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ORIGINAL ARTICLE



# Better alone? The impact of living arrangements on mortality of Costa Rican older adults

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Previous research has shown differentiated effects of living arrangement types on mortality. However, little is known about this phenomenon in Latin America and its multigenerational households. This study measures the relationship between older adults' living arrangement types and subsequent mortality. Gompertz event history models were performed to estimate mortality differences across living arrangements. We used the Costa Rica Longevity and Aging Study (CRELES) pre-1945 cohort in the 2005, 2007, and 2009 waves. The results show that older adults who live with a partner have the highest survival rates among the categories tested. When controlling for sex and age in the model, the effect of living alone is not different from partnered living. When controlling for socioeconomic and health factors as well, older adults living with their children or others show an increased risk of death by at least 40% (p-value<0.05). The study demonstrates an association between living arrangements and older adult mortality in Costa Rica. Results show that the highest survival chances rely on being partnered and suggest that support exchanges with other family members are not equally effective. Including this variable type in mortality studies is crucial to better understanding how household conditions relate to health and mortality outcomes.

Keywords: Living arrangements. Old-age mortality. Costa Rica.

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## Introduction

Aging is an inexorable process inherent to every individual. However, what differs across individuals are the actions before the process of aging that predispose them to experiencing disease and affect how they will age and die. Health determinants are factors that increase the risks of having a particular condition; their origin can be genetic or social. Social health determinants are the non-medical factors that determine someone's health outcomes (COMMISSION ON SOCIAL DETERMINANTS OF HEALTH *et al.*, 2008). Such determinants include education, working life conditions, early childhood development, and access to health services, among others. Wilkinson and Marmot (2003) point out that, although health outcomes have a genetic component, most diseases have environmental causes that affect health outcomes more than genetics. Therefore, these causes are of interest to both health professionals and social scientists.

There is much literature from different disciplines that explains what the causes and determinants of mortality in old age are. Authors such as Crimmins and Seeman (2004) point out the importance of doing comprehensive research with attention to biological, medical, and epidemiological aspects, as well as those related to demographics, behaviors, and psychosocial factors. This allows us to understand these phenomena holistically and to make better demographic estimates, as well as to make better targeted health interventions that serve to reduce inequalities. This paper explores living arrangement conditions of Costa Rican older adults and their relationship to mortality, therefore assessing the extent to which this variable is a determining factor for the death of older adults.

The main objective of this research is to measure to what extent there is a relationship between mortality of the elderly and their type of living arrangement. Two further specific objectives are estimating the sociodemographic factors that influence mortality of the elderly according to their different living arrangements and modelling mortality based on living arrangements to determine if the association between these two factors is modified by other sociodemographic and health determinants.

## Background

Living conditions for older adults have changed due to technological changes and changes in the immediate social environment. This is argued by Pérez-Amador and Brenes (2006), who show that in Latin America, living arrangements have changed from how they used to be, and that they are linked to life cycle stages.

Do these new living arrangements for older people constitute a better support network that might improve survival? Studies have focused on this topic from different perspectives. Montgomery and Kosloski (1994) show that care work performed by an elderly individual's partner is significantly different from that of their children, and that spouses dedicate the

most time and resources to caring for their partners. In the context of mortality, care factors can be decisive for survival.

On the one hand, Rogers (1996) describes the relationship between living arrangements and mortality as something that can be explained by the costs and rewards of social relations. The main argument is that social ties are a source of different physical and emotional factors that can positively affect health. Still, if provided ineffectively or if unwanted, they can result in poorer health and, in the worst cases, death.

As an example of these exchanges, Saad (2005) shows that living arrangements in Latin America significantly impact older adults' economic well-being. The mechanism behind this is that living arrangements operate as a compensatory system of social transferences at older ages. Moreover, the author also concludes that co-residence with a child ensures the needed support for vulnerable individuals.

On the other hand, Manfredini and Breschi (2013) studied mortality as a function of living arrangements in Italian Tuscany between 1819 and 1859. Although this study is focused on demographic history, it observes that when older adults must compete for resources (both care and financial), their survival is compromised. Generally, this competition occurs with grandchildren, so older adults living with their descendants who also have children does not seem to be the best strategy for survival.

In recent work, Zueras, Rutigliano and Trias-Llimós (2020) show the effect of living arrangements on old-age mortality in Europe. This study particularly highlights the differences across genders and welfare states. Their results especially emphasize the importance of being partnered for survival, given its protective effect. On the other hand, the authors show that living with others rather than a partner is related to higher mortality for both sexes. Requena and Reher (2020) found that living arrangements in Spain affect mortality and health levels. In particular, they state that the protective effect of living with a partner diminishes with age and that there is a positive selection for those living alone.

Although most of this literature demonstrates the protective effect of death for people living with a partner, there is a lack of literature studying the impact of living arrangements on mortality in Latin American and developing countries. Recently, Rueda *et al.* (2022) studied the effect of living arrangements on life expectancy in three countries (Spain, Chile, and Costa Rica). In their results, the authors did not find differences in life expectancy in Costa Rica by living arrangement. However, the study highlights the need to include other mortality-related variables to untangle the relationship between living arrangements and mortality.

Additionally, some of the existing literature in Latin America focuses on living arrangement composition, as opposed to its effects on mortality. De Vos (2014) described Latin American households for women over 60 years old. The study states that childless women tend to live in extended family households when they start aging, unlike in European countries. She also finds that most people over 60 live in extended households in Latin America. The author also highlights that Latin American family arrangements and

households should be studied independently from other contexts, as they differ from those in other regions.

