were conducted by phone after repeated failed attempts to conduct the interview in-person. The household interviews were all completed by two teams of 3 interviewers each who were continuously in the field over a two year period, thus the interviewers were highly experienced. Blood draws were conducted by a trained phlebotomist mostly after the interview was finished.

All the data from the fieldwork were recorded using handheld Pocketbooks, a type of "Personal Digital Assistants" (PDAs), with a software application developed at the *Centro Centroamericano de Población* for this study. This included the main questionnaire which featured complex skip patterns and linkages. The same technology and procedure was used for the cohorts born before 1945 and interviewed between 2004 and 2009. During pilot fieldwork for that study, the questionnaire answers were recorded in the PDA and on paper simultaneously by two interviewers, yielding an extremely high level of concordance (Hidalgo-Cespedes, Rosero-Bixby et al. 2007). The PDA shows on the screen the text of each question that the interviewer should read and, when needed, it also provides instructions. The answers are usually registered in the PDA by pressing on the screen ("tapping") on the selected option from a list, but also it can be registered by

entering numbers or text directly in "graffiti" or into a virtual keyboard, if the interviewer chooses to. The PDA controls the flow of the interview; it skips questions and employs filters based on previous questions; it also executes verifications of consistency programmed ahead of time, and it automatically generates certain variables such as the date and time. The PDA does not allow recording of inconsistent data or dates that are outside of the range, nor does it allow skips in the sequence of questions. Data were backed-up daily in the field and uploaded regularly to allow real-time data quality monitoring during fieldwork.

Physical, anthropometric and mobility and flexibility tests:

The following describes materials, equipment and methods used in the physical measurements: blood pressure, anthropometric measurements, flexibility and mobility tests, hand strength and peak breathing flow. More detail of the tests is available in the interviewer's manuals on the project website: (http://ccp.ucr.ac.cr/creles/index.htm).

Blood pressure
It was measured on two occasions during the main interview, with an average interval time of 20 minutes between each; the measurement was taken using OMRON brand digital monitors with automatic inflating, model HEM-711 (precision: ± 3mmHg) that were calibrated periodically. The bracelet was adjusted to the thickness of the adult's arm.

Anthropometric measurements
These were taken by the interviewers who were trained and certified for this purpose, with updated training after a year of fieldwork. The measurements taken and the equipment used are the following:

Body weight: The scale used was the Life Source brand, A&D medical, model UC-321; it was placed on even floor and without carpets, the measurement was carried out without shoes, and objects of weight were removed from the pockets of those participants with clothes.

Height: A Seca brand stadiometer was used to measure the height of the senior adults. The measurement was not taken if the person had major deformations of the spine.

Knee height: The measurement was carried out in the right leg whenever the interviewee did not have a lesion on it. For this measurement an inclinometer was used to indicate the angle of 90 degrees, and then height was measured with a stadiometer manufactured by Shorr Productions (USES Knee-Height Caliper).

Abdominal measurement and Hip circumference: These measurements were made with the participants standing, in a semi-anatomical position (with the feet separated and the palm of the hands resting on the lateral thigh). The metric tapes used were the Quick Medical brand tapes.

Calf circumference: The person was seated, with the right leg exposed.

Arm circumference: With the person seated or standing, the circumference was measured in the half point between the acromion (or posterior bone of the shoulder) and the olecranon or protruding bone of the elbow.

Tricipital and sub-scapular skin folds: The interviewer carried out the measurements using his or her thumbs and index fingers in order to make sure to take only the fatty tissue and not muscles or nerves. For this, a Lange Skinfold caliper, from Beta Technology Incorporated, was used.

Hand strength
Two measurements of hand strength were taken (the highest value is used in the analysis) with the interviewee standing with the dominant arm extended beside their body. A Creative Health Products Inc. dynamometer of was used, model T -18.

