Universitat Autònoma de Barcelona

Condiciones de salud de la población adulta mayor en Europa y América Latina. Aportaciones metodológicas

Sarahí Rueda-Salazar

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Doctorado en Demografía

Tesis Doctoral

Condiciones de salud de la población adulta mayor en Europa y América Latina. Aportaciones metodológicas

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Resumen

La presente tesis comprende el estudio de las trayectorias de salud, desde el enfoque socio-funcional, de la población adulto mayor en diferentes contextos demográficos y geográficos a través de sus cuatro capítulos y se utilizan diferentes aproximaciones metodológicas en el análisis de supervivencia como una aportación empírica en el estudio de las dinámicas de salud, haciendo uso de datos longitudinales de diferentes encuestas de Europa y América Latina. En cada capítulo se analiza con especial atención la influencia de los arreglos de convivencia sobre los cambios de salud como un determinante fundamental en las trayectorias de salud en el envejecimiento.

En el primer capítulo, mediante el uso de "efectos aleatorios" en el análisis de supervivencia, se describen las trayectorias de salud (deterioros de salud, mejoras de salud y mortalidad) en países de diferentes regiones de Europa (por el sur de Europa: Chipre, Grecia, España, Italia, Malta, Portugal; Europa Occidental: Austria Bélgica, Irlanda, Luxemburgo; Europa del este: Bulgaria, La Rep. Checa, Hungría, Polonia, Romania and Eslovaquia; y por la región báltica: Estonia, Lituania, Letonia). Por tanto, se analiza la variabilidad de las transiciones de salud de las personas mayores según el país de residencia y el tipo de arreglo de convivencia de los mayores. El segundo capítulo incluye un breve ensayo sobre la metodología de modelos de múltiples estados lo cual es crucial para entender su aplicación; se realiza una introducción a los modelos y se explican los principales conceptos e implicaciones. Luego, el tercer capítulo ilustra la influencia de las condiciones socioeconómicas sobre las trayectorias de salud en nueve países europeos mediante la aplicación de modelos de "múltiples estados". El cuarto y último capítulo utiliza una segunda aproximación de los mencionados modelos para el cálculo de la esperanza de vida y años saludables. Este capítulo presenta una comparación de las trayectorias de funcionalidad de las personas mayores entre dos países de América Latina (Costa Rica y Chile) y un país de Europa (España); se analiza el efecto diferencial de los arreglos de convivencia en los años de vida y se incluye la variable de participación social como un determinante del entorno asociado positivamente con los años en buena salud.

Los resultados más destacados de la presenta tesis indican que en el contexto europeo, los países del este tienen menores probabilidades de mejoras de salud que los países del sur y de occidente, sin embargo, no todos los países comparten el mismo patrón. De forma particular, la paradoja según género en la esperanza de vida no se apreció en países del este de Europa. En efecto, estas exhiben mayores probabilidades de mejoras de salud que los hombres. Característica que no se había observado en estudios previos. Esto indica un efecto de los estilos

de vida y actitudes hacia la salud diferenciados por género (exposición al riesgo de accidentes, consumo de tabaco y de alcohol). Entre los países del sur de Europa, se aprecian diferencias en la influencia de las pautas de convivencia en la salud. En el caso de España e Italia, países con pautas similares en cuanto a envejecimiento y arreglos de convivencia, se observó que la convivencia con pareja e hijos en Italia está asociada positivamente a mejoras en la salud de los mayores, en tanto que en España se observa un patrón opuesto.

Por otro lado, en la muestra de todos los países analizados, las mujeres que viven solas reportaron tener mejor salud en comparación a aquellas que viven en pareja, indicando un efecto de varios factores (efecto de selección de las mujeres que llegan a edades más longevas solas, actitudes hacia la declaración del estado de salud, la exclusión de población institucionalizada, entre otros factores). La educación tiene efectos significativos en los mayores que viven con otros, mostrando que los mayores más instruidos en este grupo tienen una mayor probabilidad de mejoras de salud respecto a los que tienen estudios de primaria o menos.

La comparación de los dos mayores en Chile, Costa Rica y España ilustró que las pautas de convivencia tienen influencia en la supervivencia y años saludables, pero se identifican diferentes efectos según grupos de convivencia. En tanto que, la participación social mostró un efecto relevante en el aumento de años saludables en los tres países con diferentes magnitudes. Por último, la ilustración de diferentes aplicaciones de análisis de supervivencia aporta evidencia empírica para el estudio de los cambios de salud con la intención de proveer alternativas para futuras investigaciones. Cada una de las técnicas utilizadas mostraron un uso diferente en correspondencia de los objetivos de investigación.

Abstract

This thesis studies the health conditions of the elderly population from a socio-functional approach in different demographic and geographical contexts through its four chapters. Different methodological approaches are applied in survival analysis as an empirical contribution in the study of health dynamics, making use of the longitudinal design of different European and Latin American surveys. In each chapter, special focus is also given to the influence of living arrangements on health changes as it is a fundamental determinant in health trajectories in ageing.

The first chapter, through the use of "random effects models" in survival analysis, describes the health trajectories (health deterioration, health improvements and mortality) in countries from different European regions (for Southern Europe: Cyprus, Greece, Spain, Italy, Malta, Portugal; Western Europe: Austria Belgium, Ireland, Luxemburg; Eastern Europe: Bulgaria, the Czech Republic, Hungary Poland, Romania and Slovakia; and for the Baltic region: Estonia, Lithuania, Latvia). It also analyses the variability of elderly health transitions according to the country of residence and the types of living arrangement. The second chapter includes a brief essay on the methodology of Multi-State Models (MSM), which is crucial to understand these models. The main concepts and implications are explained in this section. Subsequently, in the third chapter MSM are applied to exemplify the influence of socioeconomic conditions on health trajectories in nine European countries. The fourth and final analytical chapter uses a second approximation of these models by calculating life expectancy and healthy life years. This chapter presents a comparison of the functional trajectories of the elderly between two countries in Latin America (Costa Rica and Chile) and a country in Europe (Spain). The differential effect of living arrangements in life expectancy is analysed, whereby educational attainment and a social participation variable is additionally included as a determinant of the environment. Results show that social participation is positively associated with the years in good health.

The most noteworthy results of this thesis include the fact that in the European context, eastern European countries are less likely to improve their health than countries in southern and western Europe. However, not all countries share the same pattern. In particular, the gender paradox in life expectancy was not reported in some Eastern European countries (the Czech Republic, Hungary and Poland). Elderly women in these countries exhibit greater probabilities of health improvements than men. This feature has not been observed in previous studies. This also indicates gender differences in lifestyles and attitudes towards health (exposure to the risk of accidents, tobacco and alcohol consumption). Among the countries of southern Europe, there

are differences in the influence of living arrangements patterns on health. In the case of Italy and Spain, despite showing similar patterns in terms of ageing and living arrangements, an opposite pattern can be observed as living with both partner and children in Italy is positively associated with a higher likelihood of improvements in the health of elderly, while in Spain the opposite effect was observed.

On the other hand, in the sample of all European countries analysed, women who live alone reported to have better health compared to women who live as a couple. This indicates an effect of several factors (selection effect of women who reach older ages, attitudes towards the declaration of health status and the exclusion of the institutionalized population, among others factors). Education was significant for the elderly who live with others, which implies that the most educated people in this group have a higher probability of health improvements at older ages compared to those who have primary school or less.

In the fourth chapter that compares the elderly in Chile, Costa Rica and Spain, shows that patterns of living arrangements have an influence on survival and healthy life years, but different effects are identified according to living arrangement. At the same time, social participation showed a relevant effect in the increase of healthy years in the three countries, although with different magnitudes. Finally, the application of different approaches of survival models provides empirical evidence for the study of health changes with the intention of providing alternatives for future research. Each of the techniques used show a different use and correspond to the research objectives.

Table of contents/Tabla de contenido

List of Tables/Lista de tablas

List of Figures/Lista de Figuras

Introducción

Presentación y justificación del tema de investigación

Las trayectorias de salud de la población adulta mayor es un tema central de atención en la actualidad por el aumento de la demanda de programas de cuidado de larga duración en respuesta al creciente envejecimiento de la población a nivel mundial (1). En este sentido el estudio de los cambios de estado de salud de las personas mayores y sus factores asociados son de vital relevancia para la planificación de políticas públicas que proporcionen el bienestar integral de la población en la tercera edad.

En este contexto la presente tesis aborda las condiciones de salud de la población mayor en Europa y América Latina por medio del análisis de factores individuales y exógenos que influyen en los cambios de salud de los mayores en diferentes regiones. El estudio está enfocado en la influencia de las pautas de convivencia sobre los cambios de estados de salud de los mayores, como un elemento de vital relevancia de su entorno inmediato.

Contextualización del tema de estudio

Condiciones de salud

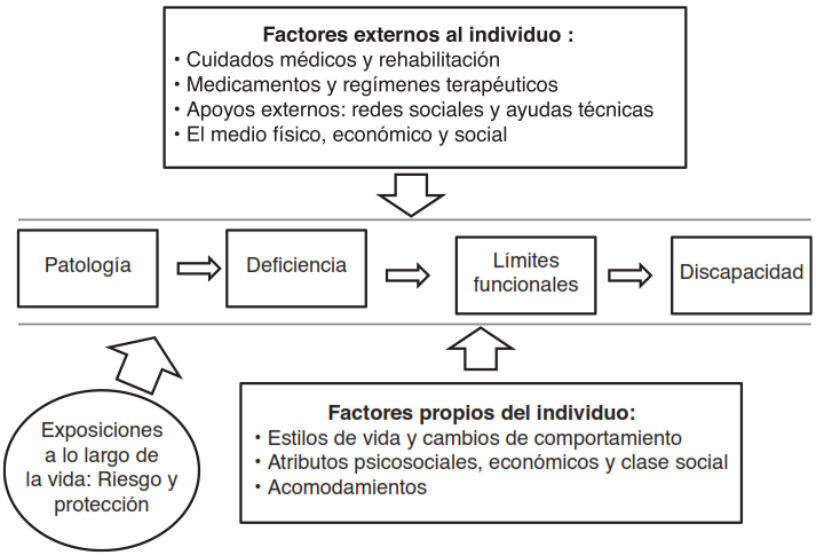
Las condiciones de salud se abordan desde las trayectorias funcionales utilizando el indicador de limitaciones funcionales. Esto se realiza siguiendo el modelo teórico del proceso de la discapacidad señalado en la "Clasificación Internacional de Funcionalidad" (2,3) y las sugerencias del grupo de Washington (4) a comienzos de la década del 2000.

El modelo de discapacidad originalmente fue abordado por Nagi (5) y modificado por Verbrugge y Jette (6). Este modelo incorpora el enfoque de los factores sociales que intervienen en el proceso de salud y se modifica el enfoque biomédico de la salud, transformando la percepción de una determinada condición o situación de salud según la capacidad que el individuo tiene para relacionarse con su entorno en función de sus actividades cotidianas. De esta interacción, surge una visión más holística de la salud en las edades avanzadas (7,8).

El modelo, incorporado en la "Clasificación Internacional de Funcionamiento, Discapacidad y Salud", comprende un camino central que comienza con el padecimiento de patologías o condiciones de salud, luego dicha condición compromete órganos y sistemas en el cuerpo originando deficiencias que se expresan en *limitaciones funcionales* para la realización de

actividades diarias. Y, como resultado de estas limitaciones surge una incapacidad para realizar determinados roles sociales.

FIGURA I.1.- Modelo teórico del proceso de discapacidad



Fuente: Zunzunegui (8)

Los roles sociales son entendidos como las actividades de la vida diaria que están socialmente estipuladas que las personas realicen en su residencia habitual y entorno. Estos van desde: a) actividades de la vida diaria (ADL), como ducharse, vestirse, comer, asearse, usar el wc, acostarse (Indíce de Katz (9)); b) actividades Instrumentales (IADL); como cocinar, limpiar, hacer la compra, seguir tratamiento médico, entre otras (índice de Lawton y Brody (10)). c) actividades avanzadas o de movilidad funcional; como agacharse a recoger una moneda (motricidad fina), levantar 5 kg, caminar determinadas distancias, fuerza de agarre, velocidad de marcha (limitaciones Nagi (5,11)); y, por último, limitaciones generales de la vida diaria (GALI) que es una medida resumen para indicar cualquier tipo de limitación funcional anteriormente mencionada para realizar actividades de la vida diaria en los últimos seis meses (12). La literatura indica que existen variaciones en la forma de medición de estos indicadores que van desde la forma de realizar las preguntas, el número de preguntas y las actividades incluidas en los cuestionarios de las encuestas (13,14).

En esta imposibilidad de realizar actividades de la vida diaria, que son básicas para vivir una vida autónoma en la vejez, se crean situaciones de dependencia. Por ende, la dependencia es

definida como la pérdida de autonomía física, psíquica o intelectual que origina la necesidad de ayuda o supervisión de terceras personas para realizar actividades básicas para manejarse en la vida diaria.

En este proceso dinámico, las trayectorias funcionales (15–17), también entendidas como *transiciones entre estados de salud* (18–25) se pueden realizar en ambas direcciones y como resultado existen transiciones entre mejoras y empeoramientos de las limitaciones funcionales a lo largo del tiempo. La distancia entre estas fases, sobre todo entre la discapacidad y la dependencia, está dada tanto por factores externos e internos (8,26).

Los cambios de salud dependen inicialmente de la exposición al riesgo y la protección a determinados eventos que las personas tienen a lo largo de sus vidas, con gran énfasis en el transcurso de la juventud (27). Los cambios externos como la adecuación de estructuras físicas y del entorno social también impactan de forma importante los cambios de capacidad funcional y la preservación de la autonomía de estas personas a edades avanzadas (8,28).

La revisión de la literatura sobre tendencias o trayectorias de salud (8,29–34) ilustra diferentes enfoques a lo largo del tiempo, según el modelo imperante, lo que dificulta la construcción de tendencias claras sobre prevalencias de enfermedades y discapacidad. Son variados los indicadores y preguntas utilizadas en las encuestas para identificar el estado saludable de las personas en los últimos treinta años (desde 1990) (35), como resultado, los indicadores que se derivan de estos instrumentos, como la esperanza de vida saludable, tienen diferentes valores en el tiempo que ilustran tendencias difusas de la evolución de salud de las personas en edades avanzadas.

Sin embargo, a partir de la última década existe un consenso en medir las condiciones de salud según el indicador de limitaciones funcionales (2,36,37), por esto, la presente tesis utiliza el mencionado indicador para medir los cambios de salud. En el transcurso de los capítulos, utilizaremos indistintamente transiciones entre estados de salud, trayectorias funcionales o cambios de salud para referirnos al análisis de las condiciones de salud; identificando tres tipos de cambios de salud: Deterioro, mejoras de salud y mortalidad.

Por último, se distingue la heterogeneidad del grupo de personas de mayor edad (31,38) y de allí la necesidad de realizar su estudio diferenciando en dos grupos: 60-79 y 80+. Por tanto, en esta investigación nos centramos en el contingente poblacional de 50+ y 60+ y realizamos un análisis a través del incremento de la edad. No obstante, puesto que en las edades más avanzadas (80+) la calidad de la información disponible es escaza deficiente, para futuros

estudios planteamos un análisis más detallado en esta población, identificando diferencias especificas en comparación con los mayores más jóvenes.

Pautas de convivencia en los mayores

Entre los factores externos más influyentes en los cambios de salud en la vejez, las pautas de convivencia, incluyendo las relaciones familiares, son un elemento determinante en las trayectorias de salud de las personas mayores puesto que funge como principal proveedor de recursos económicos, sociales y psicosociales (39).

En consecuencia, los cambios en los arreglos de convivencia y trayectorias de nupcialidad observadas en las últimas décadas tienen implicaciones en la salud y bienestar a edades adultas; el incremento de personas nunca casadas y divorciadas implican a su vez el aumento del número de personas en riesgo de experimentar cambios adversos en la salud y mortalidad temprana puesto que la convivencia en pareja es considerada un factor de protección contra el detrimento de la salud, la depresión y/o la exclusión social (40,41).

Las pautas de convivencia responden a diferentes actitudes y estilos de vida impulsados por patrones culturales y sociales, condiciones socioeconómicas (42–46), el momento y fase de la transición demográfica (47). Por lo que la comparación entre países del efecto en las formas de convivencia sobre la salud en la vejez permite identificar la variación de determinantes que pudieran ser clave para 1) comprender futuras tendencias de salud, 2) conocer la disponibilidad de cuidado en diferentes contextos y 3) identificar las causas y consecuencias de la interacción entre arreglos de convivencia, salud y cuidado.

En este contexto, aunque se aprecian diferencias en las tendencias y en los calendarios de las pautas de convivencia entre los países de las dos regiones estudiadas en esta tesis y también dentro de los países, se establece un patrón general por género en el que, las mujeres siempre con mayor supervivencia envejecen solas, en tanto que, los hombres mueren antes y lo hacen en pareja (48). Este patrón refleja la feminización de la población mayor como una pauta común en todos los países.

En relación a las trayectorias de nupcialidad en la actualidad en el contexto europeo se aprecia un retraso en el matrimonio y en la llegada del primer hijo, siendo más común la cohabitación sin hijos, con mayor incidencia en el contexto europeo (49). Esto trae como resultado una menor proporción de personas conviviendo en parejas como también menor probabilidad de obtener apoyo o cuidado de hijos adultos en la vejez en el caso de que estos no hayan tenido hijos. La

menor fecundidad o incluso la infecundidad conllevan a una menor disponibilidad de hijos y hermanos en el momento en el que se necesitan los cuidados.

No obstante, se observa un aumento de nuevas nupcias originando estructuras de familias más complejas con la inclusión de medios hermanos y parientes políticos (40) que podrían compensar los déficits en la oferta de cuidados (50) . Adicionalmente, estudios muestran que entre la población mayor (50+) en países de Europa occidental y en Estados Unidos las cohortes más antiguas nacidas entre las dos guerras mundiales, en comparación con las jóvenes tuvieron menor probabilidad de contraer nupcias (50), reduciendo la posibilidad de recibir ayuda de un esposo o esposa en la vejez (46). En consecuencia, el momento de la transición demográfica, las pasadas pautas de fecundidad y nupcialidad juegan un rol importante en la actitud de las personas en la conformación de hogares (51).

En el caso latinoamericano, se observa el más acelerado proceso de envejecimiento en comparación con otras regiones (52) y un patrón bastante heterogéneo entre los países en concordancia con su transición demográfica. Los países que experimentaron la transición más temprana fueron inicialmente Argentina y Uruguay a finales del siglo XIX, luego Chile y Cuba a finales de los años 60´s. En consecuencia, estos países al igual que algunos países del Caribe (53), tienen un mayor componente poblacional de personas mayores, menores tasas de fecundidad, y, por tanto, menores probabilidades de tener hijos para el apoyo y cuidado en la vejez al igual que los países europeos.

La diferencia entre estas dos regiones radica en que las tasas de crecimiento de la población mayor (60+) en América Latina tiene aproximadamente el doble de celeridad que la observada en Europa por el rápido descenso de la fecundidad (54). Sin embargo, en términos absolutos, la población mayor en América Latina está por debajo de lo observado en Europa y las tasas de fecundidad no alcanzan cifras tan bajas (1.5 hijos por mujer) como en el viejo continente. En este sentido, la mayoría de los países poseen en la actualidad una estructura poblacional joven, aunque envejecen rápidamente, por lo que este fenómeno se ha convertido en una preocupación (en el caso de Chile en el mediano plazo) (55).

En consecuencia, los países latinoamericanos (algunos más que otros) tienen que adecuar velozmente sus políticas públicas al rápido crecimiento de la población mayor entre una serie de obstáculos: dificultades socioeconómicas propias de los países en desarrollo económico, grandes brechas sociales y gobiernos inestables con gran convulsión política. Esto trae como consecuencia que el envejecimiento en la mayoría de los países de América Latina comienza en un contexto de bajos niveles de condiciones de vida en general (56).

Además, de estos factores demográficos, existen factores socioeconómicos, históricos y culturales que determinan los arreglos de convivencia de los mayores (57). La convivencia en residencias unipersonales a edades avanzadas está asociada con una positiva situación socioeconómica (sobre todo financiera) y programas estatales que beneficia la autonomía a edades avanzadas lo que se observa generalmente en países industrializados, mayormente en los países nórdicos y los países de occidente (42,58). Estos países también se caracterizan por hogares más pequeños, en tanto que los países del sur de Europa ilustran hogares intergeneracionales (50,59), al igual que los países de América Latina, pero estos últimos exhiben hogares más numerosos en su composición (53,60,61), con la excepción de algunos países del sur (Argentina y Uruguay).

Aunque existe una variedad de contextos socioculturales que influencian las pautas de convivencia de la población mayor, estudios apuntan que existen ciertas características individuales que juegan el mismo rol en todos los países: envejecer siendo soltero, sin descendencia, con mala salud y bajo nivel socioeconómico (nivel educativo y/o ingreso) aumenta la probabilidad de vivir con alguien (60,62) .Adicionalmente, el diferencial por género en la esperanza de vida entre los mayores explica ampliamente que en todas las sociedades el convivir solo es más frecuente para las mujeres que para los hombres, por ende, las mujeres duplican la proporción de hombres que viven en hogares unipersonales (50,63,64) y estas son mayormente viudas (con particulares características entre países (65–67)) porque sobreviven a la muerte de su pareja (63).

Tipología de los arreglos de convivencia

En Latinoamérica, existe pocos estudios comparativos en la actualidad sobre las formas de convivencia de los mayores. Los estudios que existen datan de la década del 2000 (47,53,59–61,68,69) y reportan tendencias con fuentes estadísticas de diferentes periodos. En general, los hogares tienen mayor tamaño (60), los arreglos de convivencia son diversos y existe poca disponibilidad de fuentes de datos para identificar formas de convivencia diferentes a la convivencia en hogares unipersonales. Estos últimos alcanzan una cifra de 13% mientras que en Europa los mayores que viven solos ronda el 25% (53) pero igualmente se observan diferencias regionales entre los países europeos (46,50,63).

La co-residencia varía según género, como se menciona anteriormente, y en el caso de las mujeres en Latinoamérica, estas son más propensas a vivir sin pareja y con sus hijos , en tanto que los hombres muestran el patrón general de la convivencia en pareja (53). La excepción a la convivencia con hijos se observa en Argentina y Uruguay, países que exhiben tendencias

parecidas a los países europeos, con altos porcentaje de convivencia en hogares unipersonales y convivencia en pareja, lo que podría estar asociado al efecto del nivel educativo y poder adquisitivo alcanzado. En el caso de los mayores Uruguayos predominan los hogares unipersonales y la convivencia en pareja (70). Mientras que la convivencia exclusiva en pareja es más común en Europa, con diferencias entre los países (ver ANNEXO 1.4).

Por las dinámicas poblaciones pasadas, el envejecimiento en América Latina comenzó a ver sus primeras señales a comienzos de la década del 2000 en algunos países por lo que las instituciones gubernamentales muy recientemente han comenzado a gestionar las demandas del crecimiento de la población mayor, pero a diferencia de Europa, el envejecimiento llegó a estos países sin el desarrollo económico necesario para un óptimo desempeño de las condiciones de vida de la población, en este sentido, los miembros familiares son los principales proveedores de cuidado y transferencias informales de apoyo en la vejez (53).

En Europa existe una amplia documentación sobre los arreglos de convivencia entre los países, sus determinantes, sus consecuencias sobre la salud y los patrones de cuidado en la vejez (44,59,71–79). El patrón general indica que la proporción de personas viviendo sola o viviendo con pareja (los grupos predominantes) están aumentando (62). No obstante, los patrones de convivencia de la población mayor varían según la región de Europa (sur, este, occidente y nórdicos); la co-residencia en hogares unipersonales es más frecuente en los países nórdicos y la convivencia en hogares nucleares (pareja e hijos) más común en países del este y el sur de Europa (59). Esta variación tienen una asociación con los estados de bienestar establecidos y con los sistemas familiares que han prevalecidos históricamente (58,80,81).

En los países del sur de Europa los mayores se caracterizan por la co-residencia con pareja e hijos lo que responde a fuertes lazos familiares y por la reducida intervención del estado en el cuidado de las personas mayores. Por un lado, las relaciones filiales son el soporte a largo plazo del cuidado de las personas mayores por una ausencia de programas por parte del Estado. Y, por otro lado, la crisis económica experimentada en estos países (España, Grecia, Portugal) pudiera estar influyendo en que los hijos se mantengan hasta edades adultas en los hogares de los padres, retornen al hogar después de disoluciones maritales o con la llegada de los nietos se establezcan intercambios intergeneracionales para el cuidado (82).

Mientras que, la convivencia de los mayores en los países de occidente y el norte, se caracteriza por hogares de menor tamaño, por la convivencia en pareja y en solitario (59,77). En estos países existen una serie de políticas públicas para el cuidado de los mayores para el cuidado formal (83,84) (ej. la institucionalización y/o cuidado en el hogar) e informal (apoyo a las familias en los

hogares) (ej. Bélgica, Alemania), como también subsidios para estudios universitarios lo que estimula la emancipación más temprana de los hijos en estos países (42,58,85,86) y más tardía en los países del sur (87,88). Adicionalmente, en la actualidad, los países del sur han experimentado periodos de inestabilidad económica originando un retorno al hogar parental (89,90). Este contexto ilustra lazos familiares menos fuertes y una vejez más autodependiente en los países del norte (91,92). Sin embargo, se indica que existen otros factores asociados a la convivencia con hijos en edades adultas, siendo un elemento importante el tipo de estado de bienestar en los países (85,93) y por otro lado, la convivencia en pareja no excluye el apoyo por parte de los hijos fuera del hogar (58,94).

Los países de Europa del este, también se caracterizan por la convivencia nuclear (con pareja e hijos) al igual que el sur de Europa por la ausencia de programas de cuidado para los mayores. No obstante, son pocos los estudios que documentan esta relación, la mayoría de los estudios sobre los arreglos de convivencia o estatus marital en esta región están enfocados al gradiente norte sur entre los países y describen diferentes dimensiones de la solidaridad familiar intergeneracional entre estos países, tomando en cuenta la proximidad geográfica, la frecuencia de contacto entre hijos fuera del hogar, obligaciones familiares e intercambios generacionales de apoyo (40).

Objetivos de la tesis

Esta tesis estudia el efecto de las pautas de convivencia como un elemento fundamental interviniente en las dinámicas de salud de las personas mayores. Frente a los cambios de las trayectorias de salud inherentes al proceso de envejecimiento, los factores del entorno inmediato, como la convivencia en el hogar, son determinantes en las trayectorias de salud, retrasando o previniendo condiciones adversas en la salud y prolongando condiciones más favorables en la funcionalidad de este grupo poblacional para el desarrollo integral de sus actividades cotidianas. El conocimiento de las dinámicas de salud de la población mayor proporciona insumos para la formulación de políticas públicas orientadas al cuidado de los mayores en el contexto de creciente envejecimiento, en el que las pautas de convivencia (y lazos filiales) fungen como principal soporte de cuidado en un gran número de países de estudio.

Es por esto que el objetivo central de la tesis está orientado a analizar la contribución que tienen las distintas formas de convivencia en los cambios de salud de las personas de 50 años y más,

en distintas zonas geográficas, según sus características individuales: cohorte de nacimiento, sexo y nivel educativo. Adicionalmente, la tesis aporta evidencia empírica en el uso de diversas estrategias metodológicas para el estudio de los cambios de salud.

La hipótesis detrás de este estudio se fundamente en la premisa de que las condiciones de salud, entendidas como la capacidad funcional del individuo para desenvolverse de forma integral en su cotidianidad, pueden ser modificada mediante factores externos, como los estudiados en esta tesis, arreglos de convivencia y condiciones socioeconómicas: nivel educativo y la posibilidad de cubrir gastos mensuales. Por tal motivo, siendo las pautas de convivencia el factor más próximo al entorno inmediato de las personas mayores, la hipótesis central apunta a que los distintos grupos de convivencias están asociados de forma diferente las trayectorias de salud de los mayores y que este efecto será modificado por variables contextuales (país de residencia y características personales).

Teniendo en cuenta el contexto descrito anteriormente, la hipótesis indica que ciertos subgrupos poblacionales de personas mayores podrían estar en desventaja y tener menor probabilidad de mejorar su salud aun cuando sus pautas de convivencias y factores socioeconómicos contribuyan de forma favorable. En este sentido, esta tesis contribuye a la gran discusión actual sobre los factores asociados a las desigualdades en la salud y en los años de vida de la población mayor.

El estudio abarca inicialmente un amplio número de países de la región europea (19) distinguiendo entre Europa del sur (España, Italia, Portugal, Grecia, Chipre, Malta), este (Bulgaria, la República Checa, Hungría, Polonia, Romania y Eslovaquia), occidente (Austria, Bélgica, Irlanda y Luxemburgo) y zona báltica (Estonia, Lituania y Letonia). Luego, se extiende el análisis a la región latinoamericana (Chile y Costa Rica), ilustrando una comparación respecto a Europa (España) mediante el análisis entre países con similitudes en cuanto indicadores de desarrollo socioeconómico y niveles de envejecimiento.

La metodología utilizada comprende varias técnicas en el análisis de supervivencia utilizando “Efectos fijos y efectos aleatorios” y modelos de “Múltiples estados” y cada una de las técnicas se usa de forma distinta para dar respuesta a los objetivos específicos abajo formulados. En tanto que, el indicador de salud utilizado refiere a las limitaciones funcionales en un conjunto de encuestas (European Union Statistics on Income and Living Conditions, EU-SILC; The Survey of Health, Ageing and Retirement in Europe, SHARE; Encuesta de Protección de Social, EPS; Costa Rica: Estudio Longitudinal de Envejecimiento Saludable, CRELES) que permiten el estudio de la

población adulto mayor y sus condiciones socioeconómicas según características individuales y del hogar en varios contextos demográficos.