An example of a study of living conditions and mortality in the region is that by Sandoval and Alvear (2018), in which they find differences in mortality by living arrangements for older adults in Chile. This article emphasizes that it is beneficial for older adults to live with their partner, while being alone or in other living arrangements is counterproductive for their survival. It is crucial to explore this relationship within the Latin American context, given the known differences in household compositions compared with European populations.

Regarding living arrangements and health, Puga *et al.* (2007) show that, in general, living with a partner has a positive effect on an individual's health, whereas living with children is associated with worse health outcomes. However, the long-lasting effects of living arrangements differ across family models. In the case of Costa Rica, authors find that the positive effect of strong social ties diminishes over time and that there is only a weak association between social networks and health status.

According to the World Population Prospects (UN, 2019), Costa Rica had the highest life expectancy within the Latin American region, comparable to that observed in developed countries (80 years). It also has a declining natural population growth rate (7.9% by 2019) and an overall fertility rate lower than the replacement rate (1.31, INSTITUTO NACIONAL DE ESTADÍSTICA Y CENSOS, 2023). These factors have led Costa Rica to an advanced demographic transition among Latin American countries, along with Brazil and the Dominican Republic. Therefore, studying the mortality of older adults in this context can be helpful for policy planning in other countries in the region that are just starting to shift their population structure.

## Data and methods

### *Data*

We used the Costa Rica Longevity and Aging Study (CRELES) for the pre-1945 cohort (CRELES, 2005) and the waves that followed this group of respondents (2005, 2007, and 2009). CRELES is an ideal data source for this study, as it is a longitudinal registry with observed deaths during the study, characteristics necessary for survival analysis. In addition, CRELES is a nationally representative study that conducts detailed analyses of the living conditions of the elderly, so it has sufficient sociodemographic and health variables to study mortality and its social determinants. As an example of this, it has been used in around 80 peer-reviewed papers to assess different health and mortality conditions of the old age population in Costa Rica (for example, BRENES-CAMACHO, 2018; ROSERO-BIXBY, 2018; NOVAK; LOZANO-KEYMOLEN, 2018).

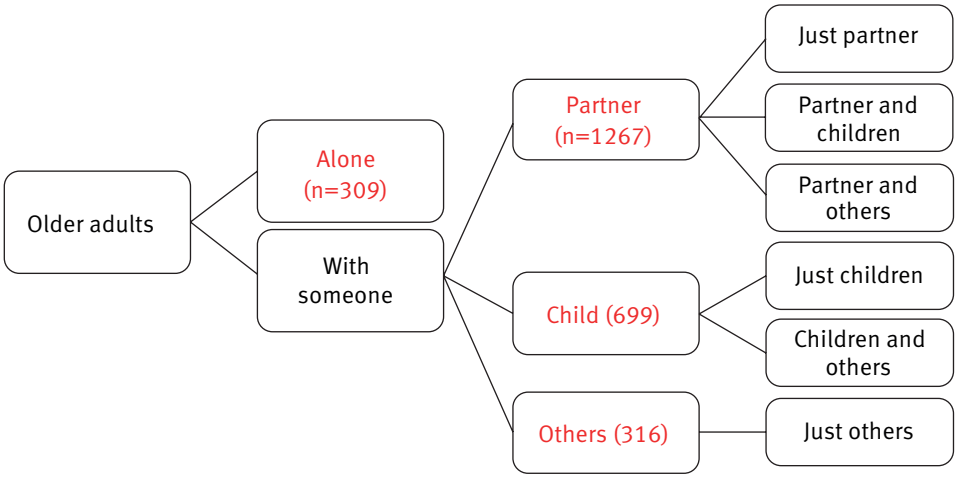
The target population for this study is Costa Rican older adults (60+ years) born in 1945 or earlier, with an oversample of people aged 95 years or older. The sample of the

first wave of CRELES consists of 2,827 Costa Ricans and 2,804 responses to the extended questionnaire. In the second wave, 195 (7%) individuals were lost to follow-up, and 249 (9%) were not contacted for the third wave. For the analytic sample, 213 individuals were excluded from the analysis because they had incomplete information on the variable of interest. A total of 505 (18%) older adults died during the follow-up period. The analytical sample includes 619 (23.88%) respondents that required a proxy after a cognitive evaluation at the beginning of the interview and the interviewer's assessment. We decided to keep them in the primary analysis, given that some of the effects of health conditions are assessed as part of the models, and mortality is the primary outcome of the study. However, a comparison of the complete models with and without proxy information can be found in the Annex .

*Variables and measures*

The variable of interest is the type of living arrangement. Information of the interviewee's household members was used to generate the living arrangements variable. It is important to highlight that this study does not intend to prove causality; however, the proposed methodology allows us to disentangle the relationship between mortality and living arrangements. Different categorizations of the living arrangements variable were considered, and we found that the four-category variable was the most suitable for this study since it was descriptive but not so extensive as to reduce the sample size. These categories are defined as follows: older adults who live alone, older adults who live with their partner (with or without others), older adults living with their children (with or without others except a partner), and older adults in other arrangements (living with other family or non-family members). Diagram 1 shows the four categories selected (in red) and the household members in each category.

**DIAGRAM 1**
**Living arrangement composition (and final sample size)**



All the control variables used were as reported in the first wave of the study. Although some of these variables remain fixed during the entire period (such as sex and educational attainment), others can change during a longitudinal follow-up (like health status). These changes are not considered in this study. The variables used for this analysis were classified into four categories based on the existing literature (ROGERS *et al.*, 2010). The group of demographic variables included age and sex. Age was included in its continuous form since the data sample is large enough, and there are no age clusters. The marital status variable was not considered within the demographic variables since it would remove independence on the categories of the variable of interest.

