Costa Rican Longevity and Healthy Aging Study

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Overview

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 life-course experiences of older Costa
Ricans, conducted by the University of Costa
Rica's *Centro Centroamericano de Población* in
collaboration with the University of California at
Berkeley. CRELES is part of the growing set of
Health and Retirement Surveys being conducted
around the world (See ▶ "Health and Retirement
Study"). 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.

CRELES comprises five waves of data from
two birth cohort panels (See ▶ "Cross-Sectional
Research/Panel Studies (Longitudinal Studies)").
The original **CRELES Pre-1945** cohort is a sam-
ple of more than 2,800 Costa Rica residents born

in 1945 or before. There are three waves of inter-
views for this panel conducted mainly in 2005,
2007, and 2009. Wellcome Trust funded this panel
(Grant N. 072406). The **CRELES 1945–1955
Retirement Cohort (RC)** is a sample of about
2800 Costa Rica residents born in 1945–1955 plus
1400 of their spouses, interviewed mainly in 2011
and 2013 (waves 4 and 5). The US National
Institute on Aging (grant R01AG031716) funded
this panel through the University of California,
Berkeley.

CRELES data are well-suited for studying lon-
gevity and health determinants, relationships
between socioeconomic status and health, stress
and health, patterns of health behaviors, and pro-
spective mortality.

Study Design

The Samples

The samples for the two panels are probabilistic,
following complex, multistage designs. The
populations represented in the samples are resi-
dents in Costa Rica at baseline dates, born in the
years specified for each panel. The CRELES pre-
1945 was randomly drawn from a larger probabi-
listic sample of 9600 individuals systematically
selected from the 2000 census database. Sampling
was stratified by age with oversampling of older
individuals (details in Rosero-Bixby et al. 2004).
Individuals were linked to birth, death, and voting
national registries to conduct survival-time

analyses by 2000 census characteristics (see, for example, Rosero-Bixby 2018). The sample for in-depth interviews was obtained in a second stage, consisting of the systematic selection of 60 "health areas" (out of 102 for the whole country). All individuals from the larger sample living in these 60 areas were eligible; the final sample excluded those who had died between 2000 and 2005, those severely impaired, and individuals who couldn't be found (details at http://www.creles.berkeley.edu/pdf/Methods_w1.pdf).

The CRELES RC sample followed a four-stage probabilistic design. The first stage was the aforementioned systematic selection of a sample of 60 Health Areas for the pre-1945 panel. The second stage selected 222 clusters, each composed of two or more census enumeration areas (*segmentos censales*) contiguous to each other in order to have at least 15 households with age-eligible individuals in each cluster. In the third stage, all households with at least one age-eligible individual were selected with complete certainty (probability one). In the fourth stage, among all people born between 1945 and 1955 in each household, one person was randomly selected as the main, or "target," informant. The spouse of the target respondent, if any, was also interviewed.

Interviewing

Data (and biological specimens) were gathered through face to face interviews in the homes of the participants by means of structured questionnaires programmed in handheld computers (Hidalgo-Céspedes et al. 2007). The computer drove the flow of the interview executing skips and filters and checking for inconsistencies and out of range responses, as well as automatically generating variables such as date and time. The device also contained preloaded data on the location and identification of each sampled participant. Daily uploaded data allowed real-time quality monitoring during fieldwork.

The main questionnaires took about 90 min to administer at baseline and less than 60 min in follow-up waves and in spouse's interviews. Questionnaires in follow-up waves were shorter since characteristics that do not change over time

(such as education attainment or childhood conditions) were not reasked.

A cognitive evaluation at the beginning of the main interview helped to determine whether or not a "proxy" informant was needed to help respond to the survey. In the pre-1945 panel, 24% of baseline participants required a proxy, compared to only 2% in the RC panel. There was also an "exit questionnaire" in waves 2, 3, and 5 for participants who died between visits. A proxy respondent (next-of-kin) provided information about the subject's final days.

During baseline visits, the field team gathered data on the geographical coordinates of the place of each participant's residence, using GPS devices. They also filled out a community questionnaire with information about the neighborhood, including physical infrastructure, services, and access to health providers.

Two teams of three interviewers, a phlebotomist, and a supervisor conducted the fieldwork. The teams worked year-around. Completing the interviews for the entire sample took nearly 2 years, after which the teams started a new wave of visits. During the first contact, participants granted their informed consent by means of their signature using a consent form approved by the Bio-ethics Committee of the University of Costa Rica.

Response and Attrition Rates

Table 1 shows the number of participants in the five waves of CRELES and the response rates: 93% in the pre-1945 baseline and 66% in the retirement cohort. From those interviewed, more than 90% agreed to provide blood by venipuncture and to allow anthropometric measurement and other physical examinations. Attrition rates between waves, after excluding deaths, were approximately 10% in each two-year interval. Because of the high level of nonresponse in the RC panel, a short interview was conducted with 500 participants to assess key characteristics of nonrespondents.