Los objetivos específicos

1. Describir las trayectorias de salud de la población mayor (50+) y la influencia de las pautas de convivencia en la salud en el contexto europeo de acuerdo con la variable de limitaciones funcionales (enfoque socio-funcional).
2. Explorar las metodologías disponibles para el estudio de las tendencias de salud en la población mayor. Aplicación de modelos de estados múltiples y modelos jerárquicos o efectos aleatorios en el análisis de supervivencia.
3. Analizar los determinantes en los cambios de salud según características individuales (sexo, educación) y variables de su entorno inmediato (arreglos de convivencia y condiciones del hogar).
4. Comparar las condiciones de salud entre poblaciones con distintos regímenes demográficos en América Latina y Europa por medio de indicadores resumen: esperanza de vida y años saludables.

Las principales preguntas de investigación que están comprendidas en cada objetivo mencionado están formuladas a continuación:

1. ¿Cuáles son los patrones de los cambios de salud (deterioro, mejoras y mortalidad) de las personas mayores según pautas de convivencia entre los países europeos?
2. ¿Qué metodologías permiten el análisis de las trayectorias de salud en la población mayor?
3. ¿Cómo influyen las relaciones de convivencia y las condiciones socioeconómicas en las trayectorias de salud en los adultos mayores en Europa?
4. ¿Cómo varían las condiciones de salud y arreglos de convivencia entre diferentes regímenes demográficos: Europa y América Latina?

En el marco de la presente tesis “Condiciones de salud de la población adulta mayor en Europa y América Latina. Aportaciones metodológicas”, con especial énfasis se utilizan diversas herramientas metodológicas, modelos de “Efectos fijos y aleatorios” y modelos de “Múltiples estados”, para dar respuesta a los objetivos de investigación planteados con la intención de mostrar en primer lugar, alternativas para el estudio de las dinámicas de salud desde encuestas con datos longitudinales (tipo panel) y, en segundo lugar, la posibilidad de describir y analizar los factores que intervienen en las trayectorias de salud.

En este sentido, se utilizaron los modelos mixtos en cada una de las transiciones estudiadas (deterioro de salud, mejoras de salud y mortalidad) para describir la variabilidad de estas trayectorias de salud entre los países de estudio en el contexto europeo (puntualizado en el primer objetivo específico) , y, los modelos de múltiples estados se utilizaron para profundizar en el análisis (en los siguientes objetivos), estudiar las transiciones entre estados en su conjunto, analizar los factores asociados en los cambios de estados de salud, incluyendo la influencia de las pautas de convivencia, y por último estimar la medida resumen, de estas trayectorias de salud, de años de vida esperados entre diferentes regímenes demográficos.

Estructura de la tesis

Esta tesis está compuesta por cuatro capítulos en formato artículo, pensando en la publicación futura de los mismos. Cada uno de los capítulos puede ser leído de forma independiente y cuentan con un resumen, introducción, metodología, fuentes, resultados y discusión.

El primer capítulo describe las transiciones entre estados de salud en 19 países europeos utilizando la encuesta European Union Statistics on Income and Living Conditions (EU-SILC), por medio de la implementación de efectos mixtos en el análisis de supervivencia, con la finalidad de describir los cambios de salud en cuanto a mejoras de salud, deterioro y mortalidad entre los países europeos. Este capítulo describe la influencia de factores individuales y de los arreglos de convivencia en las dinámicas de salud de la población mayor de 50 años, con la intención de ilustrar, con una perspectiva comparativa, los patrones de salud en el contexto europeo. Por este motivo, se incluyeron los modelos de efectos aleatorios que pueden verse como estructuras jerárquicas, que permiten identificar la variación de las dinámicas de salud según los países de estudio. Así mismo, esta metodología permitió identificar el efecto diverso que tienen los grupos de los arreglos de convivencia sobre la salud dentro de los países.

El segundo capítulo comprende una breve introducción a los modelos de múltiples estados, escasamente utilizados para el estudio de la salud por su exigencia de datos longitudinales. En este apartado se describen los conceptos básicos utilizados en esta técnica y se realiza un recuento de los principales estudios en el campo de la demografía y epidemiología.

El tercer capítulo analiza los determinantes en los cambios de salud según características individuales y variables del entorno inmediato. En este sentido, se profundiza el estudio del efecto del contexto socioeconómico sobre las transiciones funcionales estudiadas utilizando modelos de “estados múltiples”. El análisis es un estudio de casos en nueve países europeos

pertenecientes a diferentes regiones (Europa del este, Europa occidental y Europa del sur). Los países de estudio en este capítulo son una sub-muestra de la muestra inicial de 19 países utilizada en el primer capítulo y fueron seleccionados según su ubicación geográfica y similitudes demográficas: Sur de Europa: España, Italia, Portugal; Europa occidental: Austria y Bélgica; Europa del este: la República Checa, Hungría Polonia; y por la región Báltica: Letonia.

En consecuencia, se estudian las probabilidades de cambios de estados de salud de acuerdo a indicadores socioeconómicos de nivel individual (nivel educativo) y de nivel del hogar (capacidad de llegar a final de mes). Igualmente se analiza el efecto de los arreglos de convivencia según país de residencia y género sobre los patrones de salud. La utilización de esta nueva herramienta metodológica en comparación con la anteriormente utilizada en el primer capítulo, permitió observar las diferencias significativas en las trayectorias de salud (deterioro y mejoras de salud, mortalidad) entre los países de estudio y también en cuanto a características individuales.

En el cuarto capítulo, se realiza una comparación de las trayectorias funcionales de los mayores entre países de América Latina con un proceso de envejecimiento avanzado (Chile y Costa Rica) y Europa (España) considerando variables de su entorno inmediato (los arreglos de convivencia y la participación social) con la intención de comparar los cambios de salud en diferentes regímenes demográficos y proveer una mirada a similitudes y divergencias entre los países de estudio, considerando el género, la educación, los arreglos de convivencia y la participación social. Este capítulo comprende una segunda aplicación de modelos de múltiples estados que permitieron la estimación del indicador resumen de años de vida y años en buena salud según variables interés y su comparación entre países. En este sentido, se utilizaron tres encuestas longitudinales tipo panel que abordan las condiciones de vida de la población mayor en los países: “Encuesta de Protección de Social” (EPS) en Chile y “Costa Rica: Estudio Longitudinal de Envejecimiento Saludable” (CRELES) en Costa Rica y “The Survey of Health, Ageing and Retirement in Europe” (SHARE) para el análisis de España. Por último, el análisis de este capítulo contribuye al análisis de las diferencias socioeconómicas de las condiciones de salud y supervivencia entre países.

El último capítulo, refiere a la discusión de los principales hallazgos de los capítulos de la tesis; se describe la contribución de los arreglos de convivencia y las condiciones socioeconómicas en las trayectorias funcionales. Adicionalmente, se plantean comparaciones con otros estudios, las limitaciones en el desarrollo de la investigación, las fortalezas y futuras líneas de investigación.

Notas sobre la medición de las trayectorias de salud

En la literatura consultada sobre los determinantes socioeconómicos de las condiciones de salud (95–103) la mayoría de los estudios abordan la salud (prevalencias de enfermedades, discapacidad y dependencia, etc.) mediante fuentes de información transversales (individuos con una sola observación en el tiempo, p. ej. encuestas de salud en periodos específicos), y, por tanto, realizan estimaciones a nivel de población con tasas de prevalencia para el cálculo de años de vida de la población mediante el comúnmente utilizado método Sullivan (103–108).

No obstante, como se explica anteriormente, el proceso de la discapacidad comprende un proceso dinámico que va desde la edad y el año de la aparición de la patología o condición de salud, la probabilidad de recuperación de esa condición y la muerte (8). Es por esto que las trayectorias de salud requieren su estudio con perspectiva longitudinal como es la aplicación de análisis de supervivencia, aproximación que puede identificar los cambios entre los estados de salud ocurridos en el curso de vida mediante tasas de incidencia para el cálculo de las probabilidad de transición (109–113). En tanto que las tasas de prevalencia utilizadas por medio de encuestas transversales no permiten identificar los cambios entre unidades de tiempo específico (años de calendario o entre edades)[1].

Por ende, la metodología utilizada para el estudio de las condiciones de salud en esta tesis comprende el análisis de sobrevivencia por medio de dos aproximaciones: 1) efectos fijos y aleatorios o modelos jerárquicos (114–120) incorporado en el modelo proporcional de Cox, y, 2) modelos de múltiples estados (121–128). Cada una de las aproximaciones en el análisis de supervivencia utilizadas permite dar respuesta a cada uno de los objetivos específicos de la tesis mostrados más adelante y fueron aplicadas según el proceso de aprendizaje durante el desarrollo de la tesis.

En el primer capítulo, se realiza una primera aplicación del Modelo Proporcional de Cox, incluyendo efectos aleatorios (“Mixed effects”) con el objeto de mostrar la variabilidad de las transiciones entre estados de salud según el país de referencia y según grupos de arreglos de convivencia. Este tipo de modelos reciben diferentes nombres según el campo de estudio donde se utilicen, en demografía son llamados también “frailty models” y refieren en su mayoría al

[1] Para una mejor compresión de las tasas de prevalencia, tasas de incidencia y probabilidades de transición en el análisis de supervivencia ver Kleinbaum (113).

análisis de los componentes de la varianza. Estos modelos permiten describir la dependencia de las observaciones o la ocurrencia de un evento dentro de una estructura jerárquica (por lo que la variación puede ser dentro del clúster y/o entre clústeres) (129). En consecuencia, estos modelos tienen factores multiplicativos indicando que tan propensos o "frágiles" son los individuos a experimentar el determinado evento condicionado a la pertenencia del grupo o nivel. Estos factores multiplicativos son llamados aleatorios y siguen una determinada distribución (130). La distribución de los eventos puede ser exponencial, Weibull, Gaussean (normal) y Gompertz (119).

Inicialmente este tipo de modelos se utilizaron para evaluar los límites de la longevidad y la dispersión o la "heterogeneidad" que existe en la edad promedio de muerte (esperanza de vida) de una determinada población y como factores externos contribuyen a la variación de años de vida (131–134) . No obstante, la aplicación de este tipo de análisis es más amplia, y más allá del estudio de la mortalidad, se utiliza para estudiar la variación de ocurrencia de eventos según la dependencia de factores aleatorios en epidemiología y bioestadísticas. Por ejemplo, en estudios clínicos se utiliza frecuentemente Mixed effects Model para evaluar el efecto de tratamientos *"random"* en pacientes con condiciones de salud especificas (118–120,129,135).

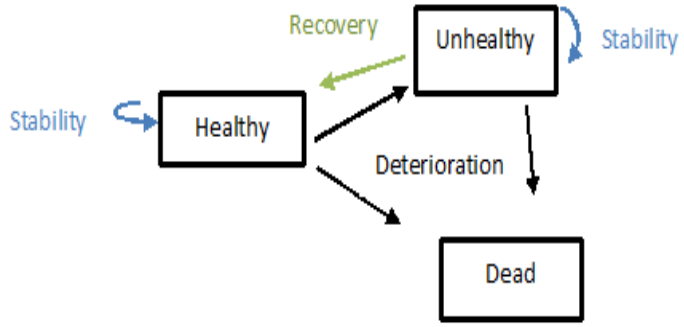
En vista de las posibilidades de análisis de los modelos de efectos aleatorios, se utiliza este tipo de modelos para estudiar la variación de las transiciones de salud según países y arreglos de convivencia. En concreto, se utilizaron modelos mixtos por medio del análisis de la varianza como factor "aleatorio" con la aplicación de los paquetes en R "survival" y "coxME". Por tanto, se realiza el análisis de la varianza como un efecto aleatorio de los países en cada una de las transiciones de salud por separado (deterioro de salud, mejoras de salud y mortalidad) con una distribución Gaussean. Esta aplicación permitió observar la heterogeneidad de las trayectorias de salud de las personas de 50 años entre el contexto de países estudiados como también la variación del efecto de los grupos de convivencia según nivel educativo, sexo y cohorte de nacimiento dentro de los países. No obstante, no se pudo identificar cuales países comprendían diferencias significativas con el riesgo promedio (de cada una de las transiciones). En este sentido, el primer capítulo comprende un análisis descriptivo de los cambios de salud en el contexto europeo y en los siguientes capítulos se introducen otras aproximaciones metodológicas para profundizar en el análisis.

Para los siguientes capítulos, se realizó una revisión teórica sobre la aplicación de tablas de múltiples estados en el estudio de la salud, los supuestos estadísticos que comprenden, los alcances, limitaciones (ilustrado en el segundo capítulo) y las fuentes de datos disponibles para

su uso con el objeto de realizar un análisis detallado sobre las transiciones entre estados de salud de forma conjunta y los factores asociados a la ocurrencia de las mismas. Por ende, se aplicó esta técnica en los siguientes capítulos con la finalidad de identificar el impacto de las condiciones socioeconómicas (educación, genero, pautas de convivencia, cubrir gastos mensuales) en las trayectorias de salud.

Las tablas o modelos de estados múltiples son utilizadas ampliamente en estudios clínicos para el estudio de progresión de enfermedades, tratamiento y reincidencia de ciertas patologías como los distintos tipos de cáncer (18,119,127,136,137), factores de riesgo (18,128), proceso de recuperación después de intervenciones quirúrgicas, proceso de deterioro cognitivo como Alzheimer (138–141), entre otros estudios (110,142,143). Es por esto que, en el marco de esta investigación, esta metodología permitió identificar la probabilidad de ocurrencia de mejoras y deterioro en la condición de salud (desde el enfoque socio-funcional), el riesgo de mortalidad y los factores asociados en el proceso de cada una de las transiciones.

Figura I.2.- Modelo de Múltiples estados utilizado.



Las tablas de múltiples estados aplicadas en estudios de salud, permiten calcular tasas y probabilidades de transición entre diferentes estados con la finalidad de estimar el tiempo esperado (en años/meses/días) que una persona a determinada edad, y con ciertas características esté expuesto a determinada situación de salud al siguiente intervalo de tiempo (109); como pueden ser cambios en la gradualidad de las limitaciones funciones, discapacidad o finalmente, situaciones de dependencia o muerte.

Los modelos de estados múltiples, adicionalmente, también son utilizados en las ciencias sociales para estudiar eventos en el ciclo de vida de las personas, como lo son las trayectorias laborales, entradas y salidas de mercado laboral por medio de tablas de vida activa (144–146); cambios en los pautas de convivencia (122,147), desde la convivencia de los padres, vivir

independiente, cohabitar o contraer nupcias, hasta la llegada del primer hijo; y también en estudios de migración (148,149). Estas trayectorias que se realizan sin ningún tipo de orden específico y pueden ser bidireccionales hasta llegar a un estado absorbente como el retiro, la llegada del primer hijo o la muerte, dependiendo de los estados estudiados.

En este sentido, se utilizaron dos tipos de modelos de múltiples estados: 1) Modelos semi-parametricos de riesgos proporcionales de Cox con hazards estratificado según tipo de transición y dependiente de la escala de edad (122,150,151), y 2) Modelos paramétricos de riesgos proporcionales siguiendo una distribución Gompertz. La aplicación de cada tipo de modelos en el tercer y cuarto capítulo se realizó según el proceso de aprendizaje y los interrogantes de estudio.

Por tanto, en el tercer capítulo, el modelo de Cox estratificado utilizado permitió analizar la influencia de factores asociados a los cambios de salud en las personas mayores (50+), mediante el paquete en R "survival" y "mstate". Con esta técnica se analizó la influencia de los arreglos de convivencia en la salud y su interacción con factores socioeconómicos. Se calcularon riesgos relativos de las variables de interés sobre las transiciones de estados y se mostraron las diferencias significativas con el riesgo de referencia[2].

Mientras que, en el cuarto capítulo se utilizó un modelo más robusto que permitió la estimación de indicadores refinados mediante el paquete en R "msm" y "elect". Este tipo de modelos permitió los cálculos de las probabilidades de transición, igualmente que, en el capítulo anterior, en diferentes poblaciones de personas mayores (60+) y se estimaron medidas resumen de mortalidad y salud: la esperanza de vida y los años saludables, así como la contribución de factores socioeconómicos en los años de vida. Este tipo de modelos reportó mayores bondades para el cálculo de las transiciones de salud debido a la posibilidad de incluir estados de salud censurados y transiciones latentes hacia estados no incluidos en la matriz de transiciones (ver cuarto capítulo). Adicionalmente, la herramienta posibilita el cálculo de los años de vida según las variables de interés, lo cual no fue posible con las aplicaciones en los capítulos iniciales.

[2] El riesgo de referencia en Modelos Proporcionales de Cox de Múltiples estados refiere a un individuo masculino, viviendo en pareja, con estudios primarios (o inferior), con capacidad financiera para cubrir gastos mensuales, en el periodo 2008-2011.

Finalmente, en las conclusiones se ilustran las discusiones finales de los resultados de la tesis, se realiza una comparación con otros estudios que han utilizado aproximaciones metodológicas similares, se identifican posibles sesgos por el uso de las fuentes e indicadores de salud utilizados entre los países de estudio y se detallan los alcances y limitaciones de la tesis.

1. Health status by living arrangements from a European comparative perspective

Abstract

We explore the effects of different living arrangement types on health dynamics among the 50+ years old 19 European countries using data from the panel survey European Union Statistics on Income and Living Conditions. Employing both the fixed and mixed effects of the multi-level Cox Proportional Hazards models, we first describe whether socio-demographic variables (sex, education and birth cohort) modify the effects that living arrangements have on health improvements, deterioration and death transitions. We then ascertain any country differences in the results and illustrate the utility of mixed effects/multilevel modelling applied to survival analysis.

Results show that younger cohorts are more likely to experiment a change in their health status than older ones. In the basic Cox Proportional Hazards model, living with both partner and children is not significant for health deterioration when compared to living with only a partner, but it becomes highly significant for health improvements at older ages. However, when we applied the mixed effects multi-level model, living with partner and children becomes significant for the transition to health deterioration. In the transition to death model, living only with a partner decreased the likelihood of death by about 20% comparing with living with a partner and children. Country variability explained 37% of the differences in the average relative risk of health deterioration, 46% of health improvement and 41% of the transition to death. Older women are more likely to experiment health deterioration than older men, but with notable differences in the level of heterogeneity between countries (more variability for eastern European countries and less for Belgium). Southern countries exhibit living arrangements effects in opposite directions over health status. For instance, the effect of living with both partner and children improves the health status in Italy but does the contrary in Spain. Finally, models with three levels of hierarchy show a much larger variation of the living arrangements effect on health transitions by cohort and education groups than is the case for gender. This demonstrates the utility of using a mixed effect model, which allows the identification of the heterogeneous pattern of living arrangements across European countries.

1.1. Introduction

Previous studies in the field of older people's health, with some of them using transition probabilities (152), mainly focused on calculating the expected total and healthy or disability-free years of life at older ages (153–155), by gender and others characteristics, using several health measurement approaches (health self-perceived, functional limitation, longstanding

diseases) and usually within an international comparative context (97,156–163). Through these studies it is important to observe that there have been significant contributions for improve methods to estimate life tables with covariates using cross-sectional and longitudinal data sources (26,164,165). For example, Vaupel and colleagues introduced the analysis of heterogeneity in mortality dynamics. Their main finding (which is of interest to this study) was to show how individuals experiment different mortality risks based on their characteristics. They used the term "*frailty*" to study and model unobserved heterogeneity, particularly for the elderly (131,132,166,167). Their work also showed large dissimilarities between countries in relation with the processes of compression or expansion of mortality and health conditions.

In European countries, heterogeneity in elderly health status is quite substantial (168–170). Mortality has declined with varying intensities among regions, countries and by socioeconomic gradients (104,171–173). While the increase in extra years of remaining life expectancy were due to improvements in elderly health and functional status between 1970 and 2000 (174–176), nowadays life expectancy (LE) is reported to be stagnating in some countries and in specific ages (177,178) when compared with the improvements observed in 2000s. However, there is still a debate with regard to health trends over time, as this depends on the health dimensions used, the time period under study and the population covered (31). Some studies illustrate the existence of complex interacting mechanisms for the mortality and morbidity trends, including different dimensions of health (77) .

Eastern European countries have experienced lower levels of LE at birth than other major regions of Europe about 1980s, although some convergence has taken place over the last decade. Moreover, especially former USSR countries have the largest gender gap, while it is the lowest in Scandinavian countries (179,180). Since the early 2000s a similar pattern is observed for healthy life expectancy (HLE). Currently, official statistics show that for males aged 65, Southern European countries (except Portugal) as well as France, Switzerland, Norway and Sweden have the highest LE and the latter two countries plus Ireland and Spain the highest HLE (EUROSTAT, (181)[3] In the case of women, the Southern European countries do best in terms of LE but are slightly behind the level of HLE in Sweden, Norway and Ireland. In turn, current levels

[3] Among countries with more than 1 million inhabitants.

in both indicators are lowest in Eastern European countries that also have large between-country differences, whereby most former Eastern Bloc countries exhibit higher levels of LE and HLE than former USSR countries. Slovakia is an exception with the fewest years of HLE (4 years in the case of both sexes in 2017). Lastly, as shown in numerous studies (95,163,182) the well-known gender health-survival paradox is most evident in countries with high female LE which is associated with greater disability at old age, but non-existent where gender differences in LE are greatest, especially in Eastern European countries that have both low male LE and HLE.

If we turn to differentials in life expectancies and health state transitions according to education and gender, Bohacek et al (183) recently showed that more years in education considerably improved male survival, while for women, this increased their chances to change to a better health state. Results from a study by Majer et al (20). showed for Western-European populations that a higher educational level leads to more expected years free of disability (DFLE), both before and after retirement. Bohacek et al (183) showed that while overall females experience higher morbidity alongside lower mortality, this paradoxical pattern of women getting sicker but men dying quicker is almost absent among high educated individuals. However, according to Matthews et al. (184) other types of socioeconomic measure are to be taken into consideration when studying health transitions. According to their UK study, housing tenure showed a greater differential in DFLE in both men and women than social class or income adequacy.

Living Arrangements

Besides socioeconomic status, living arrangements are also known to affect health. Well-known is the protective effect of living in a couple in comparison with others who do not (185) Yet, analyzing health transitions by living arrangements has not been previously done, including the effect of living with children. Particularly the latter has an important cohort component which is worth studying. For instance, the older population born after 1935 has an advantage in terms of the availability of offspring compared with those born in the early 1920s where the proportion of childless is much higher. As a consequence, among these cohorts household size is smaller and intergenerational-co-residence less frequent, which has led to greater demands for formal care services among elderly with poor health (77).

However, in Europe, there are notable country differences in intergenerational coresidence which is more common in southern countries than in other parts of Europe. Particularly, in eastern European countries proportions of older people living with their adult children are low due their lower fertility in past decades and therefore, they have fewer available children to live

with. Previous research (51,62,63,186) has shown that when the number of children borne is higher, the higher is the probability to live with one of them in later life. Additional regional family patterns that are linked to marriage and fertility indicators, however, also influence intergenerational solidarity on parent child relations, which are the basis for understanding understand living arrangements preferences at older ages (63,187).

Dykstra and Fokkema's study (58) on intergenerational family relationships[4] across European countries has shown that the distribution of family type across European countries does not fit the north-south division that has been suggested by Reher (187). They argue that different family types are concurrently present in each country but that the distribution varies considerably. Their results show that support provided by parents to adult children (descending familialism) is strongly present in Belgium. Conversely, but as expected, support by children to parents (ascending familialism) is highest in Spain, Italy and Greece and Austria. Being supportive at distance is more common in Sweden, Denmark and the Netherland. Autonomy is strongest in France and Switzerland, but also high in Sweden, Denmark and the Netherlands.

The same authors also pointed out that family type varies over time in response to changes in the life course. When children move from young adulthood (e.g. university, being single) to middle-age (e.g. living with a partner, a paid job, having children), there is a likely shift from being supportive at distance to descending familialism. The next shift is probably from descending to ascending familialism, when the parents reach advanced ages, characterized by deterioration in health status and widowhood. Related to this, Reher and Requena (80) suggest that over the life course, age has important links to health, preferences for living arrangements and the role of family´s members. Other studies (188) on determinants of intergenerational proximity mention sociocultural, demographic and socioeconomic factors. Lastly, both parental and child needs may vary in importance not only across different stages of the life course but also across countries.

[4] The authors defined four types of late-life families: 1. ascending and 2. descending familialism. Both are characterized by having strong norms of family obligations, living nearby and having frequent contact. The difference is that primarily help in kind is upward: from children to parents in the former and primarily help downward, from parents to children, in the latter. 3. Supportive at distance, not living nearby but having frequent contact, refutation of family norms, and primarily financial transfer from parents to adult children. 4. Autonomous, not living nearby, little contact, refutation of family obligations and few support exchanges.

In contrast, individualism in later life is known to be higher among divorced than for widowed parents (187). Adult children from large families are more likely to have frequent contact with their parents than when they reach older ages (58), while the non-married are known to compensate their lack of couple companionship by having friends (189). But also here, differential effects exist according to gender, socioeconomic status and between countries. Regarding the latter, the typically strong family system characteristic of southern European countries appears to be more vulnerable to the effect of demographic change than the weaker ones that exist in northern and western Europe (188).

It is also well-known that not living with a partner is associated with having worse health than those who do (44,185). However, we do not know whether living arrangements are also associated with differences in (the rate of) health transitions. The aim of the present research is to find this out. By health transition we mean health deterioration (from healthy to unhealthy), health improvements (from unhealthy to healthy) and death (from any of these two statuses). To analyze the effect of living arrangements on health status transitions, we apply a multilevel approach —also known as mixed effects survival modeling (190,191) or shared frailty model (133)— to all three transitions separately. We perform the analysis on a pooled data set of 19 European countries than were obtained from the panel survey European Union Statistics on Income and Living Conditions (EU-SILC). We further contribute to the current body of knowledge by also including countries from Eastern Europe and the former Soviet States where studies on health transition are rare.

1.2. Data and Method

Data

The data source used for this study is Eurostat's panel survey EU-SILC, which provides up-to-date comparative information of income and living conditions across countries from all parts of Europe. The source combines the use of registers with interviews in household sample surveys, providing information at individual and household level of household members aged 16 and over between 2004 and 2016. For this study we use information from 2007 to 2014 (TABLE 1.1).

The EU-SILC survey has a rotational design that defines the sample in cross-sectional and longitudinal form. Specifically, the sample selection is based on a number of sub-samples or

'replications', each of them similar in size and design, and representative of the whole population. Every year three-quarters out of four replications are maintained, while the other one is dropped and replaced by a new replication (192). For this study, the longitudinal design is used, which, given the survey design, permits health transitions to be estimated across four-year spells. Although Eurostat provides the harmonized data across countries, variations in data collection procedures do exist among EU-SILC countries (see ANNEX 1.2). For instance, there are countries where data collection relies on surveys with personal and proxy[5] interviews while others also use data from administrative registers (193) .

Unfortunately, large percentages of missing and truncated data persist in EU-SILC countries that only provided register data (TABLE 1.1). For example, there are high proportions of missing data at the first observation (time 1) in Slovenia (64%) and the Northern European countries (52-60%), remaining quite constant across the period of study, while the surveyed countries show response rate ranging from 3% (Austria, Greece) to 17% (Czech Republic). Despite the fact that some researchers consider the coverage rates of register data to be generally better than survey data (particularly in the measure of gross disposable income), personal health variables are typically not available in register data (193). We therefore considered that estimates from both type of data could not be compared, as they would lead to possible biases in the results.

[5] We do not discuss the use of proxies for the personal interviews but acknowledge that there is potential bias. For instance, proxies are more likely to be employed when a sampled respondent is in a very bad health or too old to answer the question (381).