The socioeconomic variables were consistent with what Rosero-Bixby and Dow (2009) used in their study with the same data source. The variables analyzed include household wealth, defined as a simple count of household assets (max. 14). In this indicator, wealth corresponds to data-driven cut-off points defined in the quartile breaks in the distribution, resulting in a three-category variable (low, medium, and high) of household wealth level. Similarly, the education variable (three categories included: none, elementary, and secondary or higher) and type of locality were included in this category (rural or urban).

The variables related to health outcomes were classified into specific health conditions and health-related behaviors. These health-related variables are incorporated into the analysis because diseases and behaviors associated with them are directly related to lifespan. In the first group, a multimorbidity variable was calculated if the interviewees had at least two of the following conditions: cancer, lung disease, heart attacks, heart disease, arthritis, or stroke. Additionally, dummy variables for diabetes and hypertension were incorporated into the analysis. A variable of disability was constructed by using the Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADLs) variables. The cut-off point for disabled individuals was the inability to perform five or more (out of 14) tasks alone. In this case, both questionnaires were considered together since Rosero-Bixby and Dow (2009) showed the questionnaires were measuring the same dimension of disability in this sample.

The self-rated health indicator was considered in the same group of health outcome variables. Although other health conditions were already considered in the analysis, literature has shown that self-rated health incorporates additional dimensions of health into the models (GUMÀ, 2021). The survey was initially measured on a five-item Likert scale, and recategorized into two groups (good health and fair/poor health). Exercise and smoking were coded as dummy variables in the models on behavior-related variables. Also, information about obesity was considered by defining obesity as having a body mass index (BMI) higher than 30.

## Methodology

We estimate mortality differences using a Gompertz survival model with covariates. The initial time was calculated as the time of the first interview, while the final time was the date of death or the date of the last interview for censored respondents. For individuals lost to follow-up, censorship time is the mean time between their previous interview and the average interview date in the successive wave. This methodology assumes that those lost to follow-up contributed to half the risk exposure between their last observed time. This approach was taken because there are only three waves in the study, and it is a standard procedure in demography to consider individuals as half-time exposed to risk (e.g., Lexis triangles). Exposure time was calculated for all subjects as the difference between final and initial times in days.

A Gompertz regression model was used to analyze the risks of death (HOSMER; LEMESHOW, 1999). The goodness of fit tests were performed using the Cox-Snell criterion to verify the distribution. The descriptive and multivariate analyses were performed on the STATA 15 platform (Stata Corp. 2017).

## Results

*Descriptive analysis*

About 10% of older adults in Costa Rica reported living alone, and 60% living with their partners (Table 1). In addition, it was observed that both the demographic and socioeconomic variables are significantly different across living arrangements. Regarding the distribution of living arrangements, it was observed that women tend to live more with children or with other people than men. This could be explained as a side effect of widowhood. Similarly, it is observed that the majority of the sample (72.2%) is between 60 and 75 years old and that this younger group tends to live more with a partner than the older age group. Again, this can be explained as an effect of widowhood.

Table 1 shows the descriptive analysis of the variables in round one for each category of the variables of interest and the total. The results were obtained by applying sample weights, which allows us to generalize them to the entire Costa Rican elderly population. In addition, the table presents the statistical significance level for each variable obtained by the chi-squared test by groups at the sample level (no weights). This helped to determine whether the variable was distributed differently according to living arrangements.

**TABLE 1**
**Variable distribution on wave 1**
**Costa Rica – 2005**

Percentage

| Variables / living arrangements | Total | Alone | With partner (with/ without others) | With children (with/without others except partners) | Other arrangements |
|---|---|---|---|---|---|
| | 100 | 9.77 | 59.51 | 20.05 | 10.66 |
| **Demographic** | | | | | |
| Sex *** | | | | | |
| Female | 52.69 | 55.63 | 39.52 | 80.26 | 71.53 |
| Male | 47.31 | 44.37 | 60.48 | 19.74 | 28.47 |
| Age*** | | | | | |
| <75 years | 72.20 | 56.91 | 80.85 | 56.80 | 66.99 |
| 75+ years | 27.80 | 43.09 | 19.15 | 43.20 | 33.01 |
| **Socioeconomic** | | | | | |
| Household wealth*** | | | | | |
| Low | 11.71 | 26.48 | 9.66 | 10.85 | 11.24 |
| Mid | 64.47 | 61.46 | 62.84 | 69.44 | 67.01 |
| High | 23.81 | 12.06 | 27.50 | 19.71 | 21.75 |
| Educational Attainment *** | | | | | |
| None | 13.50 | 15.20 | 11.86 | 16.55 | 15.34 |
| Primary | 64.97 | 63.53 | 64.68 | 68.63 | 61.01 |
| Secondary or higher | 21.53 | 21.28 | 23.45 | 14.82 | 23.65 |
| Type of area*** | | | | | |
| Urban | 62.47 | 63.85 | 59.37 | 66.73 | 70.44 |
| Rural | 37.53 | 36.15 | 40.63 | 33.27 | 29.56 |
| **Health variables** | | | | | |
| Hypertension | | | | | |
| Yes | 48.37 | 50.29 | 46.61 | 54.71 | 44.46 |
| No | 51.63 | 49.71 | 53.39 | 45.29 | 55.54 |
| Diabetes* | | | | | |
| Yes | 20.75 | 14.85 | 21.95 | 20.93 | 19.19 |
| No | 79.25 | 85.15 | 78.05 | 79.07 | 80.81 |
| Multimorbidity** | | | | | |
| Yes | 11.59 | 10.26 | 10.64 | 13.66 | 14.22 |
| No | 88.41 | 89.74 | 89.36 | 86.34 | 85.78 |
| Self-rated health | | | | | |
| Good | 52.64 | 51.42 | 52.48 | 53.03 | 53.94 |
| Fair or bad | 47.36 | 48.58 | 47.52 | 46.97 | 46.06 |
| ADLs & IADLs*** | | | | | |
| Healthy | 81.23 | 83.15 | 86.28 | 69.92 | 72.56 |
| Disabled | 18.77 | 16.85 | 13.72 | 30.08 | 27.44 |
| **Health-related behaviors** | | | | | |
| Smoked *** | | | | | |
| Yes | 42.77 | 46.69 | 47.20 | 30.48 | 37.58 |
| No | 57.23 | 53.31 | 52.80 | 69.52 | 62.42 |