Content

The main topics of the study are: socioeconomic and demographic characteristics; Mini-mental

Costa Rican Longevity and Healthy Aging Study, Table 1 Response and attrition rates

	Pre-1945 cohort			Retirement cohort	
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Eligible	3,024[a]	2558	2067	4,254[b]	2749
Interviewed	2827	2364	1855	2798	2430
Response rate	93%	92%	90%	66%	88%
Years	2004–6	2006–8	2009–10	2010–11	2012–14
Deaths	–	269	297	–	49
Blood specimen	95%	95%	–	94%	–
Anthropometry	90%	88%	89%	98%	97%
Short interview				491	
Spouse interview					
Eligible				1768	1512
Interviewed				1338	1109
Response rate				76%	73%

[a]Not counting individuals in the 2000 census who couldn't be found ($N = 806$), or had died (601), or were severely impaired (291)
[b]Not counting closed homes with no information

cognitive evaluation (See ▶ "Mini-Mental Status Examination"); basic characteristics of household members, spouses, resident and nonresident children, parents, and in-laws; fertility; insurance and pensions; health (chronic diseases, symptoms, use of health care and expenditures, geriatric depression, stress); lifestyles (smoking, alcohol consumption, physical activity); childhood conditions; functional status (ADLs and IADLs); medications (inventory of items in participant's medicine chest); family and social support; employment history and income; house amenities; diet (consumption frequency and quantity of selected foods); anthropometry and physical tests (flexibility, strength, blood pressure); neighborhood characteristics; and death (cause of death, hospital and assisted-facility stays, bequests).

The interview for spouses (RC panel only) used a shorter version of the questionnaire, centered mainly on health and social support.

Biomarkers and Physical Measures

Table 2 summarizes the biomarkers and physical measures available from each CRELES wave (See ▶ "Social Environment and Biomarkers of Aging Study"). The 2005 wave of the CRELES Pre-1945 cohort included fasting blood and overnight urine collection, with blood collection repeated in wave 2. The baseline CRELES-RC (wave 4) drew nonfasting venous blood. DNA has been extracted from blood cells in both cohorts. Other biomarkers measured are blood pressure, anthropometrics, frailty, and mobility. Details on collection procedures and assay techniques are in Rosero-Bixby et al. (2010).

Auxiliary Data

CRELES participants were linked to the birth, death, and voting registries using the number on their ID-card (the *cédula*) that all Costa Ricans have. Foreigners (2% of the sample) are left out of this linkage. Ages are computed with the exact dates of interview and birth. Daily local weather conditions (rain, surface temperature, and humidity) in each sample cluster during the entire fieldwork period have been linked from remote sensing and local stations. A complementary sample of 91 centenarians from the Nicoya region has been studied with the same protocols of the three waves in the pre-1945 panel. This sample, however, is not part of the public databases (Rosero-Bixby et al. 2013).

Costa Rican Longevity and Healthy Aging Study, Table 2 Biomarkers in CRELES waves

Biomarkers	W1	W2	W3	W4	W5
Main year	2005	2007	2009	2011	2013
Anthropometry (weight, height, knee height; abdominal, hip, calf, and arm circumference; tricipital and sub-scapular skin folds)	X	X	X	X	X
Blood pressure	X	X	X	X	X
Hand grip strength	X	X	X	X	X
Peak breathing flow	X				
Flexibility and mobility (standing, sitting, bending, and walking)	X	X	X	X	X
Agility	X	X	X	X	X
Walking speed	X	X	X	X	X
Overnight urine	X				
Creatinine clearance	X				
Epinephrine	X				
Norepinephrine	X				
Cortisol	X				
Fasting[a] blood (venipuncture)	X	X			
Glucose	X	X			
Glycosylated hemoglobin	X	X		X	
Total cholesterol	X	X		X	
HDL-cholesterol	X	X		X	
Triglycerides	X	X			
Serum creatinine	X	X			
C-reactive protein	X	X		X	
DHEAS	X	X			
Genetic markers from leukocytes	X	X		X	
DNA extraction and storage	X	X		X	
Telomere length	1200	1000		2800	
Methylation	1000				

[a]Nonfasting blood in wave 4

Key Findings

The analysis of CRELES data has introduced new evidence about a nonexistent or reverse socioeconomic gradient in mortality, health, and utilization of health services in developing countries, like Costa Rica, Taiwan, and Mexico (Goldman et al. 2011; Rosero-Bixby and Dow 2009; Rosero-Bixby 2018). This pattern is observed in a context where Costa Rican nonagenarians have a life expectancy as high as their peers in industrialized countries, and the Nicoya Peninsula – a rural region in the Pacific coast – is considered a global hot-spot of high longevity. Older Costa Ricans have an advantage in cardiovascular health compared to other countries, and Nicoyans have an even greater advantage, as well as longer telomere length and higher DHEAS levels (See ▶ "Telomeres"), which are markers of healthy aging (Rosero-Bixby 2008; Rosero-Bixby et al. 2013).

Future Plans and Innovations

Data collection in the households ended in 2010 for the pre-1945 panel and in 2014 for the RC panel. Computerized follow-up of the two panels for survival-time analyses continue to be updated annually. Further DNA analyses are also in development.

Among the innovations and unique features of CRELES are: (1) oversampling of oldest old: 279 participants are 90 years or older at baseline; (2) data from year round that allow studies of seasonal variation; and (3) use of a small number

of interviewers, which allows analysis and corrections of interviewer bias.

Data Access

CRELES data (excluding identification variables) and documentation are downloadable from:

The National Archive of Computerized Data on Aging of the University of Michigan (ICPSR 2015).

The CRELES web site at the University of California (http://www.creles.berkeley.edu) (Berkeley Population Center 2012).

The Gateway to Global Aging Data at the University of Southern California (CESR 2018). This is a harmonized data file across waves and with HRS-type surveys in other countries.

Cross-References

▶ Cross-Sectional Research/Panel Studies (Longitudinal Studies)
▶ Health and Retirement Study
▶ Mini-Mental Status Examination
▶ Social Environment and Biomarkers of Aging Study
▶ Telomeres

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