TABLE 1. 1.- EU-SILC country samples according to panel period and missing and attrition according to follow-up year in the survey

Countries		Data collec-tion	2004 -07	2005 -08	2006 -09	2007 -10	2008 -11	2009 -12	2010 -13	2011 -14	total time series	Truncation(attrition) T1	T2	T3	T4	Missing (GALI) T2	T3	T4	Population
Austria	**AT**	S									8	3.7%	23.7%	34.0%	42.2%	2.4%	1.3%	0.0%	33.086
Belgium	**BE**	S									8	5,5%	24,4%	32,3%	37,9%	3,4%	2,3%	0,9%	30.841
Bulgaria	**BG**	S									6	3,7%	10,1%	16,8%	23,1%	2,5%	1,3%	0,3%	22.132
Cyprus	**CY**	S									7	5,4%	11,5%	16,8%	21,5%	3,4%	1,9%	0,1%	18.775
Czech Rep.	**CZ**	S									7	1,9%	10,2%	15,1%	18,0%	17,7%	18,0%	18,0%	42.538
Denmark	DK	R									7	3,9%	14,9%	22,4%	27,9%	51,6%	50,7%	50,1%	17.513
Estonia	**EE**	S									7	4,8%	14,7%	20,8%	25,9%	3,9%	2,3%	0,7%	23.256
Greece	**EL**	S									8	3,1%	16,4%	26,8%	35,3%	2,5%	1,6%	0,7%	33.746
Spain	**ES**	S									8	5,1%	19,1%	26,9%	32,7%	3,5%	2,3%	0,7%	75.756
Finland	FI	R									8	5,2%	18,0%	26,4%	33,0%	53,9%	51,8%	50,4%	40.263
Croatia	HR	S									1	2,7%	22,4%	31,2%	40,9%	44,7%	3,8%	2,6%	4.469
Hungary	**HU**	S									7	3,0%	16,1%	25,1%	33,2%	2,8%	2,1%	0,2%	47.666
Ireland	IE	S									5	31,7%	23,5%	26,7%	49,0%	2,4%	1,2%	0,0%	14.472
Iceland	IS	R									7	10,5%	20,9%	27,8%	35,4%	58,0%	56,8%	55,3%	12.682
Italy	**IT**	S									8	3,1%	18,7%	27,1%	35,0%	3,8%	3,3%	2,7%	108.757
Lithuania	**LT**	S									7	1,6%	9,9%	16,8%	22,4%	4,6%	3,9%	3,0%	22.754
Latvia	**LU**	S									5	3,9%	18,6%	26,9%	32,7%	3,6%	2,5%	1,7%	27.330
Luxemburg	**LV**	S									7	6,3%	20,7%	33,8%	41,8%	3,6%	2,7%	1,5%	25.668
Malta	**MT**	S									5	2,7%	16,6%	25,6%	31,5%	2,8%	1,5%	0,0%	17.570
Netherlands	NL	R									5	1,9%	21,8%	35,5%	45,2%	48,5%	48,2%	47,7%	39.270
Norway	NO	R									1	32,9%	30,5%	40,0%	37,9%	52,9%	51,0%	49,5%	7.688
Poland	**PL**	S									7	2,6%	12,4%	19,4%	24,6%	9,2%	8,0%	6,7%	67.599
Portugal	**PT**	S									8	3,6%	11,6%	15,6%	19,4%	2,9%	1,6%	0,3%	26.656
Romania	**RO**	S									5	1,3%	2,8%	4,3%	5,4%	2,2%	1,3%	0,2%	21.299
Sweden	SE	R									8	8,3%	19,6%	29,6%	37,2%	51,4%	49,7%	48,7%	32.465
Slovenia	SI	R									6	3,4%	27,2%	40,2%	48,3%	63,7%	63,2%	62,4%	53.375
Slovakia	**SK**	S									6	2,0%	6,7%	12,3%	17,4%	3,0%	2,3%	1,3%	22.316
United Kingdom	UK	S									7	3,9%	31,8%	46,7%	55,8%	4,4%	3,4%	1,9%	43.544
Total Countries per year			12	20	24	26	25	25	26	24		4,5%	17,9%	26,5%	33,3%	15,4%	13,9%	12,6%	933.486

Note: R: Register; S: Survey. T: Follow-up year. Bold letters refer to selected countries in study. High rates of attrition and missing data are marked in red.

There were fewer country-differences in the proportion of attrition (with Ireland and Norway being notable exceptions). Instead, rates increased sharply over time, from mainly under 5% at the first follow-up to generally above 20% at wave 4 (Romania being an exception here with just 5%). Given the above described patterns, we removed from our analysis the countries with register data as well as the others which reported the higher rates of attrition and missing data[6] (colored in red) in the health question, and also those where it was not possible to identify rotational groups with at least two waves in the data files (e.g. France), which are required in order to observe at least one transition between one wave and another. This left us with 19 countries with data from 2004-07 to 2011-14. The advantage of having such a large pooled sample of dataset is that it increases the accuracy of the final results (20). By pooling the data, we also deal with two problems that remain in the selected countries: 1) We were able to recuperate individuals that were dropped for one or two waves; 2) The small sample size that most countries had (except Spain, Italy and Poland) became less of an issue. But small sample size become again an issue when the data had to be disaggregated by control variables like sex, cohort, education, health status (in particular death) and living arrangements.

The sample size for the 19 countries includes 258.824 non-institutionalized individuals: 143.524 women and 115.300 men, who at the first time observation they were observed (baseline) were aged 50 and over. Of those, 251.593 were observed twice, 226.729 three times and 206.673 four times (See ANNEX 1.1).

Indicators used in the analysis

The GALI[7] indicator is used to measure health changes related to functional limitation in activities people usually do due to health problems for at least the past six months. This indicator is considered as a good proxy of disability and dependence (194). We also choose GALI instead of self-perceived health or long standing illness as our health indicator in order to be able to compare with previous research (12,36,182,195). Moreover, GALI is used to calculate HLE by the European Statistical Office, Eurostat[8]).

[6] Missing data refers to the non-responses from the question on the "General Activity Limitation Index" (GALI). Truncation or attrition refers to the population who dropped out in any year during the four-year period of observation.
[7] Question PH030 in the Personal Data File (P-File).
[8] Metadata: https://ec.europa.eu/eurostat/cache/metadata/en/hlth_hlye_esms.htm]

For the analysis of the transition to death, the membership status variable was used (RB110) to identify the respondents who had died since the previous survey. Other variables used for the analysis include the respondent's sex, year of birth (grouped into 1924-33, 1934-43, 1944-53 and 1954-64), country of residence, educational attainment (grouped into "primary or less", "lower and upper secondary" and "post-secondary vocational and tertiary") and marital status. Information on the ID of the spouse ID, father ID and mother were used to derive the living arrangements of the respondents. Living arrangements were grouped into four categories: 1. Living with a partner (2-people household); 2. living with partner and children (which also include other co-residents in the same household but their link could not be attained); 3. living alone (1-person household); 4. and living with others, which include other relatives or people who shared the same household (this category also include living only with children).

Finally, for comparative purposes and to ease the description of the results we have grouped the selected 19 countries into four geographical-historical regions: Eastern Europe (Bulgaria, Cyprus, Czech Republic, Hungary, Poland, Romania and Slovakia); Baltic countries (Latvia, Lithuania and Estonia); Southern Europe (Cyprus, Greece, Italy, Malta, Portugal and Spain); and Western Europe (Austria, Belgium, Ireland and Luxembourg).

Method

Modelling strategy

We started by estimating Cox Proportional Hazards models (PH) for measuring the effects of the different kinds of living arrangements on our three types of health transitions. However, as individuals appear in different waves, we need to take this into account for possible inter-individual correlation. Also, individuals live in different countries and therefore share common and unobserved characteristics that violate the Cox assumption of proportionality between covariates (196). This is why we also estimated mixed effects models (with more than one random effect), which allows to model statistical dependence (197), and, at the same time, to take into account individual- and country-level intra-correlations. This kind of model allows to control for the existence of hierarchical correspondence (133), or nesting effects, very similar to multilevel modeling. This approach is also considered to be the same as introducing interaction terms between variables (198). Studies which include random effects in Cox PH (133,134,199) have proven to be useful contributions for the description of diverse mechanisms interplaying in the ageing process and life course events in various contexts as countries.

Cox Proportional Hazards model

In order to evaluate the impact of different kinds of living arrangements on health transitions, a simple Cox PH model is used in a first stage. This is a robust and very flexible method that has been shown to fit the data very well (112,200), with results being similar to a PH model with a Poisson distribution and a logistic transformation (135). Cox PH models allows to estimate empirical cumulative hazards by time (age), from the observed transition rates. Klotz and Göllner (201) applied this method to estimate socioeconomic mortality differentials, for which EU-SILC data was also used.

Using the R package "survival", we then performed a covariate analysis on the hazard ratios (exponentiated coefficients), thereby obtaining the multiplicative effects of the predictors (for a more detailed explanation see (122,202,203).

In our model, we assume the existence of proportionality across time, which means that the relative hazard is constant over the time range used (in our case, the age range of the individuals in the study) for the possible transitions (122). The hazard ratio between two individuals at any point in time is constant, and changes in the hazards depend on the covariates (200) In this sense, it is also defined as the relative risk compared to the reference category, which corresponds to the baseline hazards (204):

$$\lambda_i(t) = \lambda_0(t)e^{\sum_k \beta_{k,i}x_k}$$

Where $\lambda_0(t)$ is an unspecified baseline hazard function and $\beta_{k,i}$ is the log hazard ratio for individual or category *i* for a predictor x_k, compared to the reference category (119,200).

The assumption of proportional hazards by age with the same level for the different health transition types studied here (i.e. health improvements (NH), health deterioration (HN) and death (ND)) is not always met in studies on recurrent events. This is due to distinct causal mechanisms governing each kind of transition(200). Fortunately, this can be resolved by relaxing the proportionality hypothesis of the Cox model by stratifying the baseline hazard function for the three transition types studied. Although another option could be to introduce an interaction effect between time and the covariates (112,196), we apply a Cox model for the three studied transition types and introduce mixed effects modeling to test whether the control variables sex, cohort and educational attainment modify survival time according to living arrangements.

Mixed effects Cox PH model

Studies which use mixed effects survival modeling are frequently medical trials, which study changes in health states. They focus, on the one hand, on exploring treatment effects on specific diseases, recurrent infections or disease stages as chronic-degenerative diseases as cancers and Alzheimer. On the other hand, they also explore the association between exogenous factors in the onset of specific health disorders.

Changes in health status can be modeled as repeated event processes. Individuals as patients can therefore experience the event of interest multiple times throughout the period of observation, and the correlation at the individual level (occurrence of events for the same individuals) can be measured by using a hierarchical structure or a shared frailty term (118). This frailty is then described as the relative risk which individuals in the same group share.

In a similar way, health transitions can be correlated at the country level, and therefore, individuals can share unobserved characteristics that distinguish them from others from the very fact of living in another country. Using Mixed Effects Survival Modeling (MESM) with a Cox approach allows us to include this hierarchical structure and even include other kind of grouping as well. In this paper we use the multilevel aspect of this methodology to explore differences between countries according to each one of the interested covariates.

To apply multilevel modeling to Cox PH model we use the recent version of the R package "coxME" developed by Therneau (191). This method fits a Cox PH model with a Gaussian frailty distribution. He showed that there is no closed formula to estimate variances. However, the key requisite is to have enough cases that contribute to each random effect, which our data set has. In this sense, we fit the following Cox PH model with mixed effects. Following Therneau (191):

$$\lambda(t) = \lambda_0(t)e^{X\beta+Zb}$$
$$b \sim G(0, \sum(\theta))$$

"…where λ_0 is an unspecified baseline hazard function, X and Z are the design matrices for the fixed and random effects, respectively, β is the vector of fixed-effects coefficients and b is the vector of random effects coefficients. The random effects distribution G is modeled as Gaussian with mean zero and a variance matrix Σ, which in turn depends on a vector of parameters θ". Therefore, frailty assumed as "*random effects",* is measured by the variance component as it has been shown by other studies on life span (131,132,134,166,167). Cox PH with mixed effects allows us to account for the shared frailty

by all subjects within the same groups. Through the variance or the standard deviation, it is possible to observe the variability (increase or decrease) of hazards between groups taking into account the average event occurrence (hazard) for a reference subject. The exponential of the standard deviation provided by the model illustrates the excess risk that certain groups have (lower or higher) over the mean hazard of the sample. Random effects represented by standard deviation equal the average relative risks associated with group or cluster membership, which are the different hierarchical levels analyzed. Excess risk usually range from 1.1 (exp 0.1) to 1.3 (exp 0.3), while values greater than 2 are very rare (for further explanation see Therneau (190,191,205).

A Cox model with only fixed effects (simplest conditional model) and a Cox model with mixed effects are interpreted in different ways. Regression coefficients from a conditional model denote the main change in the event occurrence produced by changing status of the explanatory variables, keeping all else constant and the error indicates the combined effects of all the variables not included into the model (116). Regression coefficients in the latter model denotes the effect of explanatory variables on the hazards, conditional on both: the random effects being fixed or held constant and the other covariates being fixed. Therefore, coefficients are sometimes described as having a cluster-specific interpretation (119).

Lastly, it is important to highlight some issues related to the population size and cluster-specific event counts. For the living arrangements variable, there were not enough events in the category of “living alone” for transition type “unhealthy to death”. For that reason, random effect estimations in this transition type were not shown.

Random intercepts and random slopes as a tool for studying country effects

In this study we also take advantage of multilevel modeling as a tool to explore different dimensions of the country effect by including a third level to the model. Apart from the individual and the country levels, we add intermediate levels of hierarchy between the country variable (at highest level) and each covariate (sex, cohort, educational level, living arrangement) at lowest level. This can also be interpreted as introducing interaction terms between country and sex (or the others variables). And the dimensions of the country effects can then be explored by analyzing the random intercept and the random slopes of these interactions.

Design

Three simple Cox PH models were fit for each transition separately. Although results are the same than those obtained with a multistate Cox proportional model with stratified hazards for the three transition types (see ANNEX 1.10 and Putter (150)), a multilevel approach is difficult to be used in the latter[9]. As we were interested in identifying country-specific variation in the hazards of each type of health transition, we therefore needed to include country-specific random intercepts and coefficients for each transition and this explains why each transition is modeled in a separate model. In total, we fitted ten different models for each health transition type:

- Model 1 is a classical Cox PH model with fixed effects of living arrangements, controlling for sex, birth cohort and educational attainment. This type of model is commonly used to represent the effects of factors on the hazards (transition rates), but doesn't make any assumption on the baseline reference risk. Some authors have called this free baseline or free reference risk (109,200,202,204). The reference individual is a male, born between 1924 and 1933 (oldest cohort), with primary studies and living with a partner[10].
- Models 2 and 3 are multi-level models with 1 level, the response variable, which is the reference risk or random intercept in each health transition. In model 2, the random intercepts are individuals. Model 3 includes a random intercept by country, which is to account for the differences in the heterogeneity to experiment changes in health status at older ages between countries.
- Models 4-7 are multi-level models with 2 levels or random slopes that deal with different effects of covariates at each level. As explained by Rabe-Hesketh (116), the response variable in such models, in our case the hazards of health status change, always varies at the lowest level, i.e. it has different values for the distinct level-1 units within the same level-2 cluster. Because the values for individual-level intercepts reported by the second model was not substantial, we used living arrangements as the lowest level of analysis in model 4, cohort in model 5, sex in model 6 and educational attainment in model 7. Each variable was then nested within the level 2 country clusters to account for the varying effect of these predictors/covariates across countries. Lastly, explanatory variables (random slopes) can either vary at level 1 and at level 2. For purpose of this study we focus our

[9] We were not able to introduce multilevel effects with multistate modelling, but we don't discard the possibility that it can be done.
[10] Without children but that may include other co-resident persons (including other type of kin).

attention on the variation of explanatory variables at level 1 within the level 2 country cluster and are therefore compared to model 3.

- Models 8-10 are 3-level models that comprise two nested levels of clustering (116). The data can be viewed with 3 levels of hierarchy in this kind of models. As the individual intercept (model 2) doesn't report any important variance (see below), we take living arrangements as units at level 1, which are nested in level 2 by sex (model 8), cohort (model 9) or educational attainment (model 10), which in turn, are nested within groups of countries (level 3). This type of model provides us with the observed variation of living arrangements effects on health transitions within the different units (or groups) of cohorts, sex or education level and are therefore tested against model 4.

1.3. Results

The results show that all models with random effects fit significantly better than the simple Cox PH model for each transition type (see ANNEX 1.7-1.9). Nevertheless, when considering the log-likelihood and chi square values, the model with only the country level as random intercept - model 3- still does not have a good fit as the log likelihood is significantly lower when two and three hierarchical levels are introduced into the model. This is also reflected by the chi squared values which indicated the significant reduction in deviance when we fit 3 levels models (see ANNEX 1.6). Although in models with higher hierarchical level the increment of the log-likelihood value decreases notably, model 2 that contained the individual as random intercept was excluded due the scarce variance reported for the random effect (see random effects and fixed effect in ANNEX 1.7-1.9).

As our purpose is to explore whether living arrangements have different impacts on health changes within gender, cohort and educational groups, the 2-level Models 5-7 were also discarded because the 3-levels models (8-10) explain more of the within- variability of living arrangements on the health transition type within cohort, gender and educational groups. Below we discuss in more details the results for the selected models.

Model 1. Cox PH model

In general terms, Cox PH ratios for living arrangements[11] are very similar in the simplest model 1 (see TABLE 1.2), to the values we estimated with the models that also include random effects[12], but with one important difference. While fixed effects for the three transition types are similar when sex, education and birth cohort are held constant, the main distinction are in the changes in the significance of the risks for the living arrangements categories when we take into account country-specific random effects.

For instance, the risk of health deterioration is statistically the same for those who live only with their partner compared with those who also co-reside with adult children according to the simple Cox PH model. But the difference in these risks becomes significant when the country random intercepts are included (see Model 3). Living alone, on the other hand, does lead to a significantly higher risk of health deterioration (in all models), whereby elders in one-person households experiment a 6% higher chance of worsening their health status, and living with others leads to a 3% higher risk of deterioration than older persons living with their partners.

For health improvement the picture is different. Elders living with a partner and adult children are 13% more likely to experience an improvement in health than older people who only live with a partner. Conversely, elderly living with others and living alone are 14% and 8%, respectively, less likely to have improvements in their health status than the reference category.

For the transition to death, in comparison with elders living with their partners, those who exclusively live with others have a remarkably 86% higher mortality risk and those who live with their partner and children a 19% higher risk. All coefficients are highly significant. As there are insufficient events in the living alone category, we discarded this transition from the multilevel model analysis.

Additionally, we pointed out high differences by birth cohort groups in all health transitions types, while the results by sex and educational level are as expected; women are more likely to deteriorate

[11] Living arrangements without variation in time ("*Fixed"* variable). There is also a variable of living arrangement that varies between observed period (*"Random"* variable or "time varying") that have not been used here.

[12] See ANNEX 1.7-1.9. Model description: Mixed effects models by transition type.

(RR:1.13, p< 0.001), less likely to improve their health status (RR: 0.98, p<0.01) but they have better survival (RR:0.49, p<0.001) than their male counterparts. Regarding the educational level, the more educational level, the lower the probability of deterioration and mortality risk as well and lastly the greater the probability of improvement in health.

Another point to highlight is the possibility of a selection effect on the health status of those who live with their partner and children; an older person in this living arrangements could be due to this person was in a weak state and very possibly in a worse state of health. This effect could lead an overestimation of the risk of deterioration for the elderly who live with children and partners, but this is not observed. On the contrary, results shown that the presence of children living at home of those who live as a couple have a greater probability of recovery and equal probability of deterioration to those who live only with a partner (and later we will appreciate the variation of this effect between countries). Therefore, we can rule out a selection effect on the state of health in this living arrangements group.

TABLE 1. 2.- Model 1. Cox PH Model with stratified hazards (by transition type)

Fixed coefficients	*Deterioration*						*Health Improvements*						*Death from unhealthy*					
Living arrangements	***N***	***event***	**coef**	**HR**	**CI**	**Sig.**	***% N***	***event***	**coef**	**HR**	**CI**	**Sig.**	***% N***	***event***	**coef**	**HR**	**CI**	**Sig.**
**Living with partner(ref)*	43%	*40%*					42%	*40,7%*					42%	*5,2%*				
Living with partner+kids	30%	*32%*	-0,01	0,99	*0,97-1,01*		21%	*47,1%*	0,12	1,13	*1,10-1,15*	***	21%	*4,1%*	0,18	1,19	*1,12-1,27*	***
Living Alone	15%	*47%*	0,06	1,06	*1,04-1,08*	***	20%	*34,4%*	-0,09	0,92	*0,89-0,94*	***	20%	*0,1%*	-4,56	0,01	*0,01-0,02*	***
Living with others	12%	*43%*	0,03	1,03	*1,01-1,06*	**	16%	*32,3%*	-0,15	0,86	*0,83-0,88*	***	16%	*10,8%*	0,62	1,86	*1,76-1,98*	***
Sex																		
**Male(ref)*	47%	*36%*					41%	*41,1%*					41%	*6,5%*				
Female	53%	*42%*	0,12	1,13	*1,11-1,15*	***	59%	*38,3%*	-0,02	0,98	*0,96-0,99*	**	59%	*3,6%*	-0,71	0,49	*0,47-0,52*	***
Cohort born																		
**Cohort 1924-33 (ref)*	15%	*60%*					30%	*27,0%*					30%	*9,8%*				
Cohort 1934-43	26%	*46%*	0,29	1,34	*1,29-1,39*	***	30%	*40,1%*	0,32	1,38	*1,32-1,44*	***	30%	*3,8%*	0,25	1,28	*1,15-1,43*	***
Cohort 1944-53	39%	*33%*	0,55	1,73	*1,64-1,82*	***	29%	*47,3%*	0,56	1,75	*1,65-1,86*	***	29%	*2,2%*	0,76	2,15	*1,76-2,63*	***
Cohort 1954-63	20%	*26%*	0,80	2,22	*2,08-2,37*	***	11%	*50,1%*	0,80	2,23	*2,08-2,39*	***	11%	*1,3%*	0,99	2,68	*1,99-3,62*	***
Education																		
**Primary (ref)*	48%	*45%*					59%	*37,6%*					59%	*5,3%*				
Secondary	37%	*34%*	-0,17	0,84	*0,83-0,86*	***	32%	*41,3%*	-0,04	0,96	*0,95-0,98*	***	32%	*3,6%*	0,04	1,04	*0,98-1,10*	
Tertiary	15%	*28%*	-0,41	0,66	*0,65-0,68*	***	9%	*49,6%*	0,26	1,30	*1,27-1,34*	***	9%	*3,3%*	-0,15	0,86	*0,78-0,95*	**
N	191.351	74560					156.393	61.698					156.393	7.530				

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05. HR: hazard ratio.
Coefficients calculated with "survival" R package, "coxph" function

Model 3. Random effects between countries (1 level)

The country effect, equal to a random intercept coefficient in the model for the 19 countries observed takes the form:

$$\lambda_{i,j}(t) = \lambda_0(t)e^{\alpha_j}e^{\sum_k \beta_{k,i}x_k}$$

With α_j the coefficients for the country *j* where individual *i* lives, which follows a gaussian law with mean equal to 0. Its exponentiated value of its standard deviation then represents the average excess of risk associated to country membership. As an application of this, we compute the variation of the reference risk[13] for each country while holding all of other coefficients (sex, cohort, education and living arrangements) and the variance fixed.

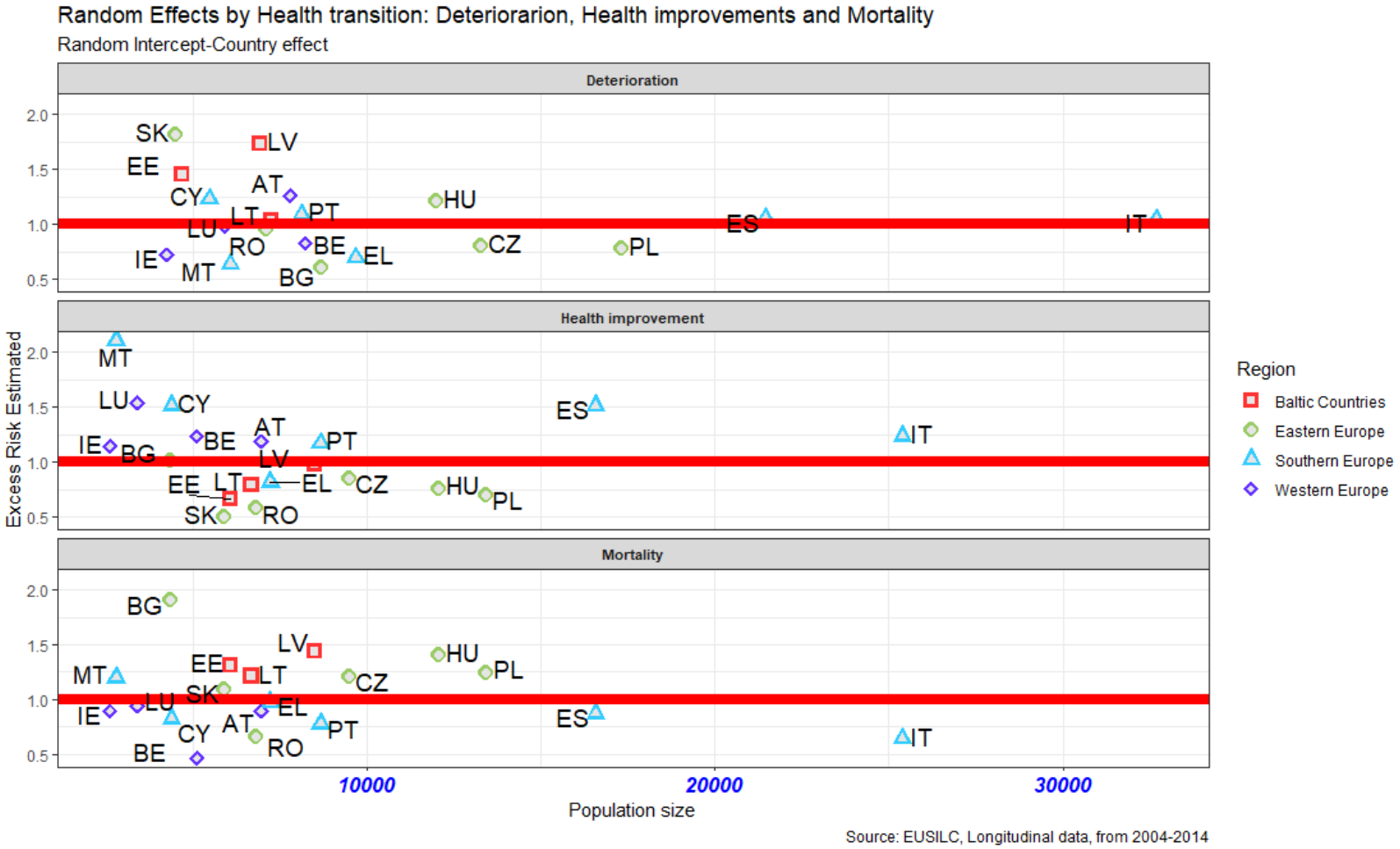
The FIGURE 1.1, below, illustrates the differences in the risks for the three transitions at the country level, taking into account the size of the sample population by country. The size of the population at risk was included to show the effects of smaller and larger country size (e.g. Luxembourg and Spain, respectively) which could shrink or inflate the estimated risk closer to the overall mean (Therneau 2018:11).

For *deterioration transitions*, 37% of the total variance is explained by the variation between countries. For *health improvements* and d*eath*, the average between-countries variation is even higher (respectively, 46% y 41%). There are country effects in the risk score for *deterioration transition*, ranging from less than 2/3 to over 1.8 times the average risk of deterioration. We would expect that elders living in Baltic and Eastern European countries concentrate the maximum excess of risk to experiment deterioration in their health status in comparison with the mean displayed in the fixed coefficients. Slovakia and Latvia have health deterioration risks more than 1.75 times (75% higher) and Estonia 1.45 times (45% higher) than the mean. Conversely, there is lower relative risk of deterioration in elders living in Bulgaria and Greece with 50% less risk than the mean.

[13] Baseline hazard without any proportionality assumption / reference risk is linear function of covariates.

For *health improvements*, the variation of the reference risk is quite wider between countries, even more than for the previous transition. It shows that country effects vary from ½ to over 2 times the average. Countries with higher estimated risk of health improvements are mainly southern countries: Malta (2.1), followed by Luxemburg, Cyprus and Spain with excess risks estimated close to 50% more than the reference risk. On the contrary, Eastern European and Baltic countries have lower propensities for improvements than the mean. For instance, an individual living in Slovakia approximately has half the risk of experimenting health improvements than the sample average.

FIGURE 1. 1.- Model 3. Random intercept by countries compared with sample transitions counts



Note: the red line represents the reference risk for each transition type (which is unknown in Cox PH) and the estimated excess risk reported by the (exponentiated) standard deviations for each country. The model controls for sex, education and birth cohort in the fixed coefficients. Mixed coefficients calculated with "survival" and "coxME" R packages

For *death transition* from unhealthy status, country effects are ranging from less than ½ to 1.9 times the average risk. The model results show Baltic and Eastern European countries to have the highest excess of risk of death (Bulgaria 1.9 times the mean, Latvia and Hungary 1.5 times) and Belgium, Romania and Italy the lowest risk.

Regarding country effects on health transitions, Western European countries tend to report values close to the average risk for three health transition types, although Belgium exhibits the lowest mortality risk. On the other hand, Baltic and eastern European countries have a higher propensity for deterioration and southern European countries for health improvements. Several countries do not follow this regional pattern, such as Bulgaria and Romania who have a lower than average risk of health deterioration and death transition.

Spain has the average risk for mortality and health deterioration, but regarding health improvements its risk is 50% higher than the sample mean. For health improvements there are no eastern European and Baltic countries above the mean risk, indicating a lower likelihood for elderly to improve their health status. Only Bulgaria and Latvia are close to the average risk.

For health deterioration, most eastern European and Baltic elderly experiment a higher risk (more than double in Slovakia and 50% more likely than the average in Estonia), although Bulgaria, the Czech Republic and Poland are exceptions with 20-35% lower risk. On the other hand, the worst situation is shown for Hungary, Lithuania and Estonia. Countries which report lower health improvement and higher deterioration and mortality risk, as well. Meanwhile striking values are reported by Slovakia and Latvia. Slovakia with the lowest risk to improve for elderly their health status (less than 50% the mean risk) and the highest risk for deterioration (more than double mean risk). And, Latvia with 50% higher relative risk than the average for deterioration and mortality risk.

Lastly, if we compare the results with the simple Cox PH model, the mean effects of living arrangements observed few changes after including the random country intercepts. In the case of health improvements, it declined slightly, most noteworthy for living with children and partner (from 13% to 10%). This also applies to living with others in the case of the transition to death (from 1.9% to 1.8%), while living with both children and partner became significant in health deterioration (from 1% to 2%, with $p<0.05$). This implies that the effect of living with both children and partner contains significant country-specific differences in comparison with the reference risk (living with a partner), while living with others doesn't.

Model 4. Random slopes by living arrangements within countries (2 levels)

This model with living arrangements at level 1 and countries at level 2, with both having a varying random intercept coefficient, takes the form:

$$\lambda_{i,j,h}(t) = \lambda_0(t) e^{\gamma_{h,j}} e^{\alpha_j} e^{\sum_k \beta_{k,i} x_k}$$

Where again α_j is the coefficient for country *j* where individual *i* lives, $\gamma_{h,j}$ is the coefficient for living arrangement *h* and country *j*, with both coefficients following a gaussian law with mean equal to 0.