(continue)

(continued)

| Variables / living arrangements | Total | Alone | With partner (with/ without others) | With children (with/without others except partners) | Other arrangements |
|---|---|---|---|---|---|
| Exercise*** | | | | | |
| Yes | 31.95 | 30.86 | 36.16 | 22.11 | 28.00 |
| No | 68.05 | 69.14 | 63.84 | 77.89 | 72.00 |
| Obesity | | | | | |
| Yes | 29.35 | 31.02 | 29.39 | 29.25 | 27.72 |
| No | 70.65 | 68.98 | 70.61 | 70.75 | 72.28 |

Source: CRELES pre-1945 cohort wave 2005.
***p<0.000, **p<0.05, *p<0.10.

Table 1 shows statistically significant differences in the socioeconomic variables by living arrangement. On the health variables, we see that multimorbidity and some degree of disability differ significantly between living arrangement categories. At the same time, self-rated health and hypertension do not differ among groups. That is to say, they do not vary depending on the living arrangement. Regarding the impact of health-related behaviors, we see that exercising and having smoked are distributed differently across groups. The low effect of hypertension, diabetes and obesity observed can be explained by a nationalized and accessible healthcare system.

*Model analysis*

Four Gompertz regression models were calculated to evaluate the effect of the living arrangement variable. The models allow us to observe how mortality levels vary by the tested covariates. The first model shows the effect of the different living arrangements, controlled by the demographic variables. Subsequently, a model that incorporates the socioeconomic variables is shown. The third model adds the health variables to the analysis. Finally, a model that includes all previous variables and behaviors related to health is presented. The estimates of these models are presented in Table 2.

**TABLE 2**
**Gompertz models' relative risks estimates**
**Costa Rica – 2005- 2009**

| Variables | Model 1 RR [CI] | Model 2 RR [CI] | Model 3 RR [CI] | Model 4 RR [CI] |
|---|---|---|---|---|
| **Living arrangements** | | | | |
| With partner (with/without others) ref. | 1 | 1 | 1 | 1 |
| Alone | 0.93 [0.66, 1.30] | 0.94 [0.67, 1.32] | 1.15 [0.82, 1.62] | 1.17 [0.83, 1.65] |
| With children (with/ without others except partner) | 1.50** [1.18, 1.92] | 1.51 ** [1.18, 1.93] | 1.44 ** [1.12, 1.84] | 1.44 ** [1.13, 1.84] |
| Other arrangements | 1.35 * [0.99, 1.85] | 1.36 * [0.99, 1.86] | 1.39 ** [1.02, 1.91] | 1.41 ** [1.03, 1.93] |

(continue)

(continued)

| Variables | Model 1 RR [CI] | Model 2 RR [CI] | Model 3 RR [CI] | Model 4 RR [CI] |
|---|---|---|---|---|
| Sex | | | | |
| Male ref. | 1 | 1 | 1 | 1 |
| Female | 0.75 ** [0.62, 0.92] | 0.75 ** [0.61, 0.91] | 0.65 ** [0.53, 0.80] | 0.60 *** [0.48, 0.75] |
| Age (cont.) | 1.08 *** [1.07, 1.09] | 1.08 *** [1.07, 1.09] | 1.06 *** [1.05, 1.07] | 1.06 *** [1.05, 1.07] |
| Household wealth | | | | |
| Low ref. | | 1 | 1 | 1 |
| Mid | | 1.03 [0.79, 1.36] | 1.10 [0.84, 1.45] | 1.10 [0.84, 1.45] |
| High | | 1.05 [0.74, 1.48] | 1.13 [0.80, 1.60] | 1.13 [0.80, 1.60] |
| Educational attainment | | | | |
| Primary ref. | | 1 | 1 | 1 |
| None | | 0.90 [0.72, 1.13] | 0.85 [0.68, 1.07] | 0.85 [0.67, 1.06] |
| More than primary | | 0.91 [0.65, 1.28] | 1.07 [0.77, 1.51] | 1.08 [0.77, 1.52] |
| Type of area | | | | |
| Rural ref. | | 1 | 1 | 1 |
| Urban | | 0.99 [0.80, 1.21] | 1.00 [0.82, 1.23] | 1.00 [0.82, 1.22] |
| Hypertension | | | | |
| No ref | | | 1 | 1 |
| Yes | | | 0.91 [0.75, 1.11] | 0.89 [0.74, 1.09] |
| Diabetes | | | | |
| No ref | | | 1 | 1 |
| Yes | | | 1.44 *** [1.14, 1.82] | 1.41 ** [1.11, 1.79] |
| Multimorbidity | | | | |
| No ref | | | 1 | 1 |
| Yes | | | 1.26 * [1.00, 1.58] | 1.25* [0.99, 1.57] |
| Self-rated health | | | | |
| Good ref. | | | 1 | 1 |
| Fair or bad | | | 1.26 ** [1.03, 1.54] | 1.24** [1.01, 1.52] |
| ADL & IADLs | | | | |
| Healthy ref. | | | 1 | 1 |
| Disabled | | | 3.00*** [2.35,3.83] | 2.78 *** [2.17, 3.56] |
| Smoked | | | | |
| No ref | | | | 1 |
| Yes | | | | 0.91 [0.74, 1.12] |
| Exercise | | | | |
| No ref | | | | 1 |
| Yes | | | | 0.62 ** [0.44, 0.87] |