Flexibility and mobility
The flexibility and mobility tests were carried out with the purpose of measuring (1) equilibrium and balance, (2) agility and (3) walking speed. The exercises that were carried out were the following:

Equilibrium and balance: To measure equilibrium and balance two tests conducted, (1) to remain standing with feet together for 10 seconds and (2) to stand up five times from a sitting position, with arms crossed on the chest.

Agility: The agility was measured beginning with the senior's ability to bend over, to pick up a pencil and to straighten out. If the interviewee could not do it in less than 30 seconds the test was not continued. The test was also not conducted if the senior had a cataract operation or another retinal procedure in the six weeks previous to the test.

Walking speed: To measure the senior's ability to rise off of a chair and walk, the interviewee was asked to rise from a chair and walk a distance of 3 meters in the manner that he normally does it; neither slower nor faster. The test was registered with a chronometer, noting the time in seconds that it took to carry out the test.

Laboratory procedures

The blood sample was obtained by venipuncture, mostly shortly after the interview was conducted. Two tubes of blood samples were collected: One with anticoagulant (VACUTAINER / EDTA) of 3-4 ml that was centrifuged later to separate the plasma of the cells and another tube without anticoagulant with coagulum activator (VACUTAINER SST, 5 ml) for obtaining serum. In the laboratory a fraction of serum was separated in a conical tube type Eppendorf for tests of total cholesterol, HDL (High Density Lipoprotein) and CRP (C-reactive protein), and 1 ml of complete blood in the tube EDTA for the analysis of HbA1c (glycated hemoglobin).

The biomarkers measured from blood samples of the CRELES-RC project were analyzed at the clinical laboratory of the Office of Health and Student Well-being of the University of Costa Rica (UCR). The tubes for the specimen collection were sent at the end of the day to the laboratory for analysis. Samples were kept at the appropriate temperature using a cooler box with ice. The remaining fractions of serum and plasma were aliquoted in red-top cryovials and they were stored in ultra-refrigeration (-140°C). When the fieldwork team was interviewing in regions outside the capital, San Jose, the blood samples were stored in refrigerators at public clinics and hospitals that are part of the Caja Costarricense del Seguro Social (the main public health care provider in the country).

The following are the assay methods used to analyze biomarkers:

Biomarker	**Method**
Total cholesterol	Enzymatic colorimetric test, wavelength: 505 nm; temperature: 37°C; Reagents Roche, Equipment: Cobas c501 Analyzer
HDL	Enzymatic colorimetric test, wavelength: 600 nm; temperature: 37°C; Reagents Roche, Equipment: Cobas c501 Analyzer
CRP	Particle-enhanced immunoturbidimetric assay, using anti-CRP monoclonal antibodies, Equipment: Cobas c501 Analyzer
HbA1c	Turbidimetric Inhibition Immunoassay (TINIA) for total hemolyzed blood; Reagents Roche, Equipment: Cobas c501 Analyzer

Research Ethics

The study was approved in April 2009 by the Committee for Protection of Human Subjects (CPHS II) at the University of California at Berkeley. The study and procedures for fieldwork and informed consent were also approved by the Ethical Science Committee of the University of Costa Rica in the sessions held in April 24, 2009, August 10, 2009, and February 23, 2011 (references: VI-2878-2009, VI-5308-2009, and VI-1313-2012), as part of the research project number 828-A2 -825. All the databases of the study have been made anonymous (the name and other identifiers were removed) to avoid risks to the privacy of the participants. Written informed consent was signed during the first wave of interviews, in which it was explained the occurrence of follow up visits after two years. Some of the subjects in the supplementary sample (the "short interviews") were interviewed by phone; these participants' consent to be interviewed is registered in a special "Informed Consent Form for Phone Interviews" approved by the Ethical Science Committee of the University of Costa Rica in the April 18, 2012 session (reference: VI-2403-2012).

References

Hidalgo-Cespedes, J., L. Rosero-Bixby, et al (2007). "Improvement in the quality and decrease of costs and surveys using hand (PDA) computers. An application in Costa Rica." Population and Health in Mesoamerica. 5(1).