The standard deviation in health deterioration and health improvements, which, respectively, comprise 37 % and 46% variation of the average risk between countries, for level 2 which are almost the same value observed for the previous random intercept model (see TABLE 1.3). Meanwhile, there is 8% average relative excess of risk related to living arrangements affiliation (level 1) within country clusters (level 2) for deterioration. In other words, there is more dispersion in the average risk of living arrangements for older people to experiment health deterioration between countries than for those reported by health improvements (5%) at the same level. This means that the effect of living arrangements could reach more extreme values for worsening health status than for health improvements between countries. The mortality risk associated with country effect remains without change compared with the previous model (40%) and the risk related to living arrangements membership is very low (1%), denoting no variation in the mean effect of living arrangements on mortality risk for elderly between countries.

TABLE 1. 3.- Model 4. Mean effect and mixed effect of living arrangements on health transition.

	Fixed coefficients by health transition		
Living arrangements	Deterioration	Health Improvements	Death
Living with partner(ref)			
Living with partner+kids	0,98	1,10 ***	1,19 ***
Living Alone	1,04 *	0,94 **	0,01 ***
Living with others	1,01	0,88 ***	1,75 ***
2-level variance			
Random Intercept(level 2 - Country)	36%	46%	41%
Random slopes(level1 - Living A.)	8%	5%	1%

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05.
Note. The model controls for sex, education and birth cohort at the individual level (mean effect).
Mixed coefficients calculated with "survival" and "coxME" R packages

Coefficients by living arrangements groups are significant for health improvements and mortality risk when there are two levels, i.e. livings arrangement groups nested within countries, holding coefficients for sex, education and cohort fixed. Results shows dissimilar patterns. However, while for health deterioration there is only a differential effect for elderly living alone between countries when compared with the reference category (living with a partner) in the case of health improvements and death transition, all living arrangements groups (highly significant) influences differently those transition within the 19 countries observed. Depending of the country where elderly live, they will have a lower or higher risk than the mean reported in the fixed effects of living arrangements groups.

In this sense, the likelihood of health deterioration increases 4% when elders live alone in comparison with elders living with a partner, and those differences are significant between countries. Two southern countries, Malta and Greece, reflect a 10% excess of risk in health deterioration over the mean effect of living alone. And with the opposite trend, Romania and Latvia shown the lowest risk (10% less than the average. See also ANNEX 1.5)

In health improvements, living with both, partner and children is a favorable factor in the elderly but not in the same magnitude between countries. Older people with this living arrangement affiliation are 10% more likely to experiment health improvements than those living with a partner. This effect is more than 5% higher in Slovakia, Italy, Ireland and Greece but 5% less likely in Luxemburg, the Czech Republic and Spain. These diverse patterns among the three southern European countries are perhaps surprising given their similar profile of living arrangements and same proportion of elderly population.

On the other hand, elders living alone and living with others are 6% and 12%, respectively, less likely to improve their health status. The negative mean effect for living alone is less pronounced (7%) in the Czech Republic and Portugal, meaning that in those countries, elders living alone doesn't represent a disadvantage in health status when is compared with elders living with a partner. Italy, Greece and Latvia present even less health improvements than the mean effect of living alone. Elderly living with others in Poland, Malta and Bulgaria would have more than 5 % higher improvements than the mean effect of this living arrangements affiliation but in Romania, the Czech Republic would have even less health improvements.

Models 8-10. Random slopes of living arrangements (level 1) nested in random intercept of sex/cohort/education (level 2) nested in super cluster of countries (level 3)

Mixed models with 3 level of random effects let us to identify intermediate factors which modify the effect of living arrangements on health changes in the 19 European countries. In this sense, we vary the fixed coefficients (slopes) for living arrangements groups -that represent the 1-level- within categories of birth cohort, sex and educational attainment (level 2), which, at the same time, those groups are nested within countries- which represent the third level (super cluster or random intercepts by countries), holding constant the control variables sex, birth cohort and educational attainment in the fixed coefficients. These models illustrated nested effect within supercluster (see TABLE 1.4).

The Models with three levels comprise similar values in the variance of random intercept by countries and for the main effect of living arrangements categories in comparison with the model with one level (model 3) and with two levels (model 4). Main differences are shown in the second levels. There are much larger differences of living arrangements effects within cohort and education levels than by gender. It means that there is more variability of the impact of living arrangements categories by cohort and education groups that gender effects have. However, for death transition, there are different pattern depending on the (second) level considered (e.g. sex, cohort or education), being the most remarkable output that there are no differences between the effect of living arrangements affiliation on mortality within educational groups. All regressors of living arrangements shown significant differences between the distinct levels included (sex-model 8, cohort-model 9 and educational attainment-model10, TABLE 1.4), with exception of living with others in deterioration transition.

TABLE 1. 4.- Models with 3-level mixed effects (8, 9 and 10).

Model 8. 3 level: Mean Effect of living arrangements on health transition within sex, nested in Countries

	Fixed coefficients by health transition					
Living arrangements	Deterioration		Health Improvements		Death	
Living with partner(ref)						
Living with partner+kids	0,95	**	1,08	***	1,19	***
Living Alone	1,04	*	0,95	**	0,01	***
Living with others	1,01		0,87	***	1,74	***
3-level variance						
level 3 (Country)	36%		45%		41%	
level 2 (Sex)	3%		2%		1%	
level 1 (Living A.)	8%		6%		9%	

Model 9. 3 level: Mean Effect of living arrangements on health transition within Birth cohort, nested in Countries

	Fixed coefficients by health transition					
Living arrangements	Deterioration		Health Improvements		Death	
Living with partner(ref)						
Living with partner+kids	0,96	**	1,09	***	1,17	***
Living Alone	1,04	**	0,93	***	0,01	***
Living with others	1,02		0,88	***	1,67	***
3-level variance						
level 3 (Country)	37%		45%		42%	
level 2 (Cohort)	8%		12%		7%	
level 1 (Living A.)	7%		5%		11%	

Model 10. 3 level: Mean Effect of living arrangements on health transition within Education level, nested in Countries

	Fixed coefficients by health transition					
Living arrangements	Deterioration		Health Improvements		Death	
Living with partner(ref)						
Living with partner+kids	0,96	*	1,08	***	1,19	***
Living Alone	1,05	**	0,94	***	0,01	***
Living with others	1,03		0,88	***	1,74	***
3-level variance						
level 3 (Country)	36%		42%		39%	
level 2 (Education	8%		7%		8%	
level 1 (Living A.)	7%		6%		1%	

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05.
Note. The model controls for sex, education and birth cohort at the individual level (mean effect).
Mixed coefficients calculated with "survival" and "coxME" R packages

In overall, there are similar variance in the second level for birth cohort groups (model 9) and for educational attainment (model 10) compared with the first level of living arrangements in the deterioration transition. For health improvements, there are much larger variance in the second level of birth cohort (12%) than for living arrangements (5%). It denotes more differences by cohort groups to experiment health improvements than in living arrangements. In addition, gender effect differences

report lower variation (2-3%) for each one of the health transition than living arrangements within countries (model 8). For mortality risk, values reflect the opposite effect, there are much more differences on the effect of living arrangements (9-11%) within countries than for sex and cohort. Meanwhile, educational attainment modifies (8%) the average mortality risk more than sex (1%) and living arrangements within countries.

1.4. Discussion

Summary of main findings

First: living arrangements coefficients

The results presented here show a diverse pattern in health transitions at older ages between European countries. This is, in part, due to the different composition between countries in living arrangement affiliation (see ANNEX 1.4). Living arrangements influence health transitions in different ways. Living with both adult children and partner has the same effect as living only with a partner (reference) in health deterioration (no significant differences; RR:.99, $p>0.05$), although in the case of health improvements, for those older, there is a 13% ($p<0.001$) higher chance to improve their health condition compared with the reference, while the others living arrangements shown lower chance of health improvements. Nevertheless, mixed effects outputs shown that there are significant between-country differences in the group who lives alone (model 3 and 4). And finally, when a 3-level model is fit (models 8,9 and 10) the effect of living with a partner and children becomes significant within countries.

Second: country effect on reference risk

However, there are countries with greater propensity for health deterioration and others for health improvement, which denotes frailty or unobserved heterogeneity in the sample of 19 European countries. In particular, eastern European and Baltic countries show much larger differences than western and southern European countries, with the latter region always reporting similar values to the mean. Western European countries also report scores close to the mean likelihood for the three health transition types. However, it should be mentioned that although the results for Belgium showed lower health deterioration and mortality risk than average, one Belgian study showed mortality to be underestimated in survey data (101), which is also likely to be the case in the other countries (201).

Regarding health deterioration and mortality, the Baltic countries reported higher risks than the mean effect (excluding Lithuania) and, at the same time, as it might be expected, the opposite trend for health improvements. It means that the elderly in those countries have a lower chance for health to improve. Several countries (Slovakia being the best example) depict a higher than average risk for both health improvement and deterioration. Although Eastern European countries tend to perform worse, in Bulgaria the risk of health deterioration is lower than average, while the risk of death in Romania is lower than average.

Third: living arrangements affiliation within countries

Southern European countries depict the most diverse patterns of living arrangements effects on health improvements. Spain and Italy which has a similar pattern in living arrangements and proportion of elderly in the population, illustrated opposite trends. In Italy, elderly living with their partner and children observed a 10% higher improvement in their health status than the sample mean, while in Spain this risk is 7% lower.

At the same time, elderly people living alone in Spain and Portugal reported a 7% higher propensity of health improvements meanwhile in Italy and Greece this effect was even below average Malta and Greece are also countries with higher risk of worsening health status (about 14 percentage points) than the sample mean effect of 4%. Meanwhile, Romania and Latvia with a different pattern reported the lowest values of health deterioration. This shows that some Eastern European countries are atypical. For health improvements, elderly living with both their partner and children in Slovakia shown more propensity (5-10%) than the overall mean to improve their health status, while the same applied to elderly living alone in the Czech Republic. In countries with strong family ties, elderly who live with their children increase the probability to improve their health status, as is the case in Italy. However, it does not represent a protective effect against health deterioration in other southern European countries like Spain and Portugal, thus depicting less health improvements for elderly living with their children.

Fourth: variation of living arrangements within gender, birth cohort and educational groups nested in countries.

To continue with the variation of the effect of living arrangements on the three health transitions we find that there are larger differences of living arrangements within cohorts and educational groups than within gender, despite studies showing that women are more sensitive to health deterioration. The variance at level 2(sex) is smaller than variance at level 1(living arrangements) within countries

(level 3). This is, the differences in the health transitions by cohorts and educational level are wider than differences by gender

Another interesting finding is that the random intercept by birth cohort and educational level within countries in the 3-level model illustrates much larger variation in health transition probabilities (excluding mortality risk) than in living arrangements. For health improvements, the average effect of birth cohort (12%) is much larger than living arrangements (5%), while for health deterioration, the average effect is around the same for both. For the former, this means that there are more differences in the likelihood that elderly health status improves by cohort groups (and therefore, in the age of the individuals) than for living arrangements, while the health deterioration probabilities depict the same differences by cohort and living arrangement. Death risk show a different pattern, as the average variation of the living arrangement effect is larger than birth cohort and sex within countries, but they are lower than educational attainment.

The average excess of risk explained by educational attainment is almost the same as for living arrangements for health deterioration and health improvements (around 7-8%). However, in the risk of mortality educational differences within countries explains more than the country differences in living arrangements. The distinct composition of living arrangements within the older population between countries is due to differences in the availability of children and also in the direction of the help, which is likely related to the age of these adult children, as is shown in Mackenbach (206).

Strengths and limitations

We defined health status according to the General Activity Limitation Index (GALI indicator) which is used to measure functional limitation. Since this measure is not collected in most of countries with register data we could not explore Nordic countries in this study. It was therefore not possible to do a broader comparative perspective in the European region. We raise this issue, because it is well known that those countries have a distinct pattern of co-residence in Europe which would make their inclusion worthwhile in future analyses.

Another issue concerns the wording of the GALI question and its response categories that changed over time in several countries (36), making this indicator not always comparable in the results (13) despite there are studies which support the validity and reliability of its use (12,207,208). We particularly raise the attention of possible bias in the results for Cyprus, Estonia, Greece, Lithuania, Latvia, Malta Portugal and Slovakia, which changed the wording in the middle of the analysed time series (36). Nevertheless, we consider the method used in our study to be a good approach of how to

use random effects on survival probabilities in order to estimate predicted probabilities of health changes at older ages. It allows the inclusion of country-specific patterns of living arrangements and personal traits (gender, cohort and education) as exogenous variables, which modify the mean risk to experiment a specific event. In this way, we were able to estimate the size of the country-specific variability for older people to change their health status by taking into account their living arrangement. By applying a multilevel approach also permitted to ascertain whether the association between living arrangements and health transitions was modified by the exogenous variables.

Finally, we do not discard that the mortality estimation in this study is underestimated due to the small size of the death count in the survey (201) for countries like Belgium and Luxembourg. An additional source of underestimation is the part of the initial survey population who was transferred to a health care institution at a later moment in time. These respondents were subsequently considered as truncated information and were most likely to come from western, eastern European and Baltic countries.

2. Introduction to Multistate

2.1. Introduction

The Multi-state approach was developed by Rogers in 1975 for the study of internal migration. It is based on an extension of the life table model created by Graunt in 1661 (209). It is well known that life table consists in the estimation of survival probabilities from observations on death records (one occupied state). Multi-state life table models (MSLT), also known as increment-decrement life tables, recognize more than one occupied state. Rogers studied migration between regions instead of mortality. Living in a region is considered as a state and interregional migrations as transitions between states. The final result was the multi-state life table as a model to study more than one active state and to allow all individuals of the model population to move from one to others states (210). Since then, MSLT have been widely used in demography to describe multiple kind of events and trajectories between states in the life cycle from birth to death (25,122).

Due to its greater flexibility, MSLT are applied, for instance, to the analysis of populations moving between different states of labor force activity (144,146), living arrangement (122), educational status (211), ageing and health conditions (25,31), migration (209) and others events in the life course. This method allows us to understand the influence of covariates on status changes.

MSLT are also applied for population projection models to describe how population composition at a given time depends on the initial population and the transitions of people between states. Willekens (212) reviewed such methods. For instance, recently the International Institute for Applied Systems Analysis (IIASA), leading the World Population Program (POP), released a Multi-State forward projection of the population of 120 countries for the period 2000-2050 according to age, sex and four levels of educational attainment based on cohort component methods, taking into account differentials in fertility and mortality fertility and mortality by education level (211).

This method has also been used with Bayesian techniques. Lynch and Brown (26) used the Bayesian extension of the Sullivan´s Method on the MSLT distribution to analysis dynamics in specific population groups. They used data from cross-sectional mortality files and systematized a method to estimate disaggregate information. Later, the same researchers (164) used Bayesian Markov Chain Monte Carlo methods to generate distributions of transition probabilities for selected values of covariates based on a sample of produced model parameters to construct life tables. They illustrated the method with three different data sources: Human Mortality database, National Health and Nutrition Examination Survey and data from the National Long Term Care Survey. Findings show advantages of using Bayesian technique to include covariates in the analysis of very different samples. Finally, in Willekens (212) MSLT is applied for biographic forecasting. It uses the life course as its framework by integrating

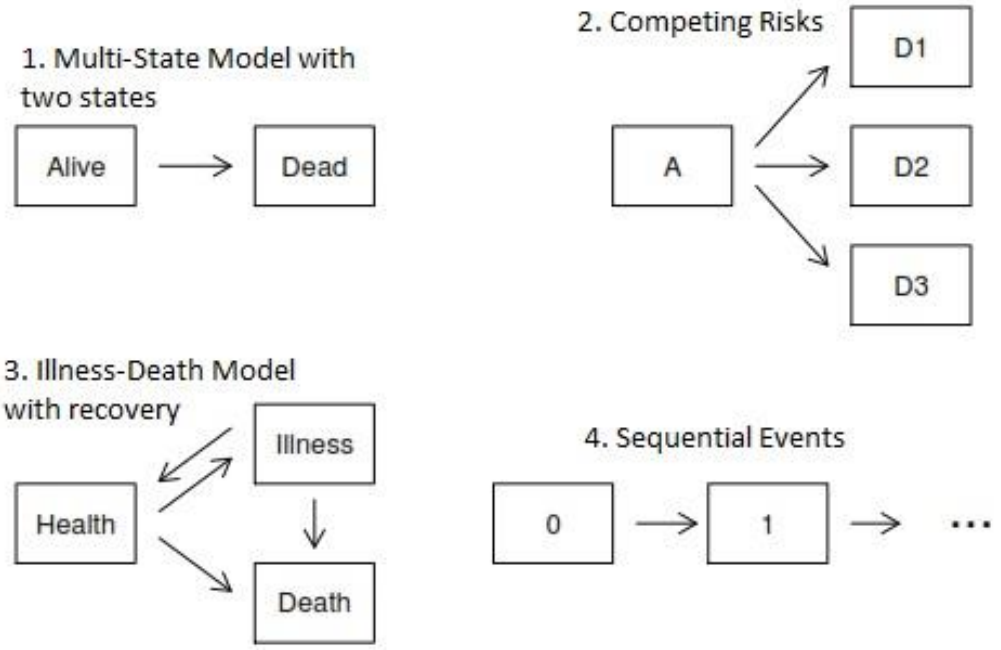
substantive knowledge on transitions people make in life (e.g. family, employment) and statistical perspectives and techniques into demographic modeling).

Multistate applied to health conditions

These models are widely used in the fields of epidemiology, biostatistics, clinical medicine, actuarial science, reliability and econometrics (122,125,126,213). For instance, Van der Gaag et al. (214) compared different scenarios of future changes in incidence rates of disability, studying risk factors like obesity over chronic diseases such as diabetes. Putter (215), Eulenburg et al. (18), studied treatment and prognostic factors associated to breast cancer. For further illustrations of the use of Multi-state models in Clinical studies, see Crowther and Lambert (216,217) for its application on cancer treatment and Titman (218) on the progression or recurrence of diseases.

Epidemiological and medical studies depict multistate models as a flexible approach to understand disease processes and its evolution over time, even in complex cases such as cognitive degenerative diseases like dementia where identifying accurate diagnosis early is difficult. For example, leading studies on dementia and Alzheimer diseases at the Faculty of Medicine of Dalhousie University in Canada use Multi-state model to identify key factors that have impact on the progression of those diseases. Findings showed that exercising is highly related with improving cognition (219,220). Allignol et al. (126) and Therneau et al. (221) illustrated this methodology through drawings with boxes representing each state and with arrows, the possible transitions. In FIGURE 2.1, case 1 refers to a simple multi-state model with two states: being alive and dead. In this situation only one transition between two states is calculated. In general, in survival analysis, individuals are observed, focusing on the occurrence of the interested event: death, diseases or complications (222).

FIGURE 2 1.-Multi State Models



Source: Therneau (221) . Note. 1) Depicts simple survival as it shown in a Life Table. 2) It is an example of competing risks, 3) It is a multi-state illness-death model, and 4) depicts sequential events.

Then, there is the classical competing risk, where all subjects start on the left and each subject can make a single transition to one of 3 terminal states. It means that the "alive state" can be fragmented into two or more transient states (213). Those states can be represented by different death causes or diseases which are competing over the "risk set", known as exposure population.

In the life course framework, competing risks are also considered similar to Multistate processes when applied to the study of multiple ways in which a single event may occur. In some cases, this is characterized as an absorbing state (e.g., the classic example is the transition from different illnesses to death). However, multistate models comprise different origin and destination states (e.g. from being ill to being healthy) and, therefore, multiple changes between states may also include competing risk processes (110). For instance, Steele et al. (110) and Willekens (149) showed in their respective studies on contraceptive use dynamics and migration decision, that when two type of events share the same origin state (e.g. from the use of a given contraceptive method to non-use or a switch to a different method or the decision to move to one place or another), these two type of events can be thought as competing risk.

The health transition types we study in Chapter III through a multistate model can be also seen as two separately competing risks. Here we distinguish four transition types that share two states of origin as follows: people with healthy status can change their status to “unhealthy” (deterioration) or to “dead”, and people with unhealthy status can turn to “healthy” (health improvements) or “dead”. Therefore, deterioration and improvement are considered transient states in which individuals could experiment the event more than once (recurrent events). Meanwhile the death is the absorbing state, with no possibility to experiment another transition one reaches the death status.

Case 4 in the graph refers to the progressive three-state model or sequential events, which could be represented as repeated infections (123) or use of contraceptive methods (223). Finally, case 3 shows the multi-state model, also known as the illness-death model which may be with recovery (reversible transitions) between states and without recovery (with irreversible transitions).

The Illness death model without recovery is used in Frydman (224) and is illustrated with diabetes survival data whereby transitions between states are irreversible. Data is interval censored because patients are periodically observed, thus the onset of disease may not be observed. The author used a non-parametric assumption and used the Aalen estimator to calculate the transitions probabilities. The times of death are right censored as well, and observations may be left censored.

On the other hand, the illness-death model with recovery comprises changes in all directions, but obviously only for the non-absorbing states. In such models, stability implies no changes in states; decline, a deterioration of the current health state, taking into account the previous one; and improvement, recovery to a better health state. Furthermore, these models allow the measurement of the effect of factors that may affect health status to change, for instance, type of household condition and living arrangement, as in the case of our study.

2.2. Methodological issues

Multistate modeling is considered an extension of the life table (or actuarial table). This approach illustrates the scenario of the life course where individuals are at risk of more than one kind of (recurrent or non-recurrent) event. It focuses on the process of changes and the sequence of events (112). The multistate model we apply in our study, and that we use in Chapter III, is based on the time-

inhomogeneous[14] Markov hypothesis (210). This hypotheses refers to stochastic processes in which the future state of an individual depends only on the state currently occupied by him or her (225). The assumption is that the past can be explored via current time measurements. The progression of a specific illness at a given time (or at a given age) depends on the time elapsed since the initial moment of observation (125). Therefore, our analysis is based on what are known as semi-Markov models, which allows us for example to explore duration effects on the hazards (time dependence). This explains why they are considered to be a more realistic and useful assumption in the field of epidemiological studies (18,226,227).

Sequences of States, Episodes and Events make up the life course (122,212). Different occupied states should be identified in a multistate system. In our study, states are related to health status, which we define as "Healthy", "Unhealthy" (based on the answer of the health-related question "General Limitation Index" "GALI") and "death". Healthy, i.e. individuals who report not having a limitation in activities of daily living (ADL) due to health problem; unhealthy, i.e. persons who reported having an ADL limitation, including both options; strongly limited and limited; and, as the absorbing state, death. Healthy and unhealthy are recurrent states. Our health-status classification is similar to those used in other disability models that have been used to measure Healthy Life Expectancy (25,123,227,228).

Episodes are related to a continuous period of time spent in the same state until an event occurs. Experimenting an event means transitioning to another state. An individual at risk can therefore experiment many types of events and life can be considered as a succession of different episodes (but an important caveat is that he or she cannot experiment these events, neither be in different states, at the same time). These events occur conditioning on an origin state, when the person is considered to be exposed to the risk, and at a reference time (the time of study or the corresponding age of the individual). In Steele et al. (110), the model is used to calculate the duration to an event from the moment at which an individual is said to be at risk. The time at risk is divided into multiples episodes, which is known in event history analysis as the counting process.

Based on the sequences of states, episodes and events, the Multistate method then allows four principals indicator to be calculated: a) Transition rates, b. Transition probabilities (or hazard), c) Expected states occupation probabilities –or survival probabilities- and d) Expected state occupation

[14] The time inhomogeneous property is the intensity that can vary (decrease or increase) in an age interval. For further explanation, see Schoen, chapter four (210).

times –time/years expected in each state, which resembles the years expected to live in a life table (122,210).

Transition rates

Transition rates are the key input to calculate transition probabilities and state probabilities. Their estimation varies depending on the parametric or non-parametric approach and discrete and continuous time used; see (111,122,142,200,204,221). The exponential model based on occurrence–exposure rates is commonly used in epidemiology and demography as a parametric approach (for a further description, see Siegel, chapter four (170)), while the cumulative function calculated with the Aalen Johansen estimator is known as a non-parametric approximation (210).

Transition probabilities

Transition probabilities or hazard function are derived from observed transition rates and, when the event of interest is death, allow estimate the *force of mortality*. The hazard function represents the **instantaneous** probability that the event occurs during the interval time in ages (e.g. one-year interval or from one wave to the next one) , conditional on the fact that the event did not occur before $\boldsymbol{t}$ (112).

They illustrate the instantaneous probability of a person who is in state "$\boldsymbol{i}$"(Healthy) at a given reference age "$\boldsymbol{x}$" (60) is in another state "$\boldsymbol{j}$" (Unhealthy) at a given later age "$\boldsymbol{x}+\mathbf{1}$" (70). Probabilities can be: a) in discrete time transition, the probability that a person with a given state will occupy another state "$\boldsymbol{t}$" months later (specific time). And, b) direct transition, which is the probability that a person will transit to another state at least once during the interval (122). In this study, probabilities are calculated from the direct transition, but for the time interval when transitions occur, as the exact time of transition is not known, due to the fact that we use panel data.

Expected state probabilities received distinct names depending on the researcher (122,229,230). For instance, Willekens (122) shows that they are related to different probabilities: event probabilities, state probabilities and transition probabilities. On the other hand, Schoen (210) applied and compared different methods to estimate them. There are four methods for occurrence exposure rates and two methods using survivorship proportions. Henceforth, based on the method chosen, the way to calculate the probability to occupy a specific state between ages, varies. However, we distinguish the following elements in which the state occupation probabilities rely to calculate the probability of

transition between two ages[15] $(\boldsymbol{x}, \boldsymbol{y})$ related to a) the occurrence of an event (change of state) or b) a continuous stay in an specific state (122):

1) *Transition probabilities between ages* $\boldsymbol{P(x,y)}$**.** It is represented in the matrix of transition probabilities between ages (illustrated below). These probabilities may be considered as a continuous state probability in an interval between two ages $\boldsymbol{p_{ii}(x,y)}$**,** which is represented as $\mathbf{S(x,y)}$**,** commonly known as **survival probability** in a given state between two ages. The survival probability at ages $\boldsymbol{x,y}$ $(\boldsymbol{p_{ii}(x,y)})$ is the probability of non-occurrence of an event given two consecutive ages (122), or said in other way, the probability of remaining in state $\boldsymbol{i}$ at age $\boldsymbol{y}$ (230).

Transition probabilities matrix

$$\boldsymbol{P(x,y)} = \begin{bmatrix} \boldsymbol{p_{ii}(x,y)} & \boldsymbol{p_{ji}(x,y)} \ \dots \ \boldsymbol{p_{Ii}(x,y)} \\ \vdots & \\ \boldsymbol{p_{ij}(x,y)} & \boldsymbol{p_{jj}(x,y)} \ \dots \ \boldsymbol{p_{Ij}(x,y)} \end{bmatrix}$$

2) *Transition probabilities between two states* $\boldsymbol{p_{ij}(x,y)}$**.** It is the probability that a person in state ***i*** at age $\boldsymbol{x}$ will be in state ***j*** at age $\boldsymbol{y}$. It is written as a distribution function called $F(\boldsymbol{x})$[16]. It is the probability that the length of life of a specific individual is less or equal to a give value $(\boldsymbol{x})$**.** For instance, $\boldsymbol{F(x) = Pr[X \leq x]}$, represented by $F(\mathbf{50})$. It is the probability that a person doesn't survive beyond his or her 50th birthday(231).

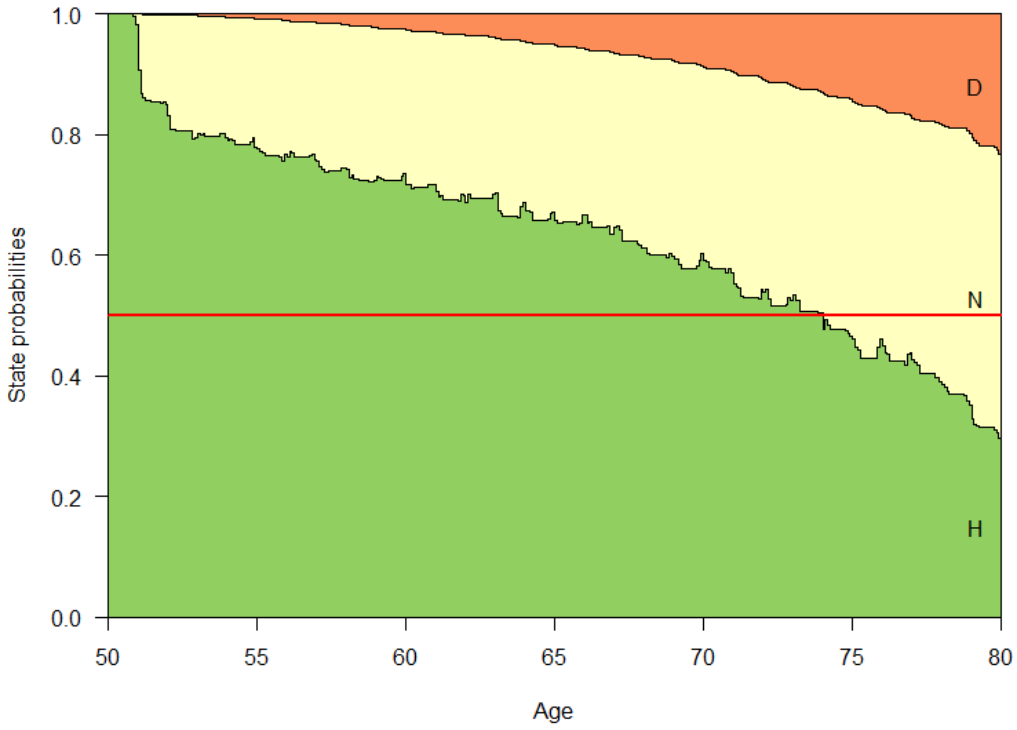
Survival function

From the distribution function the survivor function $\mathbf{S(x)} = \boldsymbol{Pr[X > x]} \rightarrow \boldsymbol{S(x) = 1 - F(x)}$ is derived**.** It denotes the likelihood of an individual who will continue occupying a specific state (e.g. being alive) at exact age $\boldsymbol{x}$, since an individual in the state space must occupy one state at given age. With the knowledge of the probabilities for all possible states it is possible to obtain a complete specification of the state probability distribution for a given individual at age $\boldsymbol{x}$.