(continue)

(continued)

| Variables | Model 1 RR [CI] | Model 2 RR [CI] | Model 3 RR [CI] | Model 4 RR [CI] |
|---|---|---|---|---|
| Obesity | | | | |
| No ref | | | | 1 |
| Yes | | | | 1.18 [0.93, 1.50] |
| **Constant** | 0.00 *** [0.00, 0.00] | 0.00 *** [0.00, 0.00] | 0.00 *** [0.00, 0.00] | 0.00 *** [0.00, 0.00] |
| **Gamma** | 0.00 ** [0.00, 0.00] | 0.00 ** [0.00, 0.00] | 0.00 *** [0.00, 0.00] | 0.00 *** [0.00, 0.00] |

Source: CRELES pre-1945 cohort: waves 2005, 2007, and 2009.
***p<0.000, **p<0.05, *p<0.10.

From model 1, it is observed that women have a 25% lower risk of death than men, while for each additional year of life, the risk increases by 8%. This indicates that age and sex create differences in mortality between those older adults who live alone and those who live with a partner. Similarly, the effect of living with children and living in other arrangements is diminished by incorporating these variables. That said, these variables are still significant, and the risk of death for those who live with their children increases by 50% compared to those who live with a partner, while living in other arrangements increases the risk by 35%.

Model 2 shows no change in the magnitude and significance of the residential variable when incorporating the socioeconomic variables. Additionally, socioeconomic variables are not significant in this model, which is an important result since they would be pointing out that in Costa Rica the mortality of older adults is not affected by economic inequality factors. This is consistent with previous findings (ROSERO-BIXBI; DOW, 2009).

In model 3, which incorporates health variables, the coefficients of the living arrangement for two categories increase, indicating that the effect is enhanced when controlling for pre-existing diseases. This finding is consistent, considering that diseases are related to mortality. In this case, living with children increases the risk of dying by 44%, while living in other arrangements increases risk of dying by 39% compared to living with a partner.

Regarding health variables, it is noteworthy that hypertension has no effect on mortality, which is unusual in this kind of population. However, Rosero-Bixbi and Dow (2016) point out that the effect of the health system in Costa Rica is associated with mortality and high life expectancy, so it can be understood that the effect of hypertension on mortality is not significant as there is a sound healthcare system with accessible medication. For example, almost half of interviewees had been prescribed with antihypertensive medicine (ROSERO-BIXBY; COTO-YGLESIAS; DOW, 2016). On the other hand, it is seen that diabetes increases the risk of death by 44%, while multimorbidity does so by 26%. Bad self-reported health increases the risk of dying by 26%.

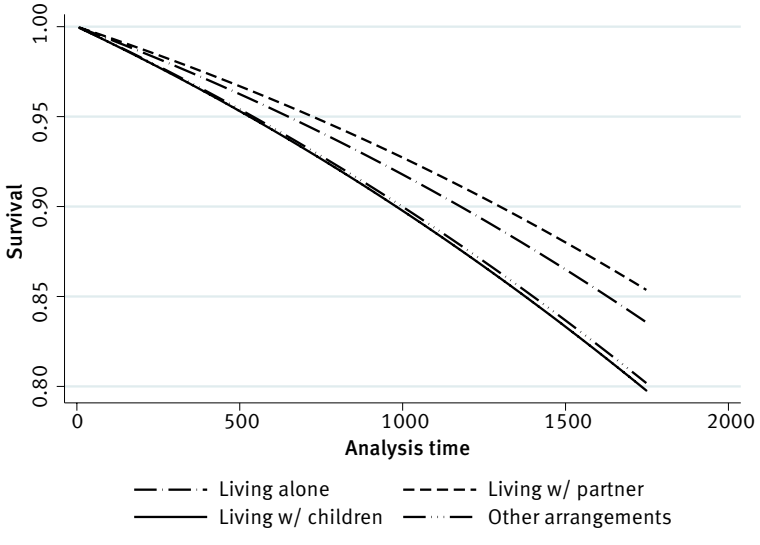
Finally, model 4 incorporates all the variables selected from the literature for this research. The findings within this model report that living arrangements continue to be

important in explaining the mortality of the elderly in Costa Rica, even when controlling for other factors. Those who live with their children increase the risk of dying by 44%, while those older adults who live in other living arrangements have a 41% increase in risk of death with respect to those who live with a partner. There are no significant differences between living alone and living with a partner.

When adding the health behaviors to the model, it is observed that the differences between the sexes get more robust and significant. Women have a 40% lower chance of death compared to men. This result is important since it shows that when incorporating the dimension of self-care, sex differences are statistically significant. Likewise, for each additional year of life, the risk of death increases by 6%, while having diabetes increases this risk by 41%. Multimorbidity, as expected, increases the risk of death by 25%. In the self-reported health variable, having regular or bad health increases the risk by 24%. This model also shows that exercising reduces the risk of death by 28%, while having physical disabilities adds more than double the risk of death. On the contrary, neither having smoked at some point in life nor obesity were significant variables in the risk of death.

From Figure 1, we can see the estimated survival trajectories from model 4 for each living arrangement. Remarkably, there is little (or no difference) across the survival trajectory for people living with their children and those living with other family and no family members. According to the model estimates, the best setting is to live with a partner, and the worst is living with children.

**FIGURE 1**
**Gompertz survival curves of model 4**




Source: CRELES pre-1945 cohort waves 2005, 2007, and 2009.