ANNEX

Sampling Design for Baseline
CRELES 1945-1955 Retirement Cohort (2010 CRELES-RC)

Study Population: Persons born between 1945 and 1955 and living in Costa Rica between 2010 and 2011, and their co-resident spouses (regardless of their year of birth).

Planned Sample Size: 3330 target individuals. The study assumed a non-response rate of 10%.

Final sample size: Long-form interviews were completed with 2798 target individuals ("main interviews") and 1338 spouses ("spouse interviews"). To investigate non-response patterns in long-form interviews, an additional 491 short-form interviews were conducted, yielding a total sample of 3289 target interviews.

Sampling design: The study employed a multi-stage probabilistic sampling design with four stages:

(a) **Primary Sampling Units (PSUs): Health Areas.** A simple random sample of 60 Health Areas was drawn out of 102 Health Areas that cover the Costa Rican territory. These PSUs were originally selected for the CRELES-2004 cohort (the cohort born before 1946). Fifty-five percent of the elderly population in 2002-2004 and 62% of the population born in 1945-1955 (ages 54 to 65 at baseline) live in these Health Areas. The study decided to keep the same PSUs for the new cohort in order to facilitate the planning of the fieldwork and to use administrative information gathered in 2009 about the health services in those areas.

(b) **Secondary Sampling Units (SSUs): Pseudo-census tracts, constructed from clusters of the 2000 Census Tracts.** Census tracts from the 2000 Population Census were clustered in order to have at least 15 houses with persons born between 1945 and 1955 in a geographically continuous territory. These clusters are called pseudo-census tracts. Most of these clusters are comprised of 2 census tracts; however, in certain cases (mostly in very rural areas), the clusters had 3 or 4 census tracts. The study selected 222 SSUs wih Probability Proportional to Size (PPS), using a systematic procedure in order to cover the whole region defined by the 60 Health Areas.

(c) **Tertiary Sampling Units (TSUs): Residences.** The study selected all houses within the pseudo-census tract (the SSUs).

(d) **Fourth-stage Sampling Units (4SUs): Persons.** Among all the persons born between 1945 and 1955 and living in each house, one person is selected randomly as the main informant.

Sampling Frame: The sampling frame is the main dataset of the 2000 Costa Rican Population Census. To correct for outdated information, we estimated survival

ratios using the electoral list of 1998 and 2006. The electoral list ("padron") has a record for every Costa Rican citizen; estimates computed at Centro Centroamericano de Poblacion suggest that, within the 55-65 age range, the population in the electoral list represents 97% of the total population. We divided the population aged 51 to 61 in 2006 by the population aged 43 to 53 in 1998, for each electoral district. Given that this is an eight-year period, we powered the ratio by 1.25 for estimating a 10-year ratio (which corresponded to 2010, the year in which the fieldwork started). The population in each census tract was multiplied by this ratio. This procedure has two assumptions:

a) The ratio in each electoral district correctly represents the mortality and internal migration patterns of the cohorts in the census tracts located in the electoral district.
b) Mortality and internal migration patterns of Costa Rican citizens (who are listed in the electoral lists) are similar to the non-citizens patterns.

After correcting the population in the sampling frame, the data was grouped in the pseudo-census tracts described before.

Fieldwork procedure: The interviewers went to each pseudo-census tract divided in two groups of 3 interviewers and one driver (one of whom was the fieldwork supervisor). They visited each residence in the pseudo-census tract to determine which house had residents born between 1945 and 1955. Information on non-responding households was gathered from neighbors where possible; remaining non-responders were assigned an estimated probability of having a qualifying resident, for weighting purposes. In each house, one person was selected randomly as the target interviewee using a random number generator algorithm programmed into the handheld computer used for data entry. If the target interviewee was married or cohabiting, this coresident partner was selected with certainty (conditional on completed target interview) for a spouse interview. Some spouses were interviewed without having the target information, because the target respondent refused to be interviewed or could not be contacted after the spouse was interviewed; there are 51 spouses without information about the target individual.