[15] In this study, age refers to the central time scale on which the health status probabilities are represented. In other studies, the time scale may be "time in study" or "calendar time".

[16] $(\boldsymbol{x})$ considered as random variable, always positive —because people don't die before they are born— and not more than 120, because an individual´s lifetime is not greater than 120 years**.**

FIGURE 2 2.- State occupation probabilities from healthy status at 50 years' old



Note: Expected transition probabilities calculated with "mstate" R package, functions "msfit" and" probtrans".

In this sense, the survival probability on state or the expected state occupation probability in a continuous state between ages can be represented graphically in the multistate system (see FIGURE 2.2, with stacked transition probabilities). Plotting $\mathbf{S}(\mathbf{x})$ or $\boldsymbol{p_{11}}(\boldsymbol{x},\boldsymbol{y})$, against the time scale (in ages) for all individuals at $\boldsymbol{i} = \mathbf{0}$ (at landmark, age=50) gives a powerful tool to explore the possible changes over the health status over time. The survival probabilities are measured by the distance between two adjacent curves. They represent the probability to occupy specific state (202). We focus our attention later on these curves and their explanation (see next section).

Expected state occupation time

Expected state occupation time is related to time duration in each state, also known as sojourn time. It shows the total time that an individual may expect to spend in each state in a multistate life table. The expected state occupation time is a summary measure of the multistate survival functions (122). It is represented in a similar way as the life expectancy at birth with two occupied states, being alive and dead, or life expectancy at a given age. In this study, it refers to time expected (in years) in healthy or unhealthy status by ages, from 50 to 80.

Remarks for recurrent events

It is important to point out two main issues in the study of recurrent events, as is the case with health deterioration and health improvement (200). First, the occurrence of one type of event could lower or raise the hazard of the occurrence of another event (e.g. mortality). In this sense, we include as time-varying variable the occurrence of health deterioration or health improvement in the analysis of mortality in chapter III. This method permits us to go more deeply into the analysis of death at older ages, for instance, by ascertaining whether prior to death there were previous health transitions (deterioration or improvement). However, as we have few cases for death in our data (see chapters I y III, section data), other data sources would need to be used.

And, second, each type of event has its own hazard function. The overall hazard function (hazards for the occurrence of any of type of health transition) is the sum of all the type specific hazard functions. There is no possibility (in our study) that an individual experiment two transitions at the same time as the clock is reset each time that an individual experiments an event. This is due to the fact that each event is bounded by their own time interval (200).

Time scale

The time scale used is chronological age rather than calendar time in all the chapters of this thesis. This is for two practical reasons. First, studies on health at older ages and events in the life course (122,232) have shown that risk factors and health status are closely linked to age because mortality risk and health status are highly age dependent (233). Therefore, the hazard function for a health event is usually assumed to be a function of age rather than time (234). This is why attained age is considered to be more precise in epidemiologic and clinical studies on disease progression, treatment effects and the onset of health conditions (235,236). Furthermore, the hazard's age effects is often much stronger than the (calendar) time effect (237). Nevertheless, and following other studies (49, 51, 53) we test the models using both scales. Therefore, choosing age as a time scale, the baseline is understood as age-specific incidence function (238). And, therefore, the reference risk is adjusted by age effects because the time scale is comprised within the unspecified hazards (233).

In the next chapter we´ll see that even though a Cox model with an age scale or a calendar time scale would produce similar hazard rates[17], we are aware of the different mechanisms that are implicit in the hazard expressions. For instance, the population at risk doesn't vary monotonically with age as it does if calendar time is used as a scale. Using an age scale model also implies late entry (delayed entry), which means left truncation takes place at the age that an individual is included at the observation period (238).

However, in the age-scale models we did include calendar time covariates as it is recommended by other studies (233,239) in order to analyze period effects. In our study we tested the effect of the great recession (2008-early 2010s) that particularly hit the southern European countries hard. We also estimate a model using calendar time as time scale to assess any age variation effect on the hazard. Hence, we include age attained, to control effects related to age and time duration on the hazard. Lastly, the methodology described here is applied in the following chapter.

[17] It is possible due to the time period followed for each individual in the EU-SILC survey

3. Health transition probabilities at older ages by living arrangements within countries from a Multistate Approach

Abstract

This study explores the effect of living arrangements and housing conditions on health status transitions and mortality risks at older ages (population aged 50 and over). We calculated health transition probabilities to estimate whether the living arrangements of individuals affect their risk of experimenting a health deterioration or improvement. We focus especially on the effect of living with a partner and children. We also study period effects in order to explore differences in health transitions in time between countries, with a special interest for the effect of the economic crisis. A Multistate approach with age dependence modelling is applied using data from the European Statistics of Income and Living Condition (EU-SILC) panel from nine countries. Results show an interaction between gender and living arrangements in the risk of health transitions. There is a protective effect of being a woman, especially when in the disadvantageous situation of living alone at older ages: women living alone have 3% lower risk of health deterioration than women living with a partner. At the country level, differences are more marked between southern and eastern European countries, for instance, Poland was the only country which reported a 30% less likelihood of health deterioration for women than the mean risk reported by Spain, whilst the others eastern European countries reported higher risk.

3.1. Introduction

Over the last decades, population ageing is a ubiquitous process in European and other industrialized countries. Only in sub-Saharan African regions and Middle East countries no increasing trend in the proportion of older people in the population has been observed (240), while in Oceanian and North American countries a large variation in the older age structure is reported (241).

This ageing process, caused by fertility rates declining to below replacement level and increasing survival at older ages (155,157,173,242), has been accompanied by changes in the household composition and family living arrangements. Family living arrangements, already well-documented by others (46,51,77), show broad differences in family ties and intergenerational solidarity (243) but are also shaped by characteristics of the welfare state (206). Previous studies have illustrated, at least for European countries (81,244), that closer family relations in southern countries, typified by a larger household size with scarce intervention from the state on elderly care, and weak family ties in Nordic countries (with a smaller average household size and greater state intervention with regard to elderly care).

We therefore observe a substantial heterogeneity of living arrangements between countries of older people, although there is a general trait Women are more likely to live alone and in widowhood. This is mainly because they are more likely to live longer than their male spouse, who also tend to be older than they are (63,244). Conversely, men are more likely to live with a partner in later life and having a partner provides a protective factor for their health status (77,185,245). However, the higher survival for women does not mean they also have a superior health status. Known as the gender paradox, the extra years of life lived by women are done so in bad health (163,183).

Survival and health status at older ages can be explored thanks to longitudinal surveys which allow prevalence rates associated with health conditions to be computed. These include: chronic diseases, self-reported of health status or functional limitation through Activities of Daily Living(ADLs), Instrumental Activities of Daily Living(IADLs) or the General Limitation Index (GALI). These indicators can be used to calculate total life expectancies and disability free life expectancies with the Sullivan method. This method is based on prevalence rates of the health status (99–105,246–250), instead of incidence rates. Studies that have used prevalence rates point out that the positive effect of higher educational levels on health is less in some western countries due to cohort effects. For instance, in southern European (Spain) and East Asia (Japan)older birth cohorts have (mainly) lower education levels and the educational effect on life expectancy is less than in other countries, including the United States (251). Another finding showed that across the life course, morbidity compresses after the age of 65 (99), even though it is debated whether the extra years gained in life expectancy in the last decades of life will be in disability or in a dynamic equilibrium (157,246).

Besides these findings, there are few studies using incidence transition probabilities between health status (252) and even less that consider the relationship between health status and living arrangements at older ages. Most studies focus on the effect of socioeconomic conditions on health status. For instance, according to Montez & Hayward (27) both early socioeconomic conditions and education impact functioning and mortality in later life. However, higher educational attainment does ameliorate the adverse effect of childhood socioeconomic adversities on health in old age.

Recently, Herm, Anson and Poulain (44) explored the association between living arrangements and marital status on mortality risks using gender and health status as control variables in Belgium and Chiu (253) studied the relationship between living arrangements and health in older Americans. The latter author used multistate life table methodology as in our study, whereby results showed a strong relationship between living arrangements and disability-free life expectancy, with significant differences according to education and sex. For instance, those who live with a partner live longer with more years without and fewer years with disability.

The elderly environment also implies their ways of co-residence as the primary social framework in which they interact and perform their daily lives. Hence, the study of the relationship between living arrangements and health allows to know firstly, the primary social support networks that surround elderly when they require help, and secondly the effect of these different networks on elderly health according to their socioeconomic characteristics.

In this sense, with the wish to contribute to defining better health care policies in the context of the available family support in an ageing population, this study rises to estimate the effect of distinct living arrangements on health status at older ages and its differences across European countries. It is also our interest to explore new methodologies for measuring variations in health statuses. This is why a brief description is provided of multistate modelling within the survival analysis framework with the purpose to illustrate its application to health status changes at older ages. The aim is to explore the effect of different living arrangements and housing condition on the deterioration and improvement health, and the risk of mortality in the population aged 50 and over.

Specifically, we calculate health transition probabilities to determine whether living arrangement situations are associated with variations in the risks of experimenting a deterioration or an improvement in health status, with a special attention to differences between countries and by gender. On the one hand, we put the emphasis on the situation of living with a partner and children, as this type of living arrangement is little explored in health studies. On the other hand, we study period effects to identify possible effects of economic periods on household conditions (cover monthly expenses), which can be also compared between countries.

Multistate modelling is used with the incorporation of age dependence by means of a Cox Proportional Hazard model with stratification by destination (health status or dead). Data from the European Union Statistics of Income and Living Condition (EU-SILC) survey is used for nine selected countries from western, southern and Eastern European countries and the Baltic region (Austria, Belgium, Italy, Portugal, Hungary, the Czech Republic, Poland and Latvia) for the period 2007-2014. Spain was taken as the reference risk to compare health transition probabilities between countries.

3.2. Data and Method

Data

Data source used in this study, EU-SILC, is a cross-sectional panel survey that provides comparative yearly information since 2003 for 37 European countries (with differences in the time follow-up)

related to household and individual income for household members aged 16 and over. The source includes indicators to measure living conditions, poverty and deprivation (254).

For this study we use files from year 2007 to 2014, comprising information from 2004 to 2014 for nine countries: Austria (AT), Belgium (BE), the Czech Republic (CZ), Hungary (HU), Italy (IT), Latvia (LV), Poland(PL), Portugal(PT) and Spain (ES). Only individuals aged 50 years and over who declared a valid health state at the start of period of observation is used for the purpose of the analysis (see population distribution in ANNEX 3.1). This subsample of the data with individuals with specific ages is also known as a "landmark data set" (124).

The analysis is based on eight variables. In the multistate model, the dependent variable used is the GALI (General Activity Limitation Index) indicator. Categories of "Yes, limited" and "Yes, strongly limited" are grouped into one category, considered as the "Unhealthy" state, and not limited as the "Healthy" state. A third category is based on the death records in the survey[18]. The dependent variable, health status, thus has three response categories: healthy, unhealthy and death, which concords with other studies (227).

Regarding the independent variables: 1) living arrangements is used as the main explanatory variable. It has four categories: living with a partner (reference), living with partner and child(ren), living alone (just for health deterioration and improvement) and living with others. 2) Gender: males (reference) and females. 3) Educational attainment, with two categories: Primary education or less (reference) and at least secondary school. 4) Country of residence with nine countries selected, taking Spain as the reference. 5) Make ends meet or cover monthly expenses, with two categories: without difficulties (reference) and with difficulties. 6) Calendar period, with three categories: 2006-2008, 2009-2011 (reference) and 2012-2014. Period 2009-2011 was chosen as the reference because this period reflects more economic stability respect with previous period.

EU_SILC panel data (recorded year to year in a four-year period) was reshaped as a counting process as the data is split into time dependent part[19] (as a" step function") (202,255–258). This technique avoids correlated data in the analysis of time dependent coefficients in the Cox PH model (for further explanation, see Therneau (256) and the vignete of the "*survival*" Package (259)).

[18] Death record was taken from variable "membership status" RB110 at individual level.
[19] Time is divided until the point when individuals experiment the events. This counting process is known as a Poisson distribution and is a common technique used in survival analysis.

Data was reshaped by intervals with a Poisson distribution in the same way as Crowther (135). Follow-up time (in ages) was split into intervals and assuming a constant hazard within each interval (109). By grouping time in intervals it is assumed that hazard and covariates are constants within grouped intervals (260). Studies (122,261) showed that by splitting follow-up time at each unique event and applying the Poisson model, identical results are obtained as those from a Cox model. Likewise, Steele (110) and Mills (112) showed similarities in results between Cox and discrete time using a logit model.

Method

This study used a multistate model to calculate transition probabilities between health statuses, for further explanation see previous chapter related with an introduction to multistate models. When health transitions are studied, four types of event can be identified, two recurring or transient transitions and two absorbing ones:

I. Healthy (H) to Unhealthy (N) (Transient/recurring event)--- Deterioration
II. Unhealthy (N) to Healthy (H) (Transient/recurring event)---- Improvement
III. Healthy (H) to Dead (D) (Absorbing) ---------- Death from healthy
IV. Unhealthy (N) to Dead (D) (Absorbing) ---------- Death from unhealthy

Healthy and unhealthy are transient states because subjects usually move in and out of these different states and, therefore, transitions from/to these states are recurrent. Death is the absorbing state with no backward transitions. The multistate model applied here therefore includes two sets of nested competing risks (110,125). A key point in multistate modelling is when a person experiments a change of health. This can be from healthy to unhealthy, which means a deterioration in her/his health status, or from unhealthy to healthy as health improves. We then model the duration starting with the moment the person is recorded to be in a healthy state. Remaining in the same state can count as a transition, or as repeated episodes between the same states or “intrastates”. For an illustration of intrastates with variations in contraceptive methods and job trajectories, see Steele (110) and Willekens (122).

In the next step, we use the incidence based multistate life table (27,141,174,233,253,262–265) to calculate the transition probabilities between states. It means that estimations depend on the initial state occupied. While four types of transitions between health states can be identified, we excluded the transition from a healthy state to death from the analysis because of a limited number of cases. In addition, we center our attention in transitions types 1 and 3, because our main interest is to investigate health deterioration and improvement at older ages. We do compute mortality risks from the unhealthy state but the results are not fully analysed.

Cox Proportional Hazard Model

In this study we apply a multistate approach based on a Cox Proportional Hazard Model (Cox PH) to calculate transition probabilities or hazards[20] from one state to another. To do so, we use hazard stratification by destination state (203,266). This means that in the multistate model the baseline hazard is stratified for every transition, and therefore, a separate baseline hazard[21] is calculated for each type of health transition: Health improvement, health deterioration and death.

Cox PH models in their standard form are considered as semi-parametric: parametric for the dependent variables and non-parametric for the time function. The hazard function depends on the explanatory variables in a log-linear way, but the time function can take any unknown shape. The Cox PH model is specified as follows (200):

$$\mathrm{Log}\, h\,(t) = a(t) + b_1 x_1 + b_2 x_2$$

In the formula a(t) is an unspecified function of time. In that form the model is considered as proportional because at any point in time, the ratio of the hazard of any two individuals is constant. This is because it depends on the values of the parameters, here b_1 and b_2, that do not vary with time. The Cox PH is considered to be a robust method for estimating the effect of different explanatory variables on specific transition probabilities in epidemiology and clinical trials (233,267).

To calculate the transition probabilities we use *"mstate"* package (202). This fits a multistate model which uses cox proportional hazard with stratification by destination state known as "state arrival extended Markov PH" (see Putter´s tutorial (151)), with ages as time scale.

Chronological age is used as the time scale, i.e., the time scale is absorbed into the unspecified hazard (233), and therefore, the baseline is interpreted as an age-specific incidence function (238). The advantage is that the reference risk, equal to baseline, is always adjusted by age effects (233).

[20] There were also calculated the baseline under occurrence-exposure rates with "biograph "R Package and compared with non-parametric estimator nelson –Aalen with "*mvna*" R package. Results were quite similar since data used comprise a short period of time

[21] We use the R package "*mstate*" which apply Aalen-Johansen estimator on Cox PH to estimate the transition probabilities.

Time varying coefficients

Time to event is proportional over the age scale, although, when we look at time interval of duration (e.g. one year, two years or three years), it is not proportional between each one of transition types. It means that time duration has different effects on the transitions here studied, that is to say, there is an interaction between time duration and health improvement, health deterioration and death.

To illustrate this interaction, time was divided by duration intervals (open on the left and closed on the right) at event (one year, two years and three years). It means that the health status (which describes whether or not each interval ends in a health transition type) and the covariate´s values were taken (recorded) at the end of the interval.

To deal with no proportionality, two different (no common) extensions in the Cox PH models were included. As shown in Therneau (256), for time dependent coefficients

a) $\lambda(t) = \lambda 0(t) e^{\beta(t)X}$ For each interval of time, the hazard of each transition is calculated, being the most significant impact the one-year interval (considered as reference category).

   And, for time varying covariates (see model 2.2)

b) $\lambda(t) = \lambda 0(t) e^{\beta X(t)}$ We calculate the effect of living arrangements (the main explanatory variable), which changes at each observation. Even though the effect doesn't report important variation with respect to fixed coefficients of living arrangements, this is likely to be due to the short observation period (four years) to show differences in household residence. Results are shown in model 2.3.

In addition, to ascertain age effects on the different health transitions, we use an equivalent of the time "transform" feature of "coxph" in the "survival" *package* (259). We followed Therneau et al. (256) example of applying the package with time variation coefficients by fitting a model that included the interaction between time intervals and the quadratic (and also cubic) terms of age centered at 65 (sample mean age). Similar applications with the inclusion of quadratic terms of age in Cox PH can be seen in Cheung et al. (236), Thomas and Reyes (258), Zhan et al. (257) and Fox and Weisberg (255,268).

Covariates effect on transition probabilities (transition-specific covariate effects)

This analysis is being conducted at the individual level, taking into consideration variables related to individual characteristics (age, sex and educational attainment, which are control variables) and household characteristics. The latter includes types of living arrangements, (living alone, with a partner, with partner and kids or living with others) and living conditions (making ends meet with or without difficulty). Finally, country of residence was also included as a control variable.

We fit a Multistate model with Cox PH, with stratified hazards for each transition type. We use different models in order to address different issues we want to evaluate. These issues are explored with three different model specifications or criteria as shown in the TABLE 3.1 (below). All models include the same set of control variables: gender, education, country and age (age attained is implicit within the time scale). Additionally, in the mortality transition we include two extra variables: as we exclude the transition from a healthy status to death due to a lack of cases, we introduce a variable that covers the whole population in the sample that died from a healthy state. On the other hand, we also include a variable before the death of a respondent who experienced a deterioration in health transition in order to evaluate if a deterioration condition before death may delay mortality.

To summarise the models, the first type of models estimates the main effect that the explanatory variables have on the hazards. Model 1.1, tests the effect of living arrangements on the hazards. Model 1.2 adds the explanatory variable "difficulties to cover monthly expenses" to the model; and Model 1.3 incorporates "calendar period" to the model.

The second type of models has time varying coefficients. They explore the effect of age[22] in the transition probabilities (model 2.1), the time interval effect on the hazard (model 2.2) and the time varying coefficients of living arrangements (model 2.3).

Lastly, the third types of models test the interactions between the covariates on the health transitions. This is because we assumed that living arrangements have different effects on health transitions when they are associated with other variables. We therefore included the interactions between living arrangements and country (model 3.1) and between living arrangements and gender (model 3.2). We also included others interactions to identify gender and educational differences on health changes among countries: between country and gender (model 3.3), between education and gender (3.4) and between education and living arrangements (3.5).

To assess the duration effect on the hazard (time varying coefficients), time varying coefficients of the hazard (formula a) were fitted (model 2.2). Results show variation of the hazard by the time interval at observation. When fitting a model with variation of the health transition probabilities by time interval (see ANNEX 3.4), the two years' interval exemplifies a reduction of the hazard while a three

[22] This model was fit with calendar as time scale instead age scale to be able to include varying effect of age.

years' interval reflects the scarcity of the event. Therefore, we only test how explanatory variables (included in the model 1.3) vary their effect on the hazards by a time interval of two years.

Model 2.3, illustrates the time varying coefficient of living arrangements (formulae b). This model was carried out to evaluate whether a change in living arrangements over time could have a different effect to that reported by fixed coefficients (models 1*).

To recall, the baseline in the cox proportional hazard model refers to a mean risk for a reference individual. In this case it is a male, living with a partner, with primary studies, living in Spain. Regarding to the variable difficulties to make ends meet (Model 1.2), the reference category is not having problems to cover monthly expenses. And, finally when the calendar period is added in the third model (Model 1.3), the reference category is period 2009-2011. In addition, we did not split the data by gender because fitting separated models by gender makes it difficult to compare the effect of gender in the different health transition types (269).

TABLE 3 1.- Model Description. Multistate model, Cox Proportional Model with stratified hazard (by transition type)

Explanatory variables by transitions type		Model 1.1			Model 1.2			Model 1.3			Model 2.1			Model 2.2			Model 2.3			Model 3.1			Model 3.2			Model 3.3			Model 3.4			Model 3.5		
		Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death	Deterioration	Health Improvements	Death
Fixed coefficients	***Living arrangements***																																
	**Living with partner(ref)*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Living with partner+kids	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Living Alone	X	X		X	X		X	X		X	X		X	X					X	X		X	X		X	X		X	X		X	X	
	Living with others	X	X		X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Ends meet																																		
	**Without difficulties (ref)*				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	With difficulties				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Calendar Period																																		
	**2009-2011(ref)*							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	2006-2008							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	2012-2014							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	From healthy			X			X			X			X			X			X			X			X			X			X			X
	Deterioration before			X			X			X			X			X			X			X			X			X			X			X
Time Varying coefficients	***Age effect***																																		
	Age										X	X	X																						
	Age^2										X	X	X																						
	Age^3										X	X	X																						
	Living Arrangements at two years interval																																		
	**Living with partner(ref)* t1*													X	X	X																			
	Living with partner+kids* t2													X	X	X																			
	Living Alone* t2													X	X																				
	Living with others* t2													X	X	X																			
	Ends meet																																		
	**Without difficulties (ref)* t1*													X	X	X																			
	With difficulties* t2													X	X	X																			
	Calendar Period																																		
	** 2009-2011(ref)* t1*													X	X	X																			
	2006-2008* t2													X	X	X																			
	2012-2014* t2													X	X	X																			
	Living Arrangements (time varying)																																		
	**Living with partner(ref)(t)*																X	X	X																
	Living with partner+kids(t)																X	X	X																
	Living Alone (t)																X	X																	
	Living with others (t)																X	X	X																
Interactions	***Living*Country***																																		
	**Partner*Spain(ref)*																			X	X	X													
	Living*Gender																																		
	*Partner*Male(ref)																						X	X	X										
	Country*Gender																																		
	*Spain*Male(ref)																									X	X	X							
	Education*Gender																												X	X	X				
	*Primary*Male(ref)																																		
	Education*Living																															X	X	X	
	*Primary*partner(ref)																																		

Multi-state model with stratified hazard by transition type. R package *"survival"and "mstate"*

Note, both the transition to health improvement and death come from the "unhealthy" state.

All models are adjusted by sex, education and country.

Proportionality

The proportional test for the Cox Proportional hazard model is done through the global Schoenfeld residual test. The test shows the presence of independence between residuals values and the time scale (257), which are ages in our study. As explained later, some violation of the proportional hazard between transition type and time intervals (one year, two years and three years) is shown When the test results are plotted, a flat line across the time scale can be seen when the time duration is tested (see ANNEX 3.5) and when it is included as a covariate in the model (see ANNEX 3.6). The assumption of proportional hazards appears to be not supported in the oldest ages group but in almost all ages groups.

The curves are fairly flat, parallel around zero. It indicates how much the curve deviates from zero line. Absence of zero line means a violation of proportional assumption (270) which is not the case in the models fitted. The test shows proportionality until age 76. Afterward, the proportionality does not hold due to the small population size at very old ages, particularly when the elderly population is desegregated by covariate groups. However, we will omit the non-proportionality in those age groups and we will continue with the analysis of the health transition probability, but always keeping in mind that at very old ages the proportionality is not met. Furthermore, the estimation of the transition probabilities through "mstate" package are test to provide reasonable results in terms of survival predictions (230).

3.3. Results

Health status al older ages

Multistate models provide state occupancy probabilities, also known as multistate survival function (122,202). It gives the probability to occupy a state at consecutive years, conditional to being part (alive) of the population (be part of the state space) for a reference age. Multistate survival function illustrate how state occupancies evolve with age (122). The FIGURE below shows the state occupation probabilities[23] calculated from two populations with different state at landmark, which is age 50. These probabilities are state based. The first are state occupancy probabilities from a population who were

[23] State occupation probabilities from model 1.1.

healthy at age 50, represented in FIGURE 3.1A. The other set of state occupancy probabilities are from a population with an unhealthy status, as illustrated by FIGURE 3.1B. Notice that $\mathbf{S}(\mathbf{50})$ will always be decreasing for the initial state (from healthy or unhealthy) at the beginning of time scale. For the absorbing state "died" the curves indicate the cumulative incidence function (230), which are always decreasing over the time scale due to the exit of the population, as can be seen in both population.

For transient states, curves may show one or more peaks/falls due to the dynamism of these population which move from two different states. Both population are dynamic and when a healthy individual changes its status to the unhealthy state, that person enters to the other population that is at risk to have a possible health improvement (at risk to change from unhealthy to healthy) and vice-versa because states could be recurrent (experienced more than once). The observed population can change their health state at least three times as there are four waves of follow up.

FIGURE 3.1A illustrates probabilities of being in specific states from a population at initial healthy state. Being healthy is shown to decrease over age due to the increasing risk to be unhealthy, which increases with age. In contrast, probabilities of being unhealthy at the initial state (FIGURE 3.1B) denote a decreasing hazard of being unhealthy at younger ages, but which starts to increase with the increase of age.

FIGURE 3 1.- State occupancy probabilities from healthy and from unhealthy status.

FIGURE 3.1A. Spain: State occupation probabilities from healthy status at 50 years' old.

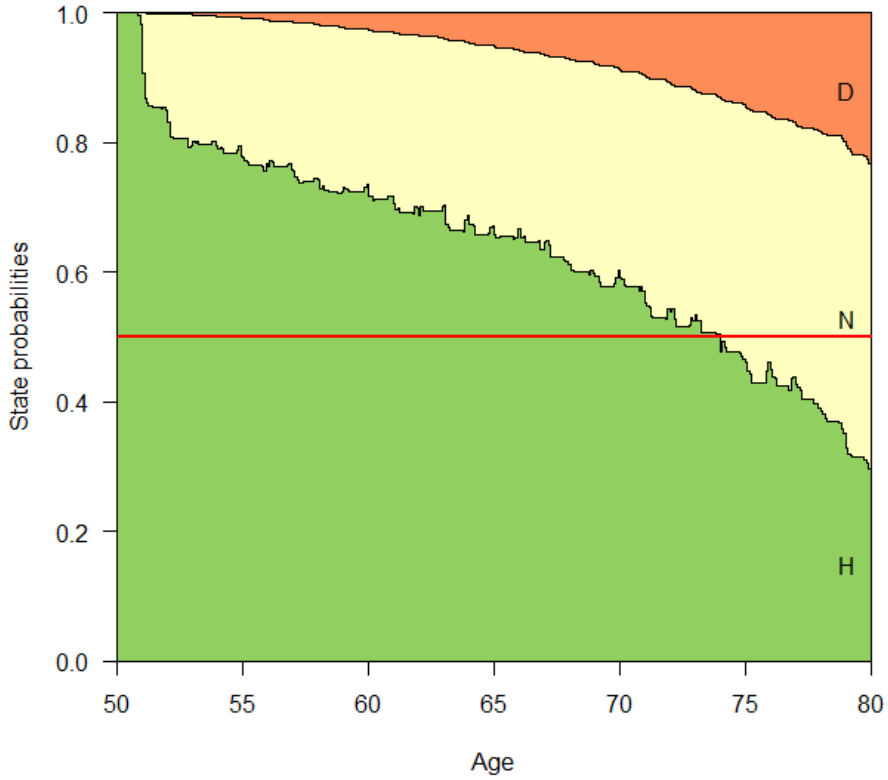
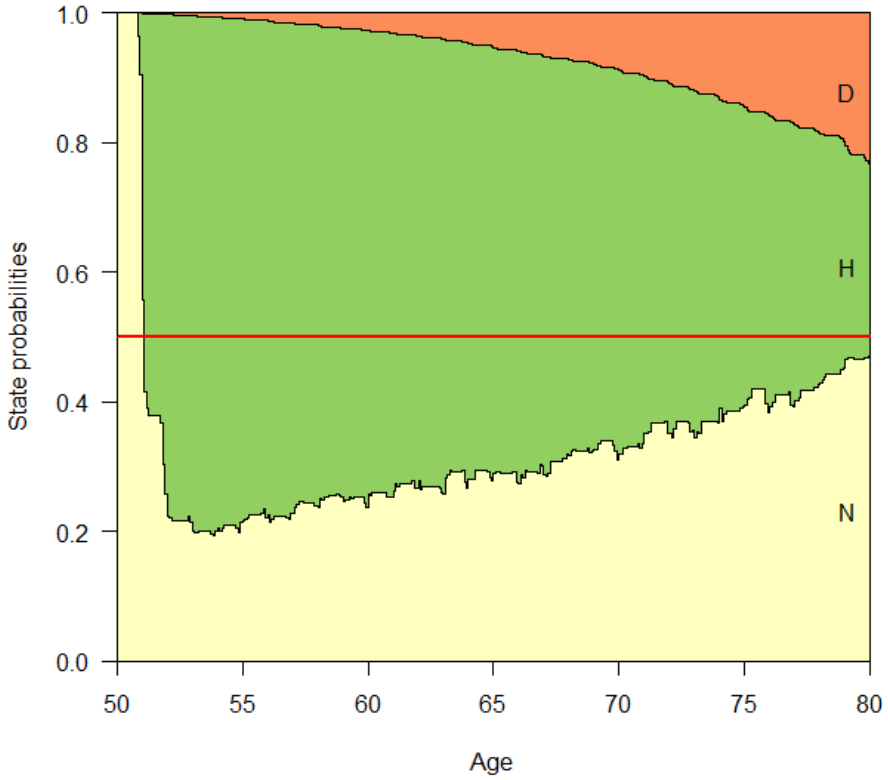


FIGURE 3.1B. Spain: State occupation probabilities from unhealthy status at 50 years' old



Note: Expected transition probabilities calculated with "mstate" R package, functions "msfit" and" probtrans".