## Discussion

From the previous analysis, it can be concluded that living with a partner improves the chances of survival for Costa Rican older adults. However, being with a partner is no different from being alone when additional factors, such as health behaviors, are incorporated into the analysis. This can also be considered a selection bias, meaning that those who live alone generally have better health, more sufficiency, and no need to share the household, as Requena and Reher (2020) suggest.

Additionally, this study shows that living with children without a partner has a higher mortality risk in all scenarios. This highlights the need for a support network for those in this living arrangement to ensure the best quality of life and health outcomes. These conclusions differ from findings of other studies in the region, such as Sandoval and Alvear's (2018), in which being alone increases the risk of death. However, in this study, there is no statistically significant difference with living with a partner, when controlling for sociodemographic variables. Nevertheless, these differences could be explained by the socioeconomic and cultural singularities between Chile and Costa Rica. Chile is an older country with a mixed social security system, whereas Costa Rica is an aging country with a public social security system. These differences directly impact mortality outcomes.

From the results, the worst scenario for survival was living with children and living with others. This result can be partially explained due to the previously mentioned healthy selection bias. However, even when controlling for some health variables (model 4), results remained the same. There are other potential explanations for these relationships. For example, survival may be reduced when children care for older adults given the lack of knowledge to take care of medical conditions. Another factor that might cause this discrepancy is divided attention. When living in multigenerational households, care providers must split their time among all those needing care; therefore, there is a care necessity competition between, for example, elders and children.

This study also shows differences when sex and age are considered. When those variables are included in the analysis, the effect of living arrangements decreases. As age increases, so does mortality, which is entirely consistent with mortality theory. In the case of sex, being a female is shown to be a protective factor, which is also consistent with mortality literature.

It is essential to point out some of the limitations of this study. Firstly longitudinal survey data has some attrition problems (more on this in annex 3). In this case, 16% of the original sample was lost. The assumption of censoring times is also a matter of methodological decision that can lead to differences if other criteria are selected. Secondly, there is a need for knowledge on the direction of intergenerational transfers. It is unclear why parents and children are living together. It could be that children are trying to be effective caregivers for interviewees. However, it could also be that older adults are helping their children (e.g., economic-related reasons).

This study also includes information from the questionnaires filled out by proxy respondents. The reason not to exclude these answers is to correctly assess the mortality of the overall population, and not a selected one (presumably healthier). The proxy respondents' group has over three-fourths of people aged over 75. However, demographic and health-related variables were introduced during the model construction, thus controlling some of the bias generated by proxy answers. Additionally, Annex 1 includes a comparison within the model with and without proxies. We can see that most of the variables' coefficients maintain their significance and direction for both models.

In addition, this study used the living arrangement at the time of the first interview to observe the occurrence of deaths. However, it is considered of interest to observe the effect of the change in the living arrangements over time. The former could help determine if the transitions through different states of this variable influence the risk of death in advanced ages. Similarly, health variables and health-related behavior covariates may differ over time, so studying their temporal effect should be considered in future studies. Finally, it is relevant to highlight that this study does not intend to show causation. Instead, it offers an association within variables. Future studies can focus on causation analysis.

Finally, it is worth highlighting the importance of family support systems in Latin America. The heterogeneous arrangements in the region make them worthy of analysis in reference to different outcomes, including mortality. This is the first step towards broader research on living arrangements and mortality outcomes in Latin America.

## Conclusions

In conclusion, there is an association between living arrangements and mortality. Living with a partner was shown to reduce the risk of mortality. On the contrary, living with children or other family and non-family members increases the risk of death by up to 40%, controlling for demographic, socioeconomic, health, and social variables for health related behaviors. Furthermore, in Costa Rica, no differences were found between living alone and living as a couple, a possible result of the Costa Rican healthcare system. It was also shown that the variables close to the socioeconomic level do not influence elderly mortality. This indicates the reduction of inequality in the later ages.

Given the current context of population aging , knowing these determinants of mortality will allow decision-makers to implement more effective actions to reduce the risks of death. It is especially important to acknowledge that life decisions, such as retirement, are made within the household. Although there is still much to investigate in this field, this is a first approximation of the conditions in which older adults live and how they are affected by them. Based on these results, it is essential to develop public policies that promote care work for older adults in other spaces and not only within couples. It is also necessary to conduct awareness campaigns for children and other family members to show the importance of physical and emotional care for older adults' health and survival.

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## Resumo

*Melhor sozinho? O impacto de arranjos domiciliares na mortalidade de idosos costarriquenhos*

Pesquisas anteriores mostraram efeitos diferenciados dos tipos de arranjos residenciais sobre a mortalidade. Entretanto, pouco se sabe sobre os fenômenos na América Latina e suas residências multigeracionais. Este estudo aborda a relação entre os tipos de arranjos residenciais de idosos e a mortalidade subsequente. A análise de sobrevivência foi realizada por meio do modelo Gompertz, estimando as diferenças de mortalidade entre os diferentes arranjos domiciliares. Foi utilizado o Estudo da Longevidade e Envelhecimento da Costa Rica (CRELES) pré-1945, de 2005, 2007 e 2009. Os resultados mostram que os idosos que vivem com companheiro apresentam as maiores taxas de sobrevivência entre as categorias testadas. Ao controlar por sexo e idade no modelo, o efeito de morar sozinho não é diferente de morar com companheiro. Se os fatores

socioeconômicos e de saúde forem controlados, os idosos que vivem com seus filhos ou outras pessoas possuem um risco aumentado de morte em pelo menos 40% (p-valor ‹0,05). O estudo demonstra que existe uma associação entre os arranjos domiciliares e a mortalidade de idosos na Costa Rica. Os resultados mostram que as maiores chances de sobrevivência estão entre os idosos que possuem um parceiro, sugerindo que os cuidados providos por membros da família não são igualmente efetivos. A inclusão desse tipo de variável nos estudos de mortalidade é crucial para entender como as condições domiciliares se relacionam com os resultados de saúde e mortalidade.