Selection probability: The sampling weight is equal to the inverse of the selection probability. Each respondent has a different selection probability. Therefore, the sample is not self-weighted. There are three sets of selection probabilities; hence, there are three sets of sampling weights: (1) For all main respondents including the supplemental sample of short-form interviewees; (2) for main respondents of the long-form questionnaire, only; and (3) for spouses (which can be used also when analyzing couples).

The planned selection probability without corrections would be:

$$P(X) = P(PSU) * P(SSU) * P(TSU) * P(4SU)$$

$$P(X) = \frac{60}{102} * \frac{Mt_{\alpha}}{984.89} * 1 * \frac{1}{\text{Number of age} - \text{eligible persons in household}}$$

where Mtα is the number of houses with at least one person born between 1945 and 1955. In "Probability-Proportional-to-Size" (PPS) design, Mtα is the size of the clusters in the sampling frame[2].

The selection probability refers to drawing 60 Health Areas out of 102, times the probability of selecting a pseudo-census tract, times the probability of selecting a person within the house. Given that the pseudo-census tracts were selected using probability proportional to size (PPS), the probability of selecting a SSU varies by SSU because each pseudo-census tract has a different size. The probability of selecting a SSU varies according to the size of the pseudo-census tract, Mtα, which is equivalent to the number of houses with at least one person born between 1945 and 1955, in each area. The probability of selecting a SSU is Mtα/984.89, where 984.89 is equal to the number of households with at least one resident aged 55 to 65 (218645) in the sampling frame divided by the number of planned census tracts to be selected (222). The probability of selecting a TSU is one because all houses are visited.

Selection probability for all main respondents (long and short-form interviews)

The effective selection probability includes three correction factors included due to limitations in the fieldwork.

(a) **factor1=0.99.** Eight pseudo-census tracts (equivalent to 16 census tracts) were completely excluded. Four of these SSUs are located in extremely dangerous neighborhoods, so they were excluded to avoid any harm to the fieldworkers. There were no target individuals at all in three SSUs, and another pseudo-census tract could not be visited because there was no easy vehicular access. Additionally, 11 SSUs were covered only partially; in 4 of them, one of the census tract was visited and the other was located in a dangerous neighborhood, therefore, only half of the pseudo-census tract was visited; in each of 7 SSUs, one of the census tracts had informants, and in the other, no informants were found. The total number of residences with expected informants in these areas with no information was equivalent to 1% of the total expected houses in the whole sample.

(b) **factor2= (Houses effectively visited in SSU X / Total number of expected houses with information in SSU X).** There were important differences

[2] Kish, Leslie (1965). *Survey Sampling*. New York: Wiley.

across pseudo-census tracts in the number of houses found to have target individuals compared to the expected number of houses according to the sampling frame. The average ratio per SSU was 0.42, but the minimum was 0.03 and the maximum was 1.6 (in 6 SSUs, the fieldwork team found more houses with target individuals than expected). This inconsistency might be due to:

i) Outdated sampling frame
ii) A high percentage of houses with target individuals that could not be found (or defined as such).
iii) Refusals.

(c) **factor3:** A differential response rate across sex, age, and education. Based on the 2011 Population Census, we found that the weighted sample weighted by factor1 and factor2 overestimates women over men, older persons over younger ones, and less educated over more educated people. We computed correction factors for 30 different groups defined by sex (males, females), age groups (54-56, 57-58, 59-60, 61-62, 63-65) and years of schooling (only primary school, at least one year of academic secondary school, at least one year of technical school or post-secondary school).