The fact that the sharpest decrease for the unhealthy population occurs at the youngest ages is also due to the small proportion of unhealthy people at age 50, just 20%, (see below, TABLE 3.2) who are at risk to health improvements. And, as they are more likely to improve their health (change from unhealthy to healthy at ages 50-55), the probability to remain unhealthy decrease in the first group of ages.

TABLE 3 2.- State Distribution for healthy and unhealthy

Population who experience the event= N-->H				Population who experience the event= H-->N			
Ages	No healthy (N)	Event (N->H)	% N->H	Ages	Healthy (H)	Event (H->N)	% H->N
50	1.499	752	50%	50	5.171	1.171	23%
51	2.109	1.098	52%	51	5.452	1.381	25%
52	2.658	1.375	52%	52	5.664	1.482	26%
53	2.761	1.388	50%	53	5.671	1.585	28%
54	2.819	1.399	50%	54	5.550	1.559	28%
55	2.972	1.486	50%	55	5.339	1.581	30%
56	3.077	1.482	48%	56	5.306	1.649	31%
57	3.018	1.460	48%	57	5.188	1.614	31%
58	3.200	1.604	50%	58	5.184	1.663	32%
59	3.234	1.557	48%	59	5.065	1.736	34%
60	3.243	1.564	48%	60	4.894	1.719	35%
61	3.183	1.552	49%	61	4.730	1.726	36%
62	3.131	1.538	49%	62	4.492	1.722	38%
63	3.083	1.514	49%	63	4.324	1.700	39%
64	3.059	1.471	48%	64	4.137	1.615	39%
65	3.048	1.390	46%	65	3.935	1.592	40%
66	3.031	1.398	46%	66	3.898	1.679	43%
67	3.177	1.394	44%	67	3.639	1.580	43%
68	3.216	1.457	45%	68	3.606	1.689	47%
69	3.239	1.397	43%	69	3.475	1.674	48%
70	3.246	1.330	41%	70	3.267	1.618	50%
71	3.149	1.291	41%	71	3.030	1.533	51%
72	3.275	1.273	39%	72	2.921	1.515	52%
73	3.123	1.182	38%	73	2.759	1.491	54%
74	3.147	1.139	36%	74	2.512	1.468	58%
75	3.207	1.139	36%	75	2.390	1.335	56%
76	3.529	1.137	32%	76	2.443	1.452	59%
77	8.162	2.153	26%	77	4.360	2.693	62%
78	9.597	2.452	26%	78	4.905	3.174	65%
79	3.374	995	29%	79	2.204	1.417	64%
80+	3.613	874	24%	80+	2.264	1.447	64%
Total general	106.179	43.241	41%	Total general	127.775	51.260	40%

From that small population starts the estimation of transition probabilities for the population with an unhealthy state at landmark. At younger ages, the hazard to health improvements is higher (decreasing the probability to remain in unhealthy state) but with the time, the hazard of health improvements decreases, and therefore, the probability to remain in an unhealthy state, increases, reaching a converging point with the probabilities to be healthy. A noteworthy point to highlight is the trend at older ages. At age 70-75 a convergence of both probabilities is observed: being unhealthy becomes

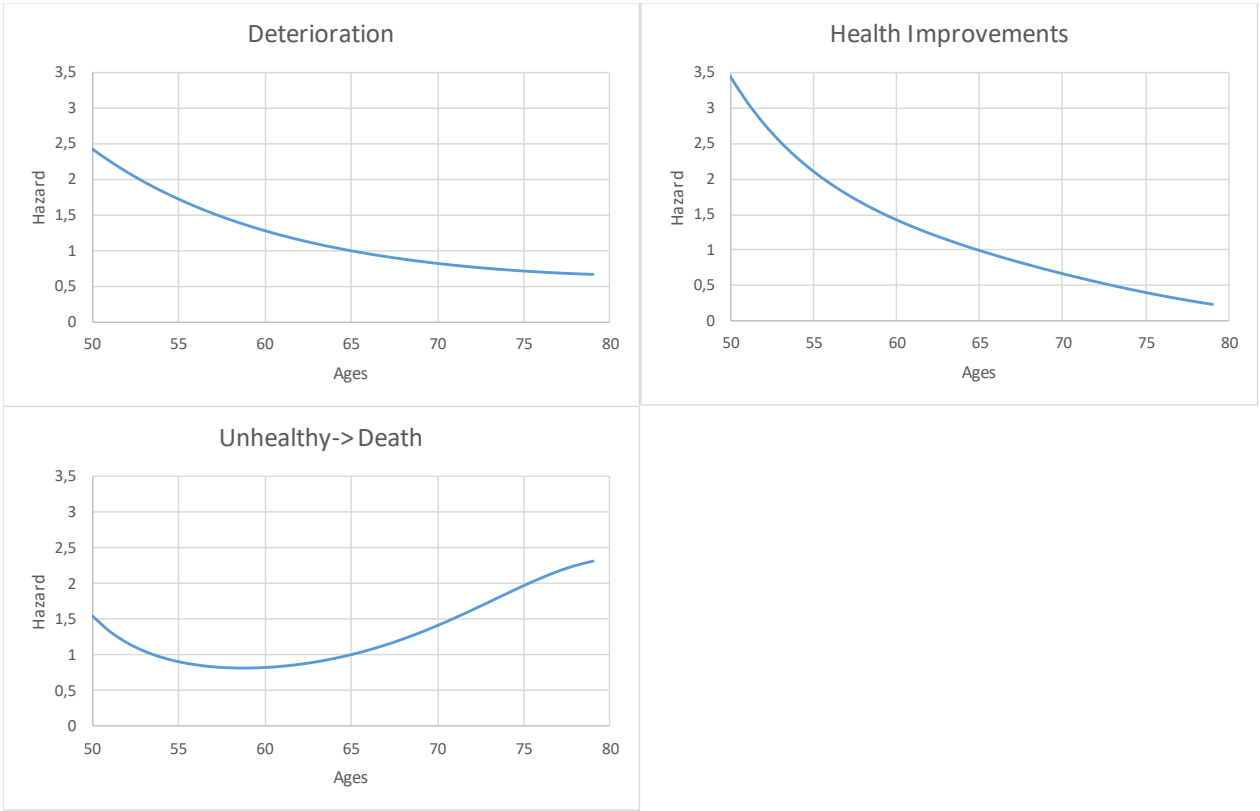
higher than being healthy after this age due to the rising probability of being unhealthy and declining probability of being healthy with increasing age.

The effect on having a deterioration transition before death was also tested (see ANNEX 3.7). The mortality likelihood slightly decreased (-15%) among the older population who experimented a deterioration before death in their health status (magenta line).

Age effects

Age changes continuously but it does not necessary imply that the risk increases at the same rate as age (256). Although it is generally true that the risk of death increases with age, an age change of one year in our data (see TABLE 3.3) only has a slight impact on the risk of death (an increase of 3%). On the other hand, although the mortality risk rises with age, for health improvements and deterioration there is a different picture. The negative coefficients show a diminishing risk for both transitions (6% lower likelihood for deterioration and 9% lower likelihood for improvement). As seen in the next graph, although the likelihood for both health transition decreases, the hazard for health improvements starts from a quite higher point and therefore the decrease is even more pronounced than for the deterioration transition.

FIGURE 3 2.- Age effect for each transition type



An age change of one year for older people would represent a minimum impact on the likelihood of health deterioration and improvement (see the quadratic and cubic terms in TABLE 3.3). The results for health deterioration are due to the fact that once an older person has experimented an impairment, the probability to move to a better status decreases with age. Therefore, population (in good health) at risk for deterioration decreases with age; there are not many people with good health at very old ages. Older people in a bad health status remain in that state with no important variations and they enlarge the population at risk for health improvements. Other studies have also shown that at older ages the likelihood for health to deteriorate increases and for health improvements the risk decreases with age (31,157,271).

For health improvements, the relative risk increases initially, reaching a peak about 5 years after the initial observation age or *landmark* (50 years), after which the risk declined constantly. Therefore, the survival curve increases rather than decreases at older ages. This effect is also shown in others studies that applied Cox with the classic survival analysis (236) and also in multistate analysis (266).

Living arrangements

Considering the three health states we described earlier, we explored how living arrangements affect transitions between those states (model 1.1). Elders living with partner and children don't have significant differences when compared with older people living with a partner (reference group) in the transition to health deterioration (see TABLE 3.3). This means that they have the same hazard to experiment deterioration than the reference group. Another picture is shown when we look at health improvements. Those living with partner and children are 8% more likely to have improvements in their health than elders who just live with their partner. In the transition to death, elderly living with both children and partner report a 74% greater likelihood to die than the reference category, living with a partner.

Coefficients for living alone show a 2% risk less than people living with their partner to experiment health deterioration and 8% less likelihood of health improvements than the reference. For the transition to death there were not enough cases to estimate the hazard ratio for those living alone. Living with others increases the risk of health deterioration by 2% and decreases the hazard for health improvement in the elderly by 14%. In addition, elderly who live with others have an 86% likelihood to die.

TABLE 3 3.- Results of models 1.1 to 2.3. Multistate Cox Proportional Model with stratified hazard by transition type

	Predictors	Model 1.1		Model 1.2		Model 1.3		Model 2.1		Model 2.2 Fixed Coeff.		Model 2.2 t2.		Model 2.3 (t)	
		RR	sig	RR	sig	RR	sig	RR	sig	RR	sig	RR	sig	RR	sig
Deterioration	***Living arrangements***														
	**Living with partner(ref)*														
	Living with partner+kids	0,98		0,97	**	0,96	***	0,89	***	0,88	***	1,39	***	0,97	*
	Living Alone	1,02	.	1,00		1,00		1,06	***	0,99		1,06	*	1,00	
	Living with others	0,98		0,96	*	0,94	***	0,99		0,95	**	0,97		0,95	***
	Make Ends meet														
	**Without difficulties (ref)*														
	With difficulties			1,36	***	1,36	***	1,32	***	1,36	***	0,97		1,36	***
	Calendar Period														
	**2009-2011(ref)*														
	2006-2008					1,36	***			1,35	***			1,36	***
	2012-2014					0,73	***			0,73	***			0,73	***
	Age effect														
	Age							0,94	***						
	Age^2							1,00	***						
	Age^3							1,00	**						
Health Improvements	***Living arrangements***														
	**Living with partner(ref)*														
	Living with partner+kids	1,08	***	1,09	***	1,08	***	1,01		1,16	***	0,72	***	1,09	***
	Living Alone	0,92	***	0,95	***	0,95	***	0,99		0,97		0,92	**	0,95	***
	Living with others	0,86	***	0,88	***	0,87	***	0,91	***	0,90	***	0,87	***	0,87	***
	Ends meet														
	**Without difficulties (ref)*														
	With difficulties			0,79	***	0,79	***			0,79	***	1,01		0,79	***
	Calendar Period														
	**2009-2011(ref)*														
	2006-2008					1,33	***			1,33	***			1,33	***
	2012-2014					0,73	***			0,73	***			0,73	***
	Age effect														
	Age							0,91	***						
	Age^2							1,00	***						
	Age^3							1,00	***						
Death	***Living arrangements***														
	**Living with partner(ref)*														
	Living with partner+kids	1,74	***	1,74	***	1,73	***	1,60	***	1,69	***	1,03		1,71	***
	Living Alone														
	Living with others	3,09	***	3,09	***	3,04	***	3,39	***	2,97	***	1,03		3,04	***
	Ends meet														
	**Without difficulties (ref)*														
	With difficulties			0,93	.	0,94	.	0,90	**	0,77	***	2,02	***	0,94	.
	Calendar Period														
	**2009-2011(ref)*														
	2006-2008					0,63	***			1,20	***			1,25	***
	2012-2014					0,64	***			0,66	***			0,64	***
	Age effect														
	Age							1,03	**						
	Age^2							1,00	***						
	Age^3							1,00	***						
	From Healthy	0,27	***	0,25	***	0,25	***	0,14	***	0,24	***	0,46	***	0,25	***
	Deterioration before death	0,87	**	0,87	***	0,83	***	0,82	***	1,03		1,12	***	0,83	***
	Loglikelihood	-8539534		-8532831		-8506584		-984231.3	-968088.4	-850176.0				-859026.6	-85065

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05. RR=Relative Risk.

All models are adjusted by sex, education and country.

Note[1], both the transition to health improvement and death come from the "unhealthy" state.

Note[2], model 2.1 was fit with a calendar time as time scale(instead ages as scale (as all other models) that allows to introduce age into the model. For that reason loglikelihood start from a different initial value.

(t) time varying coefficients for living arrangements. The rest of coefficients are fixed

Multi-state model with stratified hazard by transition type. R package *"survival"* and *"mstate"*

Coefficients of living arrangements change with slight variation with the inclusion of the explanatory variables “cover monthly expenses” (model 1.2) and calendar period (1.3) as is seen in the TABLE 3.3, above. Time varying coefficients of living arrangements (2.3) reported no variation compared with fixed coefficients.

Cover monthly expenses and calendar period

When including cover monthly expenses without difficulties (model 1.2), the relative risk for health deterioration for all living arrangements groups decreases and for health improvement increases. Regressors for living with others and living with partner and children remain with no variation for mortality risk. However, it is not the same pattern across countries when interactions between country and co-residence pattern are introduced later in the analysis.

The coefficients indicate that older people with difficulties to make ends meet are 36% more likely to experience a health problem and 20% less likely to have improvements in their health status with highly significant differences ($p<0.001$)

The effect of calendar period (model 1.3) illustrates that the 50+ population experienced a higher propensity of health improvements in the period 2006-08 than the reference period (2009-11) (RR.1.33, with $p<0.001$) as well as deterioration (RR:1.36, with $p<0.001$), whilst the period 2012-2014 observed a lower likelihood.

Country differences by living arrangements

Living arrangements across European countries comprise larger differences among countries (see ANNEX 3.1). At about 50%, the proportion of people older than 50 years living with a partner is highest in four countries: Austria (51%), Belgium (54%), Czech Republic (50%) and Portugal (47%). On the other hand, the proportion that lives with partner and lives with partner and child are approximately equal in the southern and traditionally Catholic countries that are in the sample, excluding Portugal; Spain (37% and 34%), Italy (35% and 34%) and Poland (38% and 31%). The proportion of elderly living alone is largest in western and eastern European countries (except Poland) and the Baltic, ranging from 20% to 23%: Austria (23%), Belgium (21%), Czech Republic (23%), Hungary (21%) and Latvia (23%). Finally, the proportion of elderly living with others is larger in southern and eastern European countries and the Baltic, with the largest proportion being observed in Latvia (23%), while the others countries range from 13% to 16%.

Regarding to the differences by gender (see ANNEX 3.3) within each group of living arrangements our data show that many or even most men live in a private household with a partner, with proportions ranging from 40% to 58%, while female proportions are 10-20% lower (ranging from 30% to 49%, with the largest percentage in Belgium). The pattern is similar for living with a partner and a child, but with a lower prevalence. Conversely, women are about twice as likely to live alone and with others as men, with even higher differences in eastern countries as well as Portugal.

Considering the large variation of living arrangements within people aged 50+ by country we postulate that the same type of living arrangement has a different effect on the health status of elderly in different countries. This is supported when an interaction term between living arrangements and country is introduced (see TABLE 3.4A, model 3.1), as we observe a distinct pattern between countries.

TABLE 3 4A.- Results of model 3.1. Multistate Cox Proportional Model with stratified hazard by transition type and interaction terms.

Predictors	Deterioration				Health Improvements				Mortality			
	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI
Living arrangements												
**Living with a partner(ref)*												
Living with a partner+children	0,00	1,00		(0,95 - 1,06)	-0,01	0,99		(0,94 - 1,05)	0,42	1,53	***	(1,25 - 1,88)
Living alone	0,05	1,05		(0,99 - 1,13)	-0,03	0,97		(0,90 - 1,04)		-		
Living with others	-0,05	0,96		(0,89 - 1,02)	-0,17	0,85	***	(0,79 - 0,91)	1,02	2,77	***	(2,36 - 3,31)
Country												
ES (ref)												
AT	0,26	1,30	***	(1,22 - 1,37)	-0,34	0,71	***	(0,67 - 0,76)	-0,30	0,74	**	(0,59 - 0,93)
BE	-0,18	0,84	***	(0,79 - 0,89)	-0,21	0,81	***	(0,76 - 0,86)	-0,71	0,49	***	(0,39 - 0,64)
IT	-0,03	0,97		(0,92 - 1,01)	-0,17	0,84	***	(0,80 - 0,88)	-0,42	0,66	***	(0,56 - 0,77)
PT	0,10	1,11	***	(1,04 - 1,18)	-0,22	0,80	***	(0,75 - 0,85)	0,17	1,18		(0,96 - 1,47)
CZ	-0,28	0,76	***	(0,72 - 0,80)	-0,62	0,54	***	(0,51 - 0,57)	0,06	1,07		(0,89 - 1,28)
HU	0,14	1,15	***	(1,09 - 1,22)	-0,59	0,55	***	(0,52 - 0,59)	0,36	1,43	***	(1,21 - 1,70)
PL	-0,28	0,76	***	(0,72 - 0,80)	-0,70	0,49	***	(0,47 - 0,53)	0,27	1,31	**	(1,11 - 1,55)
LV	0,51	1,66	***	(1,56 - 1,77)	-0,33	0,72	***	(0,67 - 0,77)	0,42	1,53	***	(1,27 - 1,84)
Country*Living Arrangements												
*Living with a partner*ES (ref)*												
Living with a partner+children*AT	-0,03	0,97		(0,87 - 1,08)	-0,02	0,98		(0,87 - 1,09)	0,04	1,04		(0,65 - 1,63)
Living with a partner+children*BE	-0,05	0,95		(0,84 - 1,08)	-0,02	0,98		(0,86 - 1,12)	-1,49	0,23	*	(0,05 - 0,92)
Living with a partner+children*IT	-0,09	0,91	**	(0,85 - 0,97)	0,14	1,15	***	(1,07 - 1,23)	0,17	1,18		(0,90 - 1,54)
Living with a partner+children*PT	-0,06	0,95		(0,86 - 1,04)	0,09	1,10	.	(0,99 - 1,22)	-0,52	0,59	*	(0,38 - 0,92)
Living with a partner+children*CZ	-0,10	0,90	.	(0,81 - 1,00)	0,02	1,02		(0,91 - 1,15)	0,42	1,52	*	(1,06 - 2,17)
Living with a partner+children*HU	0,01	1,01		(0,92 - 1,10)	0,10	1,11	*	(1,00 - 1,22)	0,06	1,06		(0,77 - 1,45)
Living with a partner+children*PL	-0,05	0,95		(0,88 - 1,04)	0,08	1,08	.	(0,99 - 1,18)	0,20	1,23		(0,93 - 1,60)
Living with a partner+children*LV	0,02	1,02		(0,92 - 1,13)	0,16	1,18	**	(1,06 - 1,32)	0,31	1,36	.	(0,98 - 1,88)
Living alone*AT	-0,10	0,91	.	(0,81 - 1,01)	0,02	1,02		(0,91 - 1,14)		-		
Living alone*BE	-0,04	0,96		(0,86 - 1,08)	-0,03	0,97		(0,86 - 1,10)		-		
Living alone*IT	-0,07	0,93		(0,86 - 1,01)	-0,13	0,88	**	(0,80 - 0,96)		-		
Living alone*PT	-0,07	0,93		(0,81 - 1,06)	0,22	1,25	**	(1,09 - 1,43)		-		
Living alone*CZ	0,06	1,06		(0,96 - 1,17)	0,11	1,12	*	(1,00 - 1,24)		-		
Living alone*HU	-0,05	0,95		(0,86 - 1,05)	0,05	1,05		(0,95 - 1,17)		-		
Living alone*PL	-0,07	0,93		(0,84 - 1,03)	-0,05	0,95		(0,85 - 1,07)		-		
Living alone*LV	-0,20	0,82	***	(0,73 - 0,91)	-0,05	0,95		(0,84 - 1,07)		-		
Living with others*AT	-0,05	0,95		(0,82 - 1,11)	0,00	1,00		(0,86 - 1,17)	0,48	1,62	**	(1,16 - 2,25)
Living with others*BE	0,27	1,32	***	(1,13 - 1,54)	0,03	1,03		(0,87 - 1,22)	0,06	1,06		(0,61 - 1,86)
Living with others*IT	-0,02	0,98		(0,90 - 1,06)	-0,03	0,97		(0,88 - 1,06)	0,08	1,08		(0,86 - 1,35)
Living with others*PT	0,03	1,03		(0,90 - 1,18)	0,03	1,03		(0,89 - 1,18)	-0,38	0,68	*	(0,47 - 0,98)
Living with others*CZ	0,04	1,04		(0,91 - 1,18)	-0,01	0,99		(0,86 - 1,14)	0,22	1,25		(0,93 - 1,65)
Living with others*HU	-0,06	0,94		(0,85 - 1,05)	0,05	1,05		(0,94 - 1,18)	0,20	1,22		(0,96 - 1,54)
Living with others*PL	-0,06	0,94		(0,85 - 1,04)	0,11	1,12	*	(1,00 - 1,26)	0,08	1,08		(0,85 - 1,36)
Living with others*LV	-0,04	0,96		(0,87 - 1,07)	0,11	1,11	.	(0,99 - 1,25)	0,04	1,04		(0,81 - 1,33)
Loglikelihood				-8590266-8505365								

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05. RR=Relative Risk.

Note[1], both the transition to health improvement and death come from the "unhealthy" state.

The model is adjusted by sex,educational level, calendar period and make ends meet

Multi-state model with stratified hazard by transition type. R package *"survival"* and *"mstate"*

TABLE 3.4B.- Differences of interaction terms between Living arrangements and Country. Model 3.1. Multistate Cox Proportional Model with stratified hazard by transition type

Differences	Compared with "living with a partner" in each country						Compared with each living arragements groups in "Spain"					
Interactions terms	Deterioration		Health Improvements		Mortality		Deterioration		Health Improvement		Mortality	
	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR
Living with a partner+children*AT	-0,03	0,97	-0,03	0,97	0,46	1,58	0,23	1,25	-0,36	0,70	-0,27	0,76
Living with a partner+children*BE	-0,04	0,96	-0,02	0,98	-1,07	**0,34**	-0,23	0,80	-0,23	0,80	-2,20	**0,11**
Living with a partner+children*IT	-0,09	**0,92**	0,13	**1,14**	0,59	1,81	-0,13	**0,88**	-0,04	**0,96**	-0,25	0,78
Living with a partner+children*PT	-0,05	0,95	0,09	1,09	-0,10	**0,91**	0,05	1,05	-0,13	0,88	-0,35	**0,70**
Living with a partner+children*CZ	-0,10	0,91	0,02	1,02	0,84	**2,32**	-0,38	0,69	-0,60	0,55	0,48	**1,62**
Living with a partner+children*HU	0,01	1,01	0,10	**1,10**	0,48	1,62	0,15	**1,16**	-0,49	0,61	0,42	1,51
Living with a partner+children*PL	-0,04	0,96	0,07	1,08	0,63	1,87	-0,33	0,72	-0,62	0,54	0,47	1,60
Living with a partner+children*LV	0,02	1,02	0,16	**1,17**	0,73	2,08	0,52	**1,69**	-0,17	0,85	0,73	2,08
Living alone*AT	-0,04	0,96	-0,01	0,99			0,16	1,18	-0,32	0,73		
Living alone*BE	0,02	1,02	-0,06	0,94			-0,22	0,81	-0,24	0,79		
Living alone*IT	-0,01	0,99	-0,17	**0,85**			-0,10	**0,90**	-0,31	0,74		
Living alone*PT	-0,02	0,98	0,19	**1,21**			0,03	**1,03**	0,00	1,00		
Living alone*CZ	0,11	1,12	0,08	**1,08**			-0,22	**0,80**	-0,51	0,60		
Living alone*HU	0,00	1,00	0,02	1,02			0,09	1,09	-0,54	0,58		
Living alone*PL	-0,02	0,98	-0,08	0,92			-0,35	0,70	-0,75	0,47		
Living alone*LV	-0,15	**0,86**	-0,09	0,92			0,30	**1,35**	-0,39	0,68		
Living with others*AT	-0,10	0,91	-0,17	0,85	1,50	**4,50**	0,21	1,23	-0,34	0,71	0,18	**1,20**
Living with others*BE	0,23	**1,26**	-0,14	0,87	1,08	2,94	0,10	**1,10**	-0,18	0,83	-0,65	0,52
Living with others*IT	-0,07	0,93	-0,20	0,82	1,10	3,01	-0,06	0,94	-0,21	0,81	-0,34	0,71
Living with others*PT	-0,02	0,98	-0,14	0,87	0,64	**1,89**	0,13	1,14	-0,19	0,82	-0,21	**0,81**
Living with others*CZ	-0,01	0,99	-0,18	0,83	1,24	3,46	-0,24	0,79	-0,64	0,53	0,29	1,33
Living with others*HU	-0,11	0,90	-0,12	0,89	1,22	3,39	0,08	1,08	-0,54	0,58	0,56	1,75
Living with others*PL	-0,11	0,90	-0,05	**0,95**	1,10	3,00	-0,34	0,71	-0,59	**0,55**	0,35	1,41
Living with others*LV	-0,08	0,92	-0,06	0,94	1,06	2,89	0,47	1,60	-0,22	0,80	0,46	1,59

Note [2],Differences are calculated based in the coefficients between the interaction terms and the fixed coefficients. For instance; considering the deterioration of"Living with a partner and children" in Italy compared with living with a partner in that country= -0,09+0,00 => 0,92(exp(-0,09)).

In Bold are significant RR according to the interaction terms reported in TABLE 3.4A

Living alone

When the interaction with country was added to the model (model 3.1), the living alone regressors became non-significant for health improvements (from a RR of 0.95, p< 0.001 to 0.97p<0.1). The interaction term was only significant for elderly living alone in Portugal (RR: 1.21, p<0.05) and the Czech Republic (RR: 1.08, p<0.01), i.e., they have greater health improvements than older people living with a partner. All other countries show lower rates of improvements for this population group, with only Italy reporting significant differences (RR: 0.85, p< 0.01).

In addition, comparing the probability of health improvement of elderly living alone among countries, this is more like to occur in Spain than in the other countries, but, as we shown earlier, only in the case of Italy, Portugal and Czech Republic differences are statistically significant.

Considering the transition to health deterioration, living alone regressors change from negative (RR: 0.99) to positive values (RR: 1.05) and remains non-significant compared to model 1.3. On the one hand, almost all countries report a lower risk of deterioration for those living alone than for elderly who live with a partner, but only Latvia report significant differences (RR: 0.86, p<0.001). On the other hand, there were two countries with an inverse pattern, as Belgium (RR: 1.02, p<0.1) and Czech Republic (RR: 1.11, p<0.1) show higher deterioration risks, although values are not significant.

Nevertheless, elderly living alone in Austria, Hungary, Portugal and Latvia reported higher deterioration risk than older people with the same co-residence pattern in Spain, but only Latvia shown significant differences (RR:1.35, p<0,001). The others countries (Belgium, Italy, Czech Rep and Poland), have a lower risk, although without significant differences.

Living with partner and child

The mean effect of living with a partner and child decreases and loses its significance when the interaction term with country and living arrangements for health deterioration is introduced (model 3.1, from RR: 0.95 to RR: 1.00). The same occurs for health improvement (from RR: 1.08 to RR: 0.99). Nevertheless, differences between countries do exist. Most countries report that elderly living with a child and partner have a lower likelihood of deterioration than when they only live with a partner. Exceptions are Hungary and Latvia and only Italy shows significant differences (RR: 0.92, p<0.01), i.e. Italian elderly are 8% less likely to experience health deterioration than Italian elderly living with a partner.

Furthermore, when comparing the deterioration probability of elderly living with a partner and child in Spain (reference risk) with the other countries, elderly in Austria, Portugal, Hungary and Latvia are more likely to experience health deterioration than in Spain, although differences are not statistically significant.