**Palavras-chave**: Arranjos domiciliares. Mortalidade em idosos. Costa Rica.

## Resumen

*¿Mejor solo? El impacto de los arreglos de vivienda en la mortalidad de las personas adultas mayores costarricenses*

La literatura anterior a este artículo ha mostrado efectos diferenciados de los tipos de arreglos de vivienda en la mortalidad. Sin embargo, poco se sabe sobre el fenómeno en Latinoamérica y sus viviendas multigeneracionales. Este estudio mide la relación entre los tipos de arreglos de vivienda de las personas adultas mayores y la subsecuente mortalidad. Modelos de historia de eventos Gompertz se hicieron para estimar las diferencias de mortalidad entre los arreglos de vivienda. Se utilizó el Estudio de Longevidad y Envejecimiento Saludable (CRELES) en la cohorte pre-1945 y las rondas 2005, 2007 y 2009. Los resultados muestran que las personas adultas mayores que viven con una pareja tienen las mayores tasas de sobrevivencia entre las categorías comparadas. Al controlar por sexo y edad en el modelo, el efecto de vivir solo no es diferente del de estar emparejado. Si también se controlan los factores socioeconómicos y de salud, los las personas adultas mayores que viven con hijos o hijas o con otros muestran un riesgo de muerte al menos 40 % mayor (p-valor ‹0,05). El estudio demuestra que existe una relación entre los arreglos de vivienda y la mortalidad de las personas adultas mayores en Costa Rica. Los resultados muestran que las mayores probabilidades de supervivencia recaen en estar emparejado y sugieren que los intercambios de apoyo con otros miembros de la familia no son igualmente efectivos. La inclusión de este tipo de variables en los estudios de mortalidad es crucial para entender cómo se relacionan las condiciones de vivienda con los resultados de salud y mortalidad.

**Palabras clave**: Arreglos de vivienda. Mortalidad adulta mayor. Costa Rica.

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## Annex 1

### *Proxy analysis*

**TABLE 1**
**Comparison of estimates including and excluding proxy respondents' information**

| Variables | Model 4<br>RR [CI] | Model 4 W/O Proxy answers<br>RR[CI] |
|---|---|---|
| **Living arrangement** | | |
| With partner (with/without others) ref. | 1 | 1 |
| Alone | 1.17 | 1.12 |
| | [0.83, 1.65] | [0.70, 1.79] |
| With children (with/ without others except partner) | 1.44 ** | 1.52** |
| | [1.13, 1.84] | [1.04,2.20] |
| Other arrangements | 1.41 ** | 1.26 |
| | [1.03, 1.93] | [0.76, 2.09] |
| Sex | | |
| Male ref. | 1 | 1 |
| Female | 0.60 *** | 0.57 ** |
| | [0.48, 0.75] | [0.40, 0.82] |
| Age (cont.) | 1.06 *** | 1.06 *** |
| | [1.05, 1.07] | [1.04, 1.08] |
| Household wealth | | |
| Low ref. | 1 | 1 |
| Mid | 1.1 | 1.07 |
| | [0.84, 1.45] | [0.67, 1.70] |
| High | 1.13 | 1.07 |
| | [0.80, 1.60] | [0.61, 1.87] |
| Educational attainment | | |
| Primary ref. | 1 | 1 |
| None | 0.85 | 0.81 |
| | [0.67, 1.06] | [0.52, 1.25] |
| More than primary | 1.08 | 1.09 |
| | [0.77, 1.52] | [0.69, 1.71] |
| Type of area | | |
| Rural ref. | 1 | 1 |
| Urban | 1 | 1 |
| | [0.82, 1.22] | [0.72, 1.38] |
| Hypertension | | |
| No ref | 1 | 1 |
| Yes | 0.89 | 0.83 |
| | [0.74, 1.09] | [0.62, 1.12] |
| Diabetes | | |
| No ref | 1 | 1 |
| Yes | 1.41 ** | 1.64 ** |
| | [1.11, 1.79] | [1.17, 2.30] |

(continue)

(continued)

| Variables | Model 4<br>RR [CI] | Model 4 W/O Proxy answers<br>RR[CI] |
|---|---|---|
| Multimorbidity | | |
| No ref | 1 | 1 |
| Yes | 1.25* | 1.23 |
| | [0.99, 1.57] | [0.84, 1.79] |
| Self-rated health | | |
| Good ref. | 1 | 1 |
| Fair or bad | 1.24** | 1.31 * |
| | [1.01, 1.52] | [0.97, 1.79] |
| ADL & IADLs | | |
| Healthy ref. | 1 | 1 |
| Disabled | 2.78 *** | 1.76 ** |
| | [2.17, 3.56] | [1.24, 2.51] |
| Smoked | | |
| No ref | 1 | 1 |
| Yes | 0.91 | 0.96 |
| | [0.74, 1.12] | [0.69, 1.33] |
| Exercise | | |
| No ref | 1 | 1 |
| Yes | 0.62 ** | 0.65 ** |
| | [0.44, 0.87] | [0.43, 0.97] |
| Obesity | | |
| No ref | 1 | 1 |
| Yes | 1.18 | 1.37 * |
| | [0.93, 1.50] | [0.98, 1.92] |
| **Constant** | 0.00 *** | 0.00 *** |
| | [0.00, 0.00] | [0.00, 0.00] |
| **Gamma** | 0.00 *** | 0.00 ** |
| | [0.00, 0.00] | [0.00, 0.00] |

Source: CRELES pre-1945 cohort waves 2005, 2007, and 2009.
***p<0.000, **p<0.05, *p<0.10

From Table 1, we can see that the model without proxies loses significance in the health-related variables, like self-reported health and multimorbidity. This is consistent with the hypothesis of it being a selected and healthier population. For the living arrangements, the category being with others loses significance. This could once again be explained by the fact they are in better health conditions.