The final formula for the selection probability is:

$$P(X) = P(PSU) * P(SSU) * P(TSU) * P(4SU) * factor1 * factor2 * factor3$$

$$P(X) = \frac{60}{102} * \frac{Mt_{\alpha}}{984.89} * 1 * \frac{1}{\text{Number of age} - \text{eligible persons in household}} * factor1 * factor2 * factor3$$

Selection probability for long-form questionnaires only: Of the total target interviews, 2798 (85%) responded the long-form questionnaire and 491 answered the short-form interview. In order to analyze the information that is exclusive to the long-form interview, we compute a set of sampling weights based on the specific selection probabilities of contacting the respondent and achieving their consent in answering the long-form questionnaire (rather than rejecting the interview).

Given that the short form questionnaire was implemented in order to get basic information from people that were hard to reach, these respondents are relatively different to those who accepted to answer the long-form questionnaire. Therefore, we estimated two logistic regression models –one for males and one for females– where the dependent variable is whether the target individual responded the long-form or short-form questionnaires. The model was simplified with a stepwise backward selection procedure, using an exit probability of 0.20 (we decided to use a relatively high significance in order to give priority to classification rather than explanation of the event). We estimated the probability of responding the long-form questionnaire and the selection probability of this

subsample is equal to the selection probability of being interviewed at all, times the probability of responding the long-form questionnaire:

$$P(X\ with\ long-form) = P(X) * P(long-form|X)$$

The following table summarizes the final models used to compute the probabilities of answering the long-form given that the interview was accepted.

Table 1. CRELES-RC. Logistic regression models for estimating the probability of answering the long-form rather than the short-form questionnaire, given that the respondent accepted the interview, controlling by sex

Covariates	Coefficient	Standard error	p-value
Males			
Elementary school vs more than elementary school	0.362	.140	0.010
Residing in Cartago vs in other provinces	-0.226	0.171	0.187
Intercept	1.722	0.114	0.00
Females			
Age	0.077	0.025	0.002
Bad Health vs. Good Health	0.407	0.152	0.007
Not married vs. married	0.519	0.200	0.009
Working vs. Not working	0.416	0.160	0.009
Province of residence (Ref: Rest of the country)			
-Cartago	-0.554	0.187	0.003
-Puntarenas	-0.467	0.221	0.035
-Alajuela	-0.351	0.202	0.083
Intercept	-3.352	1.485	0.024

Selection probability for spouses (or couple analysis): Spouses were only interviewed, if the main respondent accepted the long-form interview (except for 51 spouses that were interviewed before the main target individuals failed to be interviewed). Among the long-form questionnaire respondents, 24% of eligible spouses were not interviewed because of refusal or fieldwork difficulties. Therefore, there is a separate calculation of selection probabilities for spouses (except for the 51 spouses without main interviews, given that these cases do not have enough information to analyze the non-response pattern). These spousal weights can also be used when analyzing the subsample composed only of couples who both completed interviews. The spouse's selection probability is equal to the selection probability of main informants, multiplied by the response rate of spouses.

Given that the response rate varies by several characteristics, we estimated another logistic regression model where the dependent variable is whether the spouse was interviewed or not. The model was simplified with a stepwise procedure, using an entry probability of 0.05. Spouses with lower response rates are those who work, those with more education, cohabiters, and those living in Cartago province, and female spouses. Probabilities of being interviewed were computed based on this equation. The selection probability for spouses is then calculated as the selection probability of the main informant multiplied by this probability of spousal interview:

$$P(X.sp) = P(spouse|X\ married\ and\ long-form)$$

$$P(X.sp) = P(X\ with\ long-form) * P(spouse\ interviewed|target\ interviewed)$$

The probabilities estimated with the logistic model vary between 0.43 and 0.91, with a mean of 0.79. The following table describes the logistic regression model.

Table 2. CRELES-RC. Logistic regression model for estimating the probability of interviewing a spouse among long-form respondents.