In reference to health improvements, older people living with children and partner show a higher likelihood to improve their health. Italy, Hungary and Latvia report significant differences, with 10-17% more propensity to health improvements than elderly living with a partner. Belgian and Austrian elderly living with children and partner are the only two countries which report lower health improvements than those living with a couple, but without significant differences.

Compared to the reference category Spain, the risk of health improvements for living with partner and child in other countries are lower. However, differences are only significant Italy (RR: 0.96, p<0.001), Hungary (RR: 0.61, p<0.05) and Latvia (RR: 0.85, p<0.05).

Living with Others

The mean effect of living with others (model 3.1.) remains with the same risk and loses its significance in deterioration compared with the model 1.3. However, in health improvements, the already significantly lower risk becomes even lower (from RR 0.87 to RR: 0.85, p< 0.001). The country-specific results show that, overall, living with others comprise both a likelihood of lower health improvement and lower deterioration (only with significant differences in Poland; RR: 0.95, p<0.05). Conversely, only in Belgium elderly living with others exhibit a contrary pattern with respect to the others countries. They reported 26% (p<0.001) higher probability of deterioration than older people living with a partner.

All countries show that their older population living with others have lower probability of health improvements than those living with the same co-residence profile in Spain. However, only Poland reported significant differences (RR: 0.55, p<0.05). In reference to health deterioration, the pattern among countries is mixed and only Belgium shows significant differences with a 10% higher probability of deterioration than the same living arrangements group in Spain.

Living arrangements on Mortality

In mortality, living arrangements regressors reported quite large confidence intervals. We will therefore limit ourselves only to describe the general pattern. With the inclusion of interaction terms between country and living arrangements, coefficients remain highly significant and the mean effect of living with partner and child and living others decrease slightly (living with both, from 1.73 to 1.53 and living with others, from 3.04 to 2.77).

In most countries elderly who live with partner and child have higher mortality risk than those who live as a couple. Nevertheless, significant values were only reported in Belgium, Portugal, the Czech Republic and Latvia. The exception to this pattern is seen in Belgium (RR: 0.34, p<0.05) and Portugal (RR: 0.91, p<0.05), countries where elderly living with child and partner have a significantly lower mortality risk than those living with a partner. Regarding mortality levels of elderly who live with a partner and child, southern and western European countries report a lower mortality risk than Spain, while, eastern European countries show a higher risk.

The mortality risk for elderly living with others is much higher in all countries (more than double) than the risk for those who only live with a partner. However, in only two countries, Austria and Portugal, the differences are statistically significant. Comparing the risk shown by elderly living with others in Spain with other countries, the pattern previously shown by living with partner and child is repeated

as the Spanish population illustrate higher mortality rates than the other southern and western European countries (excluding Austria) but Spain has a lower risk than the eastern European countries.

Gender differences

By living arrangements

The model with interaction terms (see TABLE 3.5A and TABLE 3.5B, model 3.2B) between living arrangement groups and gender reported only significant differences among those living alone for health deterioration and for health improvement. Regressor coefficients of living alone change their effect from negative to positive when compared with model 1.3 for both transitions: health deterioration (RR: 0.99 to 1.06, $p<0.01$) and health improvement (RR: 0.95 to 1.05, $p<0.05$), with significant values.

The risk of deterioration is higher for women living in a couple than for women living alone. Between all older women, those who live alone have a 3% lower risk of health deterioration than women living with a partner. Moreover, among older people living in alone, women will have a 5% higher risk of deterioration than men.

For health improvements, women living alone have a 11% lower probability to improve their health status than alike men. At the same time, those women are 8% less likely to improve their health status than women who live with a partner.

In terms of mortality, older women who live with others and live with their partner and child have a higher mortality risk than women living with their partner. However, in each type of living arrangement women are less likely to die than men.

By country

Interaction terms between gender and countries illustrate a clear gender pattern (see TABLE 3.6A and TABLE 3.6B, model 3.3) as women are more likely to experience health deterioration than men in each of the eight countries studied. Four countries (Austria, Portugal, Hungary, Poland) report significant differences compared with the reference risk (men living in Spain). In those countries, women have around 2%-5% higher risk of health deterioration than men, with Portugal being the country with the highest difference (35% higher).

When the risk of health deterioration among older women is compared between Spain and other countries, women in Austria (RR: 1.17, $p<0.001$), Portugal (RR: 1.16, $p<0.001$) and Hungary (RR: 1.07, $p<0.001$) are more likely to experience deterioration. Poland is the only country reporting the opposite trend that is statistically significant with a 30% lower risk than older Spanish women. Belgium (RR:

0.83), Italy (RR: 0.92) and the Czech Republic (RR: 0.75) also have a lower likelihood of health deterioration than women in Spain, but without significant p-values.

For health improvements, older women in Austria and eastern European countries show a higher likelihood for health improvements than men, with significant differences, except for Latvia. Conversely, women in southern European countries report less likelihood to improve their health status than men, although differences are not significant. Lastly, when the likelihood of health improvement of older women in Spain is compared with the other countries, women in other countries show a lower propensity to improve their health status.

Regarding mortality, the results show that women in all western and southern European countries in the analysis have a lower mortality risk than Spanish women, but only in Portugal are differences significant (RR: 0.79, $p<0.05$). On the other hand, older women in eastern European countries show a higher mortality risk than Spanish women, but without significant differences. In all countries our study confirms than older woman experienced higher survival than men.

Education and Living arrangements

In continuation with the analysis of gender on health transitions, Interactions between gender and education on health transition (see TABLE 3.7A and TABLE 3.7B, model 3.4) only report significant differences for health improvements and mortality. On the one hand, women with secondary studies shown a 5% (RR: 1.05, $p<0.001$) higher likelihood to improve their health status than equally educated men, which is highly significant differences. Likewise, women have a 32% higher probability of health improvement than women with primary studies. On the other hand, in terms of mortality, women with secondary studies have a lower (RR: 0.68) mortality risk than men with secondary studies and a 15% lower mortality risk than women with primary studies.

Interaction terms between living arrangements and education (see TABLE 3.8A and TABLE 3.8B, model 3.5) only show differences in living with other and secondary studies for health improvements and mortality. Results report that elderly with secondary studies (or higher studies) living with others have a 35% (RR: 1.35, $p<0.05$) higher likelihood to improve their health status and an 8% (RR: 0.81, $p<0.05$) lower mortality risk than elderly with primary studies living with others. In addition, among elderly with secondary studies, those who live with others have a 9% (RR: 0.91, $p<0.05$) lower probability to improve their health status.

TABLE 3 5A.- Results of model 3.2. Multistate Cox Proportional Model with stratified hazard by transition type and interaction terms

Predictors	Deterioration				Health Improvements				Mortality			
	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI
Living Arrangements												
**Living with a partner(ref)*												
Living with a partner+children	-0,05	0,95	**	(0,92 - 0,98)	0,07	1,08	***	(1,04 - 1,11)	0,34	1,40	***	(1,27 - 1,54)
Living alone	0,06	1,06	**	(1,02 - 1,11)	0,05	1,05	.	(1,00 - 1,10)				
Living with others	-0,05	0,96		(0,91 - 1,01)	-0,15	0,86	***	(0,81 - 0,92)	0,59	1,80	***	(1,60 - 2,02)
Sex												
**Male(ref)*												
Female	0,13	1,14	***	(1,11 - 1,17)	0,02	1,02		(0,99 - 1,05)	-1,51	0,22	***	(0,20 - 0,24)
Living Arrangements*Sex												
**Living with a partner*Male(ref)*												
Living with a partner+children*Female	0,02	1,02		(0,98 - 1,07)	0,01	1,01		(0,96 - 1,06)	0,72	2,06	***	(1,71 - 2,48)
Living alone*Female	-0,09	0,92	**	(0,87 - 0,97)	-0,14	0,87	***	(0,82 - 0,93)				
Living with others*Female	-0,02	0,98		(0,92 - 1,04)	0,00	1,00		(0,93 - 1,07)	1,01	2,74	***	(2,35 - 3,20)
Loglikelihood				-859026,6 -850532,3								

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05. RR=Relative Risk.

Note[1], both the transition to health improvement and death come from the "unhealthy" state.

The model is adjusted by sex,educational level, calendar period and make ends meet

Multi-state model with stratified hazard by transition type. R package *"survival"* and *"mstate"*

TABLE 3.5B.- Differences of interaction terms between Living arrangements and Sex. Model 3.2. Multistate Cox Proportional Model with stratified hazard by transition type

Differences	Compared with "male" in each living arrangements group						Compared with "female" "living with a partner"					
Interactions terms	Deterioration		Health		Mortality		Deterioration		Health		Mortality	
	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR
Living with a partner+children*Female	0,15	1,17	0,03	1,03	-0,79	**0,46**	-0,03	0,97	0,08	1,08	1,06	**2,89**
Living alone*Female	0,05	**1,05**	-0,12	**0,89**			-0,03	**0,97**	-0,09	**0,92**		
Living with others*Female	0,11	1,12	0,02	1,02	-0,50	**0,61**	-0,07	0,93	-0,15	0,86	1,60	**4,93**

Note[2],Differences are calculated based in the coefficients between the interaction terms and the fixed coefficients.For instance; considering the deterioration of "Female" living alone compared with female living with a partner= -0,09+0,06 => 0,97(exp(-0,03))

In Bold are significant RR according to the interaction terms reported in TABLE 3.5A

TABLE 3 6A.- Results of model 3.3. Multistate Cox Proportional Model with stratified hazard by transition type and interaction terms

Predictors	Deterioration				Health Improvements				Mortality			
	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI
Country												
ES (ref)												
AT	0,31	1,36	***	(1,28 - 1,45)	-0,39	0,68	***	(0,64 - 0,72)	-0,07	0,93		(0,76 - 1,14)
BE	-0,16	0,85	***	(0,80 - 0,91)	-0,21	0,81	***	(0,76 - 0,87)	-0,73	0,48	***	(0,35 - 0,65)
IT	-0,07	0,93	***	(0,89 - 0,97)	-0,13	0,87	***	(0,84 - 0,92)	-0,35	0,70	***	(0,61 - 0,81)
PT	0,00	1,00		(0,95 - 1,07)	-0,13	0,87	***	(0,82 - 0,93)	0,13	1,13		(0,93 - 1,38)
CZ	-0,27	0,77	***	(0,72 - 0,81)	-0,68	0,51	***	(0,47 - 0,54)	0,26	1,30	**	(1,09 - 1,55)
HU	0,19	1,21	***	(1,15 - 1,28)	-0,60	0,55	***	(0,52 - 0,58)	0,55	1,73	***	(1,48 - 2,01)
PL	-0,26	0,77	***	(0,73 - 0,82)	-0,77	0,46	***	(0,44 - 0,49)	0,41	1,51	***	(1,31 - 1,74)
LV	0,47	1,60	***	(1,50 - 1,70)	-0,30	0,74	***	(0,69 - 0,79)	0,62	1,85	***	(1,57 - 2,18)
Sex												
**Male(ref)*												
Female	0,15	1,17	***	(1,12 - 1,22)	-0,04	0,96	.	(0,92 - 1,00)	-0,91	0,40	***	(0,34 - 0,47)
Country*Sex												
*ES*Male(ref)*												
AT*Female	-0,15	0,86	***	(0,87 - 1,08)	-0,02	0,98	**	(0,87 - 1,09)	0,04	1,04		(0,65 - 1,63)
BE*Female	-0,02	0,98		(0,84 - 1,08)	-0,02	0,98		(0,86 - 1,12)	-1,49	0,23		(0,05 - 0,92)
IT*Female	-0,01	0,99		(0,85 - 0,97)	0,14	1,15		(1,07 - 1,23)	0,17	1,18		(0,90 - 1,54)
PT*Female	0,15	1,16	***	(0,86 - 1,04)	0,09	1,10		(0,99 - 1,22)	-0,52	0,59	*	(0,38 - 0,92)
CZ*Female	-0,01	0,99		(0,81 - 1,00)	0,02	1,02	***	(0,91 - 1,15)	0,42	1,52		(1,06 - 2,17)
HU*Female	-0,13	0,88	***	(0,92 - 1,10)	0,10	1,11	**	(1,00 - 1,22)	0,06	1,06	.	(0,77 - 1,45)
PL*Female	-0,10	0,91	**	(0,88 - 1,04)	0,08	1,08	***	(0,99 - 1,18)	0,20	1,23		(0,93 - 1,60)
LV*Female	-0,02	0,98		(0,92 - 1,13)	0,16	1,18		(1,06 - 1,32)	0,31	1,36	*	(0,98 - 1,88)
Loglikelihood		-859026,6			-850584,0							

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05. RR=Relative Risk.

Note[1], both the transition to health improvement and death come from the "unhealthy" state.

The model is adjusted by sex,educational level, calendar period and make ends meet

Multi-state model with stratified hazard by transition type. R package *"survival"* and *"mstate"*

TABLE 3.6B. Differences of interaction terms between Country and Sex. Model 3.3. Multistate Cox Proportional Model with stratified hazard by transition type

Differences	Compared with "male" in each country						Compared with "female" in "Spain"					
Interactions terms	Deterioration		Health		Mortality		Deterioration		Health		Mortality	
	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR
AT*Female	0,00	**1,00**	0,07	**1,07**	-1,03	0,36	0,16	**1,17**	-0,27	**0,76**	-0,19	0,83
BE*Female	0,13	1,14	-0,03	0,97	-0,93	0,40	-0,19	0,83	-0,20	0,82	-0,75	0,47
IT*Female	0,14	1,15	-0,08	0,93	-0,90	0,41	-0,08	0,92	-0,17	0,84	-0,35	0,71
PT*Female	0,30	**1,35**	-0,09	0,91	-1,27	**0,28**	0,15	**1,16**	-0,19	0,83	-0,24	**0,79**
CZ*Female	0,14	1,15	0,14	**1,15**	-1,04	0,35	-0,28	0,76	-0,50	**0,61**	0,13	1,14
HU*Female	0,03	**1,03**	0,06	**1,07**	-1,11	0,33	0,07	**1,07**	-0,50	**0,61**	0,35	1,42
PL*Female	0,06	**1,06**	0,13	**1,14**	-1,06	0,35	-0,35	**0,70**	-0,60	**0,55**	0,26	1,30
LV*Female	0,13	1,14	0,00	1,00	-1,16	**0,31**	0,45	1,56	-0,27	0,77	0,36	**1,44**

Note [2],Differences are calculated based in the coefficients between the interaction terms and the fixed coefficients.For instance; considering the deterioration of "Female" in Portugal compared with male in that country= 0,15+0,15 => 1,35(exp(0,30))

In Bold are significant RR according to the interaction terms reported in TABLE 3.6A

TABLE 3 7A.- Results of model 3.4. Multistate Cox Proportional Model with stratified hazard by transition type and interaction terms

Predictors	Deterioration				Health Improvements				Mortality			
	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI
Educational Level												
**Primary or lower(ref)*												
Secondary and over	-0,19	0,83	***	(0,80 - 0,85)	0,18	1,20	***	(1,16 - 1,24)	-0,02	0,98		(0,90 - 1,07)
Sex												
**Male(ref)*												
Female	0,13	1,14	***	(1,11 - 1,17)	-0,04	0,96	**	(0,93 - 0,99)	-0,99	0,37	***	(0,35 - 0,40)
Education*Sex												
**Primary*Male(ref)*												
Secondary*Female	-0,02	0,98		(0,95 - 1,02)	0,10	1,10	***	(1,06 - 1,14)	-0,14	0,87	*	(0,76 - 0,99)
Loglikelihood			-859026,6 -850642,3									

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05. RR=Relative Risk.

Note[1], both the transition to health improvement and death come from the "unhealthy" state.

The model is adjusted by sex,educational level, calendar period and make ends meet

Multi-state model with stratified hazard by transition type. R package *"survival"* and *"mstate"*

TABLE 3.7B. Differences of interaction terms between Education and Sex. Model 3.4. Multistate Cox Proportional Model with stratified hazard by transition type

Differences	Compared with "male" with "secondary studies"						Compared with "female" with "primary studies"					
Interactions terms	Deterioration		Health		Mortality		Deterioration		Health		Mortality	
	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR
Secondary*Female	1,11	3,05	0,05	**1,06**	-1,13	**0,32**	-0,21	0,81	0,28	**1,32**	-0,16	**0,85**

Note[2],Differences are calculated based in the coefficients between the interaction terms and the fixed coefficients.For instance; considering the Health improvements of women with secondary studies compared with men with secondary studiesr= 0,10+ (-0,04) => 1,06(exp(0,05))

In Bold are significant RR according to the interaction terms reported in TABLE 3.7A

TABLE 3 8A.- Results of model 3.5. Multistate Cox Proportional Model with stratified hazard by transition type and interaction terms

Predictors	Deterioration				Health Improvements				Mortality			
	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI	coeff	RR	sig	95% CI
Educational Level												
**Primary or lower(ref)*												
Secondary and over	-0,20	0,82	***	(0,79 - 0,84)	0,22	1,25	***	(1,21 - 1,29)	-0,02	0,98		(0,89 - 1,08)
Living Arrangements												
**Living with a partner(ref)*												
Living with partner+children	-0,03	0,97	*	(0,94 - 1,00)	0,08	1,08	***	(1,05 - 1,12)	0,55	1,73	***	(1,56 - 1,92)
Living alone	-0,01	0,99		(0,96 - 1,02)	-0,06	0,94	**	(0,91 - 0,98)				
Living with others	-0,07	0,93	***	(0,90 - 0,96)	-0,17	0,84	***	(0,81 - 0,88)	1,16	3,19	***	(2,94 - 3,47)
Education*Living Arrangements												
**Primary*Living with a partner(ref)*												
Secondary*Living with a partner+children	-0,03	0,97		(0,93 - 1,02)	-0,01	0,99		(0,94 - 1,04)	0,00	1,00		(0,84 - 1,19)
Secondary*Living alone	0,02	1,02		(0,97 - 1,07)	0,03	1,03		(0,98 - 1,09)				
Secondary*Living with others	0,04	1,05		(0,99 - 1,11)	0,08	1,08	*	(1,02 - 1,15)	-0,18	0,83	*	(0,72 - 0,97)
Loglikelihood		-859026,6			-850643,1							

Signification level: *** p < 0.001; ** p < 0.01; * p < 0.05. RR=Relative Risk.

Note[1], both the transition to health improvement and death come from the "unhealthy" state.

The model is adjusted by sex,educational level, calendar period and make ends meet

Multi-state model with stratified hazard by transition type. R package *"survival"* and *"mstate"*

TABLE 3.8.B. Differences of interaction terms between Education and Living Arrangements. Model 3.5. Multistate Cox Proportional Model with stratified hazard by transition type

Differences	Compared with "living with a partner" with "secondary studies"						Compared with each living arrangements group with "primary studies"					
Interactions terms	Deterioration		Health		Mortality		Deterioration		Health		Mortality	
	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR	coeff	RR
Secondary*Living with a partner+children	-0,06	0,95	0,07	1,07	0,55	1,73	-0,23	0,97	0,21	1,08	-0,02	0,98
Secondary*Living alone	0,01	1,01	-0,03	0,97			-0,18	0,97	0,25	0,92		
Secondary*Living with others	-0,03	0,97	-0,09	**0,91**	0,98	**2,66**	-0,16	0,93	0,30	**0,86**	-0,20	**0,82**

Note[2],Differences are calculated based in the coefficients between the interaction terms and the fixed coefficients.For instance; considering the Health improvements of older people living with others and with secondary studies compared with people with secondary studies, living with a partnerr= 0,08+ (-0,17) => 0,91(exp(-0,09))

In Bold are significant RR according to the interaction terms reported in TABLE 3.8A

Additional Analysis on ages and time interval

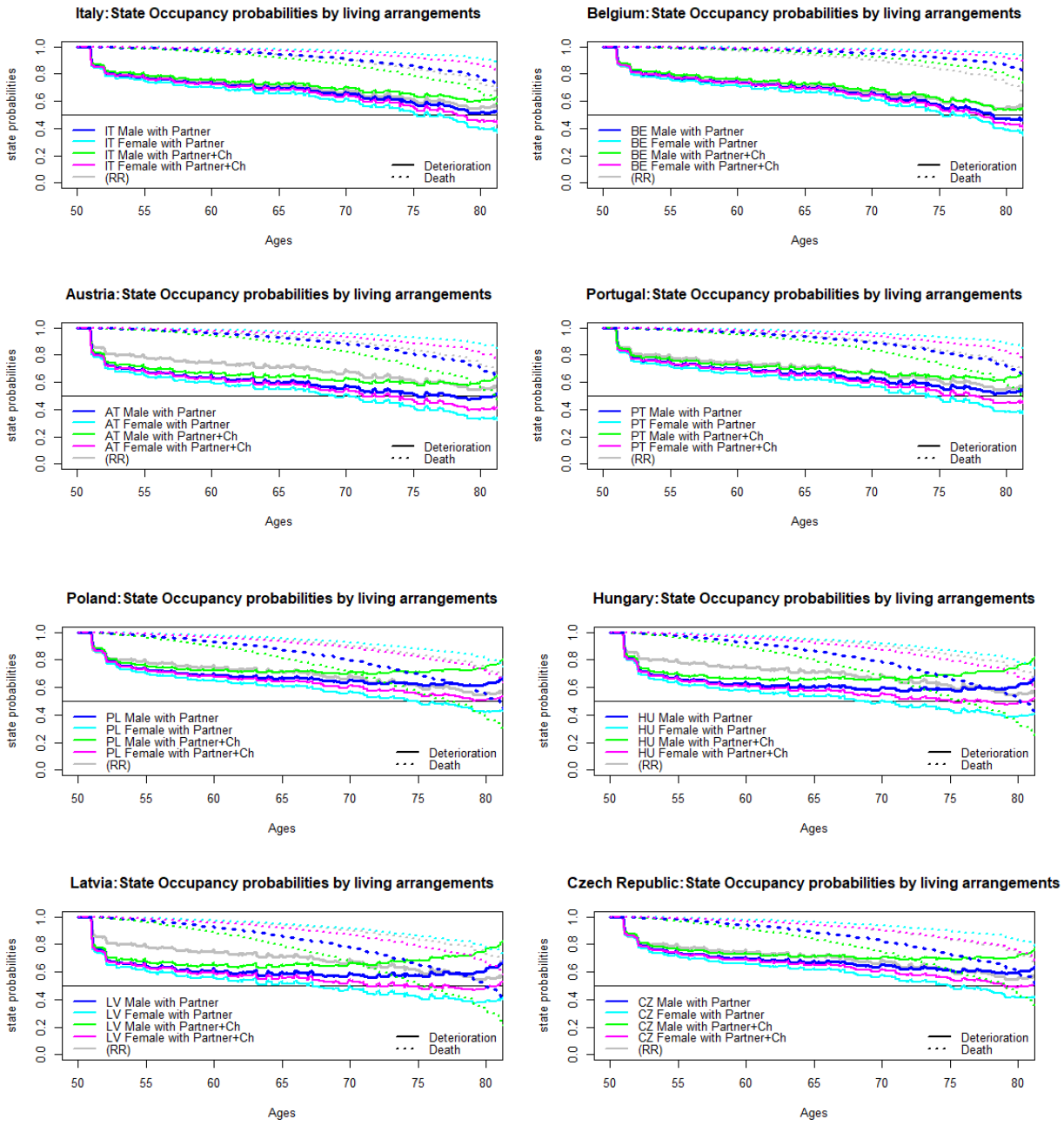
Median age at health deterioration, health improvement and death for those who live with a partner and with a partner and child.

From the model 1.3 we calculated prediction probabilities of health transition by age, sex, living arrangement and country[24] (see graph below). The general pattern is that the probabilities of health deterioration and health improvement by living arrangements reflect a similar pattern, although with different strength, among countries. The health deterioration pattern in southern and western European countries, excluding Austria, is closer to the reference, Spain than in eastern European countries as Hungary and Latvia reported a higher deterioration risk than in Austria. The Czech Republic and Poland reported similar health deterioration as in the reference. The same pattern is shown in health improvement with lower health improvements in eastern European countries and approximately the same level in southern and western European countries than in Spain and Portugal and Austria with lower probabilities.

The median age at deterioration[25] shows two crucial ages, but with country differences. In eastern European countries, the median age is reached earlier by older women, about 60-65 years (or even earlier in Hungary and Latvia). In southern and western Europe, however, the median age that health deteriorates in women is around 70-75, or even older, as in Belgium. 50% of the female population living with a partner in Italy, Portugal and Belgium experience deterioration in their health before age 75, whereas women in Austria, Hungary and Latvia this occurs earlier (before age 70), reflecting a greater propensity for those elderly women to worsen their health status. On the other hand, the median age at deterioration for men is not reached in eastern European countries and it is at oldest age of analysis in southern and western European countries. It is due population composition of elderly; eastern European countries have higher percentage of older people aged 50-60 and lower percentage of population in the age group 70+ than western and southern countries. Only exception is reported by Latvia which shown an aged population as southern countries.

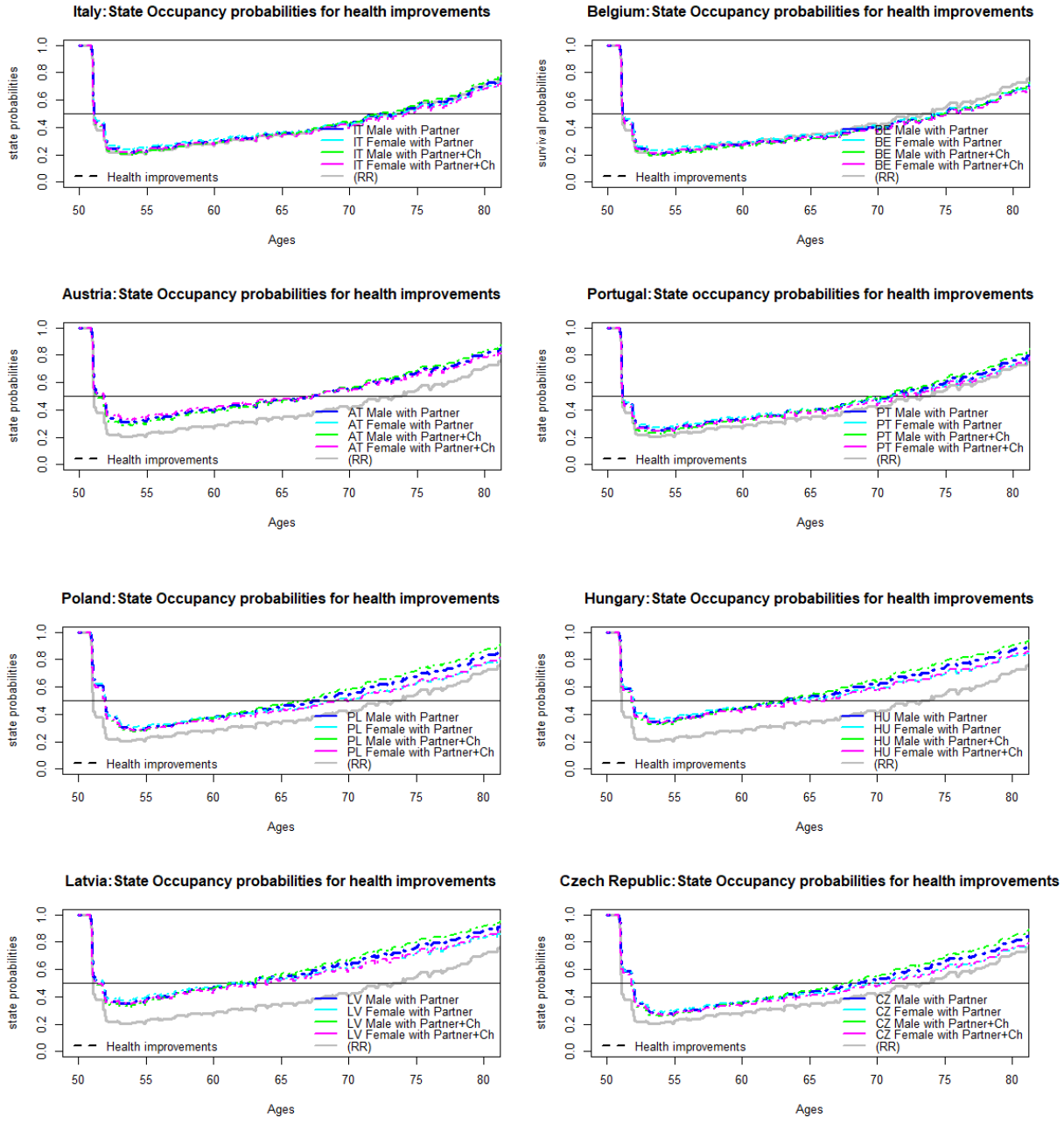
[24] Expected probabilities calculated with "*mstate*" R package
[25] The age where 50% of the population has experienced the event

FIGURE 3.3A.- State occupancy probabilities (health deterioration and death) by living arrangements and countries



Note: reference category: Male, living with a partner, with primary studies, Spain as the country of residence, without difficulties to cover monthly finances and the period 2009-2011.
Expected transition probabilities were calculated with “mstate” R package, functions “msfit” and” probtrans”.

FIGURE 3.3B. State occupancy probabilities (health Improvement) by living arrangements and countries



Note: reference category: Male, living with a partner, with primary studies, Spain as the country of residence, without difficulties to cover monthly finances and the period 2009-2011.
Expected transition probabilities were calculated with “mstate” R package, functions “msfit” and” probtrans”.

The effect of living arrangements on health improvements (shown by state occupancy probabilities in FIGURE 3.3B) did not show important differences by living arrangements in the studied countries, but there are differences with the inclusion of interaction terms between living arrangements and countries, as was showed earlier.