## Annex 2

### *Model validity*

After fitting the models, AIC and BIC tests were performed to estimate the best fit. Under AIC criteria, the best model is model 4 while under BIC is model 3. The results of

these tests are presented in Table 1. Under AIC criteria, the second-best model is number 5, while for BIC, it is number 4. This happens because the BIC penalizes by the number of degrees of freedom. It was decided to include the variables for socioeconomic level in the models despite their not being significant because the absence of significance is noteworthy. Crimmins (2005) suggested the effect of socioeconomic level in older ages decreases because those who reach these ages were previously selected, and inequalities have less influence on mortality.

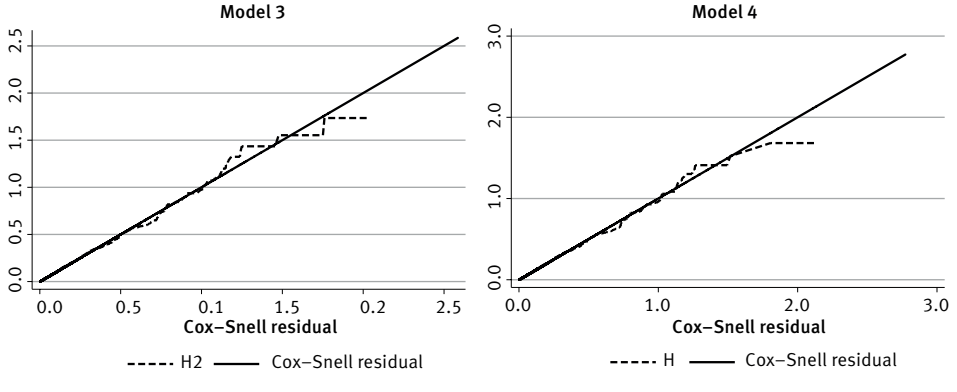
**TABLE 2**
**Akaike and Bayesian information criteria**

| Model | Observations | ll(null) | ll(model) | DF | AIC | BIC |
|---|---|---|---|---|---|---|
| 1 | 2,593 | -1616.93 | -1574.44 | 5 | 3158.89 | 3188.19 |
| 2 | 2,593 | -1616.93 | -1416.71 | 7 | 2847.42 | 2888.45 |
| 3 | 2,593 | -1616.93 | -1416.17 | 12 | 2856.33 | 2926.66 |
| 4 | 2,593 | -1616.93 | -1352.93 | 17 | 2739.87 | 2839.5 |
| 5 | 2,593 | -1616.93 | -1347.49 | 20 | 2734.99 | 2852.20 |

Source: CRELES pre-1945 cohort waves 2005, 2007, and 2009.

Cox-Snell residual models were run to estimate the goodness of fit of models 3 and 4 to decide which one has a better fit. The graph shows that the model 5 fit is slightly better since the accumulated Hazard estimates are closer to the 45 degrees line until the last survival times, where there are slight jumps, which is not uncommon in mortality studies.

**FIGURE 1**
**Models 3 & 4 Cox-Snell's residuals**




Source: CRELES pre-1945 cohort waves 2005, 2007, and 2009.

## Annex 3

*Attrition*

The original sample lost 444 (195 + 249) interviewees due to attrition. However, given the other sample selection decisions (for example, having complete information), in the final sample, only 422 subjects were lost. Of these 422, a chi-squared test did not show statistically significant differences (p-value = 0.220) in the distribution of these attrition observations by living arrangements (Table 3).

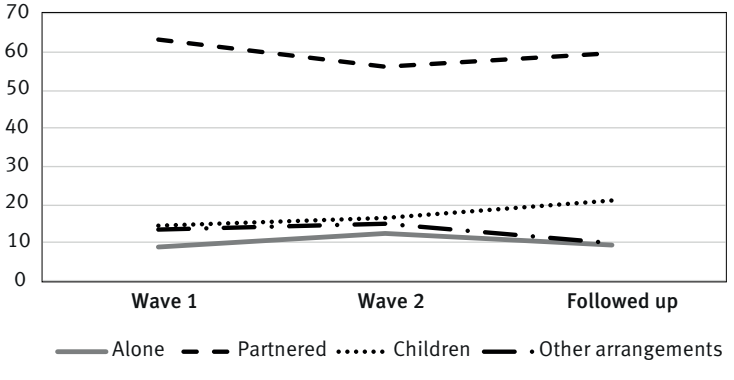
TABLE 3
Attrition by living arrangement

| Wave | Alone | With partner (with/ without others) | With children (with / without others except partner) | Other arrangements |
|---|---|---|---|---|
| 1 | 18 | 96 | 32 | 29 |
| 2 | 40 | 115 | 52 | 40 |
| Total | 58 | 221 | 84 | 69 |

Source: CRELES pre-1945 cohort waves 2005, 2007, and 2009.

When comparing to the non-lost follow up interviewees, the distribution (both weighted and non-weighted) shows a very similar trend, although with different levels in the frequency of individuals per category. Despite the differences in the distributions amounting to less than eight percentage points, the chi-squared test showed significant differences by group.

FIGURE 2
Weighted frequency distribution by living arrangement and interviewee follow up




Source: CRELES pre-1945 cohort waves 2005, 2007, and 2009.