Covariates	Coefficient	Standard error	p-value
Spouse works	-1.082	0.122	0.000
Education (Ref:Elementary school or less)			
-Secondary education	-0.533	0.148	0.000
-Post-secondary education	-0.378	0.168	0.024
Cohabiting couple	-0.413	0.152	0.007
Residing in Cartago vs in other provinces	-0.315	0.153	0.040
Male spouse	0.722	0.128	0.000
Intercept	1.646	0.122	0.000

Non-response rate: The short-form interview supplemental sample was drawn to investigate systematic properties of non-response among main interviewees. Field teams indicated that much of the non-response was due to individuals who had been invited to participate but had refused due to the 90-minute survey being too long. The 2,798 long-form (90-minute) interviews were completed as of January 2012, and the short-form interviews were conducted from January 2012 until January 2013. Most of the completed short-form interviews were in houses that had already been visited and for which the number of eligible people was known, but in which the target interviewee had earlier refused to complete a long-form interview after repeated attempts. Table 3 shows how the response rate was computed with the short interviews and without them.

Non-response can be classified in four categories: (1) Explicit refusal of eligible persons (people overtly say that they do not want to be interviewed). (2) Explicit refusal of households that give no information at all and hence the number of eligible people is unknown. (3) Implicit refusal (people that accept to be interviewed later, but are not available when visited again). According to Table 3, in the main sample, the response rate is 57%. Explicit refusal was relatively low (3.1%), but implicit refusal was greater: 26%. Not all 1269 cases of implicit refusal can be considered as such; fieldworkers had to discard visiting some people that were contacted for the first time, but could not be visited again because their houses were located too far from the scheduled route. (4) Additionally, interviewers found 6280 houses where no inhabitant could ever be contacted, even after several visits to the neighborhood. If approximately 10% of all houses in Costa Rica have a person born between 1945 and 1955 and if we assume that houses whose inhabitants could not be identified have these same proportion of target individuals, then approximately 661 houses with target individuals were missed during the fieldwork: 628 in houses with no contact and 33 houses who refused to provide information about their inhabitants. Among households with which some kind of contact was made, the long-form response rate was 85% (2798+154+330, where 330 are the total number of houses with explicit refusal to reveal number of eligible persons).

When the short-form interview subsample is included the response rate rises to 66%. Explicit refusal grew slightly (from 3.8% to 4.1%), but implicit refusal diminished considerably: from 26% to 16%. The non-response rate due to houses with no contact information does not vary at all, because fieldworkers did not return to those houses. Among households with which some kind of contact was made, the total short-form + long-form response rate was 86%.

Table 3. Estimation of response rate based on visited houses with information about inhabitants, classified according to the type of response to the survey. CRELES-2010, wave 1.

Type of response	Long-Form Response Rate		Total Short-Form + Long-Form Response Rate	
	Abs.freq.	Rel.freq. (%)	Abs.freq.	Rel.freq. (%)
Response	2798	57.3	3289	66.1
Total Non-response	2084	42.7	1684	33.9
Explicit refusal with eligible people in house	154	3.1	205	4.1
Estimated target non-response in houses with explicit refusal to reveal number of eligible persons (10% of visited houses)	33	0.7	33	0.7
Implicit refusal (Houses with known number of eligible persons who were impossible to interview)	1269	26.0	819	16.5
Estimated houses with no contact and unknown number of eligible persons (10% of visited houses)	628	12.9	627	12.6
Total	**4882**	**100.0**	**4973**	**100.0**

Note: The totals for the two groups are not the same because there are some figures that are estimated.

Differences between long-form and short-form samples: Analysis of the short-form interview supplemental sample enables inferences regarding possible selection bias due to differential response rates. Table 4 compares the samples by 5 characteristics that are known to produce differential response in Costa Rica: sex, age, education, marital status, and working status. When compared to the long-form interviews, the short form-interviews have relatively more men, more people age 59 to 62, more married men, more widowed women, more people with post-elementary school, fewer working men, and more working women. In general, the subsample of long-form respondents has a certain degree of selection bias, when compared to the respondents of the short form interview.