All countries reported differences in the probability of health deterioration of male elderly living with a partner (dark blue line) compared to Spain´s reference risk (grey line), with the exception of Italy and Portugal. The interesting fact is, however, that in western European countries the increasing risk of health deterioration slightly exceeds the reference, in eastern European countries, the risk of health deterioration starts from a very high point at younger ages but then decreases until it is below the reference in very old ages (around 75).

Differences in the risk of deterioration according to forms of co-residence are observed in southern and western European countries, from age 70-75, whilst wider differences are seen in eastern European countries and from an earlier age (age 65 and even before age 60 in the case of Latvia). Before these ages, there are no important differences in the risk of deterioration, health improvements or mortality according to the living arrangements studied.

In all countries, both men and women over 65-70 years of age living with a partner and children have a lower probability of having a deterioration compared with those who live with their partner (magenta and green lines, respectively). In Eastern European countries differences between the two types of living arrangements are greater and the health deterioration occurs the fastest after age 50. The most extreme cases are Hungary and Latvia.

Mortality

Regarding mortality (dotted line), there are no large differences in living arrangements in southern and western European countries compared to the reference category Spain, but there are in eastern European countries. However, men who live with a partner and children (green line) have higher mortality than those who only live with a partner (dark blue line). This pattern is repeated in the same way for women.

The median age of mortality is not seen in countries with high life expectancies, as in the case of Italy and Belgium. In Portugal and Austria, men residing with children and couple have a median age close to 80 years. Lastly, in eastern European countries the mortality risk at age 75 years is higher than the risk of health deterioration for the two both types of living arrangements (living with a partner or with a partner and children).

Time interval effects

The model (2.2) with interaction terms between time intervals and health transition type, reported a higher propensity to health deterioration, health improvement and death in one year of follow-up compared to a two and three years' interval (see ANNEX 3.4). However, there are some differences to

mention regarding the results for the two years' interval, in particular, for those living with a partner and children who experience health deterioration and health improvement.

In health deterioration, those older than 50 years of age living with both, partner and children, have a 13% lower risk of deterioration during the whole observation period, but they have a 28% higher risk of deterioration in a time interval of two years compared with a time duration of one year (reference category). Contrary to the effect in *health improvement,* the likelihood to improve the health status of those older is 13 % when a two-year interval is considered, with significant differences compared with one-year interval. The results are analysed with caution due to wide confidence intervals and for this reason we only describe this result.

In addition, we fit a model with time varying coefficients by living arrangements (model 2.3). All models were done twice to evaluate whether there is an effect of the variation of living arrangements on the hazard (see TABLE 3.3). Coefficient are quite similar compared with fixed living arrangements. It might illustrate that the period of follow-up is too short to capture important variation on the way that older people live.

3.4. Discussion

The analysis of health status reporting by the General Limitation Index (GALI) and mortality at older ages in nine European countries, using a multistate survival modelling, provided meaningfully insights that illustrates diverse living arrangements effects and gender effects on health pattern on ageing among countries. Our findings reveal a protective factor of living with a child and partner on the health status of people 50 years and older when compared to those who only live with partner. Living with a partner and at least one child increases the likelihood to have improvements in health and, at the same time, it is a factor of protection against health deterioration, albeit that there are countries which do not share the same pattern.

The study also showed differences in gender and education in health transitions. Gender differences illustrate that despite of the well-established gender paradox in European countries, there are countries where older women are likely to have greater health improvements than men, as in the case of eastern European countries. And, finally, effects of education on living arrangements and gender show that; firstly, higher education increases health improvements and delay mortality for those who live with others (without partner and children). And secondly, higher education contributes to narrow the gender gap of disabled years.

Country differences by living arrangements

Almost all countries (with the exception of Hungary and Latvia) reported that living with partner and children, when compared with living with a partner, delay the transition to health deterioration around 3-10% but differences were only significant in Italy (RR: 0.91, $p<0.01$). In reference to health improvements, results show that elderly living with partner and child have a lower likelihood to improve their health status than elderly living with a partner in only two countries: Austria and Belgium. In the rest of the countries, health improvements are more likely for those who live with their child and partner, although differences were not significant.

Results are likely to be due to the composition of the elderly population by living arrangements. Studies have reported that living arrangements for men and women in the elderly are highly differentiated among European countries (51,77). Our study reflects this heterogeneity among countries as is seen in the population composition (see ANNEX 3.1). Those countries in which elderly are less likely to have health improvements when they are living with their child and partner are also more likely to have lower percentages of these living arrangements, as is the case with Belgium and Austria. In those countries more than 50% of the population older than 50 years of age live with a partner and less than 20% live with their partner and child. This profile is similar in the Czech Republic, while in countries like Italy, Spain and Poland the proportion who live with a partner and live with a partner and child is very similar (around 35%).

Analysing the effect of other living arrangements within each country, we see that there are two countries where elderly who live alone are in a favourable situation compared to the reference category, living with a partner. They reported a higher likelihood of health improvements than those who live with a partner, with significant differences in Portugal and the Czech Republic. On the other hand, living alone in Latvia leads to lower health deterioration, but without significant values.

There are strong indications that surviving in good health by people living alone is due to a selection effect (63) as the spouse with poorer health dies before and only people with better health conditions remain at very old ages. This is why among this population, those who live alone and survive longer are usually (women), giving rise to the gender paradox which indicates that women live longer but spent more time in bad health than men. However, recent studies have shown (44) that living with a partner is favourable for the health status for women (253) - although more for men-, and at the same time, living alone at older ages is becoming more favourable and more frequent (62).In this study we see that elderly living alone in Portugal and Czech Republic have a health advantage over the others countries. Results in the latter country are due to the recent progress in life expectancy (160).

On the other hand, overall, elderly living with others have both lower risks of health deterioration and health improvement (only Poland with significant differences) and only in Belgium the risk of health deterioration was higher (RR:1.26, p<0.001) for those living in this living arrangement, with significant differences compared with the elderly living in a couple.

Elderly living in Spain, regardless of their living arrangements, are in a better health condition than those in the other countries studied. The Spanish population reported a higher likelihood of health improvements for those who live with a partner and children, alone, and for those living with others, although, for the risk of health deterioration there is a mixed pattern among countries. The higher rates of health improvements in Spain are due to the higher life expectancy in this country, compared with the rest of the European countries studied (181).

Gender differences by living arrangements

Differences by gender among countries illustrate that, regardless of the living arrangements, elderly women are at a greater risk to experiment a deterioration in health than men. For health improvements, the pattern is mixed, as women also experience more health improvements, with the exception of living alone. However, for both transitions, health improvements and deterioration, there were only significant differences for the interaction between living alone and sex.

The shown interaction is as expected. Women living alone are less likely to have health improvements (RR: 0.97, p<0,01) than elderly women living with a partner but surprisingly, they also show a lower likelihood to have a deterioration in health (RR: 0.91, p<0.001) than women living with partner. This shows that older women living alone delay health deterioration as a result of a selection effect (63), although once an impaired health status is reached, the probability to recover to a better health status is also lower. Regarding mortality, this pattern of higher survival for female elderly compared with male elderly is repeated in all living arrangements. That said, for women, living with a partner is reported to be a protecting factor that delays mortality.

Gender differences by country

The Female elderly population in the nine countries that were studied reported a higher health deterioration and lower mortality risk than their male counterparts. On the one hand, all countries reported health deterioration risks ranging from 2%–14%, being only significant in Austria, Portugal, Hungary and Poland. The case of Portugal is more remarkable with a 1.35 higher risk of deterioration for older women than older men in that country. On the other hand, the lower mortality risk was only significant in Portugal and Latvia. These results are consistent with the gender paradox: women are

ahead of men in terms of life expectancy, but also in years disabled. The particular case of Portugal illustrates that women have a prolonged impairment condition that might be delaying their mortality risk.

However, there are also countries performing better in health improvements. In general, Austria and eastern European countries, excluding Latvia, reported a higher likelihood for older women to improve their health status: Austria (RR: 1.07, $p<0.01$), Czech Republic (RR: 1.15, $p<0.001$), Hungary (RR: 1.07, $p<0.01$) and Poland (RR: 1.14, $p<0.01$). The rest of the countries show that elderly women have a lower risk of health improvement than older men, although no results are statistically significant.

Gender differences in health improvement and deterioration might be seen as a result of the expenditure on health care for elderly. Studies have shown (160,272,273) that countries with lower public expenditure on elderly care observe a larger gender gap in expected years with activity limitation. Southern European countries are widely known for their strong family ties and solidarity networks that provide help to older family members in response to a lack of state health care provision at older ages. Additionally, there is a shortage of resources to invest in the environment of older people (assistive devices, changes in infrastructure, protection programmes, etc.) to help them to adapt themselves to their declining function, which is a natural process of ageing. Whereas in eastern European countries, in particular former USSR countries, the economic difficulties and the collapsed welfare system that affected the entire population equally (274) trigger the higher mortality risk and lower health improvements.

Studies reported that the worst situation in terms of health and mortality has been observed in countries of eastern Europe attributable to differences in health care and treatment between eastern and western countries. However, women in these countries (especially in the Czech Republic, Hungary and Poland) were more likely to have health improvements than men in our study, that could be due to health-related personal behaviours and others risk factors as alcohol consumption mostly performed by men(275)In this study we do not go further in the analysis of mortality differences between countries due to the underreporting of mortality records in EU-SILC. The survey doesn't track elderly who move to collective institutions and probably died in some point of the follow up period. It mostly happens in eastern and western European countries where health care for elderly is a public service provided by the State.

However, regarding to the mortality pattern in eastern European countries, studies have shown a convergence with the other European countries since the fall of the Berlin wall, although with variations in timing. The Czech Republic pioneered this trend and has been experiencing continuous

progress in life expectancy over the last decades and was soon followed by Poland, Slovakia and Hungary, and very recently (if at all), by Russia and the Ukraine (180).

Differences in socioeconomic conditions

The beneficial effect of education on health improvement and mortality slightly differs between men and women. Older women with secondary school attainment are 5% more likely to have health improvements than older men with the same educational level. Also differences within type of living arrangement were found, as elderly with secondary studies who live with others have a 35% higher probability of health improvements than older people with the same living arrangements with only primary education. They also have a lower mortality risk.

Studies have shown that higher educated people have more material resources to tackle worst health conditions. They are more likely to avoid risky behaviour, receive adequate and timely medical assistance and follow medical treatments, and therefore, they are more likely to recover from diseases or disabilities as well as quicker. In this sense, education contributes to narrow the gender gap of unhealthy and disability-free years between men and women. At the same time, higher education might compensate in case they do not live with a partner, which is another potentially protective factor.

Additional analysis of calendar time and difficulties to cover monthly expenses also showed that in reference with the first indicator, elderly in the period 2006-2008 experienced higher rates of health deterioration as well as health improvement compared with the reference period 2009-2011. The health measure used (GALI) reported greater variation on how elderly answer about their health status when having economic difficulties in southern European countries (276).However, other studies have also reported that during the financial crisis in Europe higher rates of suicides, mixed outputs in self rate health and mental health deterioration (277) .Despite there are countries in this analysis that did not experienced the crisis in this period, the results shown a biases due to large population size in southern countries Lastly, as expected, elderly who couldn't face monthly household expenditures were less likely to experience health improvements and had a higher risk of health deterioration. In this sense, these results are consistent with others studies that show (184) that at older ages a socioeconomic disadvantage can lead to an expansion of years in disability.

The summary of these results comprise a brief characterization of the elderly population in Europe nowadays. Knowing that there is a growing elderly population with specific health conditions and socioeconomic living conditions, it is need to reallocate resources to satisfy the newer elderly demands influenced by the retirement age (278). In this framework, the changing age structure implies

adjustment on public transfers and long term care policies to support the large contingent of elder population. Some countries have already implemented public policies due the elderly, as for instance; Austria and Sweden showed larger adjustments on its public transfer system to the changing age composition, by maintaining elder people longer in the labour force and also providing support to families (279). But resources reallocation also implies infrastructure accommodation which allows a friendly environment (in public spaces and private dwelling) that amplify the capabilities and well-being for a healthy ageing (280).

4. Años de vida saludable según arreglos de convivencia. Una comparación de las trayectorias de funcionalidad de las personas mayores entre Europa y América Latina

Resumen

Objetivo: Comparar las trayectorias de funcionalidad para el cálculo de la esperanza de vida de la población de 60 años y más, entre Europa y América Latina, con la intención de identificar la contribución de la educación, la participación social y los arreglos de convivencia en la supervivencia y en los años de vida saludable por sexo en tres países con patrones similares de longevidad. El estudio tiene particular interés en ilustrar diferencias entre las probabilidades de deterioro y mejoras de salud entre las dos regiones en la actualidad, y, también, promover el uso de los modelos de múltiples estados para la estimación de los años de vida saludable.

En el estudio se analizan tres países con información de salud disponible de corte longitudinal para el análisis: Chile (EPS), Costa Rica (CRELES) y España (SHARE). El análisis se realiza mediante un modelo "*multistate*", el cual permite la estimación de las probabilidades de transición entre tres estados de salud y el efecto de variables de interés. Los resultados ilustran que Costa Rica tienen la brecha más corta de esperanza de vida entre hombres y mujeres y menos años de vida saludable para las mujeres. La educación tiene mayor relevancia en el mayor porcentaje de años saludables en los tres países. La participación en actividades sociales y los arreglos de convivencia incrementan la supervivencia en los tres países, pero tiene menor incidencia en las trayectorias funcionales.

4.1. Introducción

La salud de las personas mayores está representada por la funcionalidad de sus capacidades físicas y mentales, más que por las presencia de enfermedades o condiciones de salud (3). En consecuencia, la capacidad de vivir de forma autónoma de la población adulta mayor, entendida como la posibilidad que tiene una persona de realizar sus actividades cotidianas sin recibir supervisión o ayuda de terceros (8), es el principal objetivo para un envejecimiento activo y saludable (281) frente al creciente envejecimiento de nuestras sociedades. Por ende, la presente investigación explora las trayectorias funcionales de las personas mayores como un buen predictor de sus condiciones de salud y bienestar.

El presente estudio se centra en una comparación regional de la población mayor de 60 años de dos países de América Latina, Chile y Costa Rica y uno europeo, España. Esta comparación permite analizar el efecto de variables contextuales como los arreglos de convivencia y la participación social sobre la esperanza de vida y años saludables en tres países. Por tanto, nuestro estudio ilustra la influencia de los estilos de vida sobre los años de vida de los mayores con el objetivo de contribuir en el debate actual de las desigualdades en los años de vida en las personas mayores en diferentes contextos demográficos.

Los países de América Latina escogidos poseen indicadores similares a los encontrados en España; como la esperanza de vida a los 60 años[26] (282): Chile 21,5 para hombres y 25.2 para mujeres, en Costa Rica 22,4 para hombres y 25,5 para mujeres y en España 23,1 para hombres y 27,5 para mujeres, y niveles de desarrollo humano (283) como nivel educativo con estudios de primaria y nivel ingreso medio-alto igualmente similares.

Envejecimiento y arreglos de convivencia

El envejecimiento en América Latina (AL) en las últimas décadas ha evidenciado el más rápido engrosamiento de su población mayor de 60 años en comparación a otras regiones y en otros periodos de la historia (194,241,284); en el periodo 2000-2020 incrementó el 61% respecto a la cifra poblacional al inicio de periodo (de 8,3% a 13,7%), similar al crecimiento observado en Asia. Mientras que otras regiones como Europa sólo registraron un aumento alrededor de un 25% (284). Esta celeridad del proceso de envejecimiento en la región se debe en gran parte a su dinámica demográfica, principalmente al descenso de la fecundidad desde tasas muy elevadas y un descenso sostenido de las tasas de mortalidad (68).

Los países con mayor contingente de población mayor (60+) de América Latina para el 2020 (284) son Cuba (21,3%), Uruguay (20,2%), Chile (17,4%), Argentina(15,5%) y Costa Rica (15%). Son países que también reportan la mayor longevidad en la región, según la Organización Mundial de la Salud (282); para las mujeres la esperanza de vida varía de 80-82 años de vida y para los hombres de 73-79 años de vida.

Estudios indican que la población que alcanzó los sesenta años en el año 2000 ha sido beneficiada por el despliegue de innovaciones en medicina en la infancia y en la niñez por lo que su supervivencia se debe más a mejoras en tratamiento, menor exposición a enfermedades contagiosas, que a mejoras en las condiciones de vida en general. Condiciones de vida que se han desarrollado en un contexto sociopolítico de gran inestabilidad económica e institucional y apuntan a una vejez con peores condiciones de salud que las observadas en los países europeos (54).

En este contexto, los países con este acelerado crecimiento de su población mayor en la región latinoamericana necesitan adecuar el gasto público en el sistema de salud y de pensiones para atender las demandas diferenciadas y específicas de este creciente contingente derivadas de sus capacidades

[26] Información para el periodo 2016.

funcionales. Sistemas de salud que en los países de estudio comprenden características variadas. Así España (285) y Costa Rica (286) comparten un sistema de salud público universal y gratuito, mientras que Chile tiene un sistema mixto, asumido una parte por el Estado y otra parte por el sector privado (287).

No obstante, es conocido que en el caso latinoamericano (53,56) y en Europa del sur (46,47,50,77,94,245) las instituciones gubernamentales no tienen el alcance suficiente para gestionar la demanda de necesidades del creciente contingente de adultos mayores por lo que la familia es la base fundamental de las transferencias de apoyo y cuidado de esta población . En contraste, el Estado, en los países nórdicos y de Europa occidental, es el principal proveedor de cuidado formal de los mayores (249,288,289).

En este sentido, el cuidado de los mayores funge en parte como un determinante de los arreglos de convivencia; por un lado, los lazos familiares han articulado un sistema compensatorio de redes de apoyo intergeneracionales con hogares de mayor tamaño –hogares extendidos - en América Latina (43,47,52,54,56,61,68,69,290,291), como es el caso de Chile y Costa Rica, y –hogares nucleares- en Europa del sur como en España. Mientras que la pareja (mujer en la mayoría de los casos), representa la mayor proveedora de cuidado reduciendo el tamaño de hogares en los países nórdicos y de occidente (58,59,77,292,293).

Igualmente, los arreglos de convivencia difieren ampliamente entre los países y regiones, aún dentro de una misma región, y son el resultado de preferencias individuales, recursos disponibles y pautas culturales , así como de las condiciones socioeconómicas, de capacidades funcionales de la población al hacerse mayor (53,294) y de pasadas tendencias demográficas de fecundidad, mortalidad y nupcialidad (52,60,68,295). Sobre esto último, y en lo que refiere a la región latinoamericana, el momento y duración de la transición demográfica en cada uno de los países[27] tienen consecuencias directas en la disponibilidad de parientes y en la red de apoyo de la población mayor (47); los países con el descenso más temprano de sus tasas de fecundidad serán los países con mayores tasas de vivir en solitario y las tasas más bajas de vivir con hijos como es el caso de Uruguay y Argentina (53).

[27] Ver Wong, Carvalho y Aguirre (413) para una descripción de la transición demográfica en América Latina.

Estudios sobre las condiciones de salud

Los estudios sobre las tendencias de salud de los mayores en América Latina son todavía escasos en la actualidad (100,296–304), y mucho más aquellos que consideren comparaciones regionales (247,305,306). La mayoría de los estudios son de tipo descriptivo (52), basados en la encuesta SABE (54)(Survey on Health and Well-Being of Elders), realizada en siete ciudades de América Latina y el Caribe (Buenos Aires, Argentina; Bridgetown, Barbados; Santiago de Chile, Chile; la Habana, Cuba; Montevideo, Uruguay; México D.F, México y Sâo Paulo, Brasil). Única de las pocas encuestas existente en la región para el estudio de las condiciones de salud de la población adulta mayor para la década del 2000. La encuesta fue diseñada de corte transversal, pero en algunas ciudades se realizó un seguimiento de tipo longitudinal: Santiago, Sao Paulo y ciudad de México. Por ello, los datos de la encuesta en la mayoría de los países son de prevalencias de salud. De este estudio se han realizado la mayoría de las investigaciones existentes sobre estados de salud basados en prevalencias de limitaciones funcionales (300), discapacidad (304,307), deterioro cognitivo (308) dependencia (298) y satisfacción vital (303,309).

Sin embargo, pocos son los estudios sobre años de vida saludable en los países de la América Latina que utilizan tasas de incidencia para las estimaciones como en nuestro estudio (310) . Los que existen, utilizan mayormente tasas de prevalencia de estados de salud derivados de las limitaciones funcionales por medio del método “Sullivan” para la estimación de los años de vida (300,311,312). Estas tasas de prevalencias no consideran los cambios de salud sobre el ciclo de vida de individuos expuestos a condiciones de morbilidad y mortalidad actuales como es el caso de los modelos de múltiples estados (18,264,313,314), también conocidos como tablas de vida de múltiple decremento-incremento (22,26,143,164). Es un método con mayor robustez para el cálculo de las esperanzas de vida puesto que considera la dinámica de salud de la población por cada unidad de tiempo (ej. edades) , permite identificar el efecto de las tasas de transición entre cada estado de salud y la posibilidad de estimación de transiciones reversibles (315).

En este sentido, el presente estudio utiliza tasas de incidencia para la estimación de los años de vida con el objetivo de proveer insumos para la comparación en la última década de las tendencias de salud de tres países pertenecientes a dos regiones con diferentes transiciones demográficas, pero con rasgos socioeconómicos similares. Esto permite aislar el efecto de las condiciones socio-económicas, que son determinantes en los niveles de esperanza de vida, y realizar un estudio de las condiciones de salud entre los países hasta cierto punto comparables. Por otro lado, por medio de los patrones de convivencia y la participación social es posible explorar el entorno inmediato de las personas mayores,

elementos que pudieran incidir de forma positiva en la conservación de las capacidades funcionales a edades avanzadas.

4.2. Fuentes y Estrategia Metodológica

Datos

Los datos utilizados abarcan tres encuestas longitudinales(tipo panel) de tres países: Chile, Costa Rica y España; la Encuesta de Protección Social "EPS"(316) de Chile con cinco rondas (2004,2006, 2009, 2015 y 2017), Costa Rica Estudio de Longevidad y Envejecimiento Saludable, "CRELES" (317) con tres rondas (2005, 2007, 2009), y la encuesta de Salud, Envejecimiento y Jubilación de Europa (Survey Of Health, Ageing And Retirement In Europe, "SHARE")(318) para España, con seis olas de corte longitudinal (2004-2005, 2007, 2011, 2013, 2015, 2017).

Encuesta longitudinal de Protección Social (EPS)

La Encuesta Longitudinal de Protección Social de Chile (EPS), es la encuesta más antigua y de corte longitudinal existente en el país desde el año 2002, dirigida por la Subsecretaría de Previsión Social; tiene el propósito de contar con información de las características socioeconómicas, historia familiar, información de las condiciones del hogar, trayectorias laborales, sistema de protección social (pensiones) y las condiciones de salud de la población. Inicialmente fue realizada con las personas de 15 años y más afiliadas al sistema de pensiones en el 2002 y en la siguiente ronda (2004) fueron incorporando a las personas no afiliadas hasta volver representativa la encuesta a nivel nacional. Esta encuesta fue impulsada por el Banco Interamericano de Desarrollo (BID) para extender la experiencia a otros países de la región(319). Hasta ahora, los países que han seguido la propuesta son: Colombia (2015), Uruguay (2013,2016), El Salvador (2013) y Paraguay (2015).

En Chile, la encuesta cuenta con alrededor de 16.000 registros de personas distribuidas en toda la geografía del país. La primera ronda de la encuesta se realizó en 2002, luego se siguieron realizando con un intervalo de dos a tres años (2004,2006,2009,2012,2015,2017). Las rondas del 2002 y 2012 no se incluyen en este estudio; la primera no se utilizó porque no contaban con las preguntas de limitaciones funcionales, además esta muestra no consideraba a toda la población nacional, sólo los cotizantes. Por último, la ronda del 2012 no cumplió los objetivos de la encuesta y por esto se recomendó no utilizar los datos para análisis estadísticos. Seguido de esto, la encuesta del 2015 contó con un refrescamiento de la muestra.

La encuesta del 2017 es una sub-muestra de la ronda 2015 y tiene el nombre de Encuesta de Calidad de Vida Adulto Mayor e Impacto del Pilar Solidario, "ENCAVIDAM"; fue ejecutada por el centro de

Encuestas Estudios Longitudinales de la Pontificia Universidad Católica de Chile(CEEL) y la Subsecretaría de Previsión Social. La encuesta comprende 2.400 individuos mayores de 60 años y contiene preguntas específicas de envejecimiento, limitaciones funcionales, deterioro cognitivo (mini-mental test), información de cuidadores y otros indicadores para el estudio de la calidad de vida de las personas mayores. Por último, la población total entrevistada de 60+ años con más de dos observaciones durante las cinco rondas de la encuesta asciende a 5.238 individuos.

Costa Rica Estudio de Longevidad y Envejecimiento Saludable (CRELES)

La encuesta es dirigida por el Centro Centroamericano de Población (CCP) y el Instituto de Investigaciones en Salud (INISA) de la Universidad de Costa Rica con la colaboración de otros institutos del país con el financiamiento de la fundación "Wellcome Trust". La encuesta es representativa de la población de 60 años y más a nivel nacional con una sobre representación de las personas mayores (90+) (320).

La encuesta se realizó de forma longitudinal con tres rondas en 2005,2007 y 2009. Cuenta con una muestra inicial de 2.800 registros (de los cuales 2.631 tuvieron dos o más observaciones) y tiene preguntas sobre el hogar, características socioeconómicas, estilos de vida, eventos en el curso de vida en el periodo 2005-2009, examinaciones físicas como presión arterial, antropometría y mini-mental test. Comprende también recolección de sangre y orina que permite el estudio de una gran variedad de bio-marcadores (321). La encuesta es aplicada a través de un Dispositivo Móvil de Captura (PDA, por sus siglas en inglés "Personal Digital Assistants") y utilizó un software desarrollado por el mismo proyecto que llevó a cabo la encuesta.

La población objetivo de la encuesta abarca a la población residente que, independientemente de su nacionalidad, nació antes de 1946 y que al momento de la primera encuesta tuviera 60 (y más) años. La muestra inicial se deriva del censo del año 2000, y comprendió 5.000 personas, de las cuales fueron entrevistadas 2.827, por lo que la muestra comprende el 59% del territorio nacional. Dentro de los entrevistados, 95% facilitó muestras de sangre y 92% muestras de orina. El 91% aplicó para el modulo antropométrico y el 25% de la muestra requirió proxy para responder al cuestionario de preguntas. Por último, esta encuesta no tuvo refrescamiento en las siguientes rondas.

Encuesta de Salud, Envejecimiento y Jubilación de Europa (SHARE)

La encuesta de Salud, Envejecimiento y Jubilación de Europa "SHARE" por sus siglas en inglés, es de corte longitudinal (tipo panel), abarca alrededor de 380.000 registros de 140.000 individuos de 50 años y más en 27 países de Europa en el periodo 2004-2017. Esta encuesta está coordinada por el Munich Center for the Economics of Ageing (MEA) del Max Planck Institute for Social Law and Social Policy. Sin

embargo, en cada uno de los países participantes, existe un centro científico, que normalmente está afiliado al cuerpo académico de alguna universidad o institución pública, y son los encargados de la implementación y supervisión de la encuesta.

Las preguntas comprenden características socio-económicas, trayectorias laborales, redes familiares, de apoyo social y una variedad de indicadores de salud (bio-marcadores, limitaciones funcionales, mini-mental test, satisfacción en la vejez, entre otras) para la comparación de países europeos. Igualmente, las parejas de las personas seleccionadas son entrevistadas independientemente de su edad.

La encuesta cuenta con 7 rondas, de las cuales, la ronda 3 en el 2009 (SHARELIFE) es de corte transversal; sus preguntas refieren a eventos muy específicos en el ciclo de vida como padecer de hambruna en la niñez, para identificar eventos que influenciaron el curso de vida de cohortes, como periodos de guerra (guerra civil española, segunda guerra mundial). Los ítems no son comparables con las rondas anteriores, por tal motivo esa ronda está excluida de este estudio. La muestra de España es obtenida a través del Instituto Nacional de Estadística (INE) por muestreo aleatorio de las secciones censales de todos los municipios de España. Se realizó refrescamiento de la muestra en la segunda ronda y cuarta ronda para mantener la representatividad de la población mayor de 50 años en todo el periodo de observación (322). Por último, la población de 60 años y más con al menos dos observaciones comprende 5.068 individuos.

Indicadores

La variable dependiente para estimar el estado de salud de la población en estudio comprende el auto-reporte de la capacidad funcional para realizar:

I. Actividades Básicas de la Vida Diaria (ADLs, en inglés), que incluye: Bañarse, vestirse, utilizar el servicio sanitario, cruzar una habitación caminando, acostarse o levantarse de la cama, comer.
II. Actividades Instrumentales de la Vida diaria (AIDLs), que considera la habilidad de manejar el dinero propio, preparar comidas, realizar compras, tomar medicinas.
III. Actividades de movilidad funcional (Mobility Function) o Actividades Avanzadas de la Vida Diaria, las cuales considera dificultades para caminar varias cuadras, para subir por las escaleras varios pisos sin descansar, levantar y estirar los brazos por encima de los hombros, dificultad para empujar o jalar un objeto grande como un sillón.

La definición del estado no saludable se realizó según el criterio utilizado en Moreno, Albala, Lera et al. (310), el cual identifica un estado no saludable si el individuo auto-reportó una limitación en al menos una ADLs, dos IADLs o en tres preguntas de movilidad funcional. Las preguntas que contempla cada encuesta para la medición de los indicadores utilizados se muestran en anexos (Nº1).

Las principales variables de nuestro análisis son: los arreglos de convivencia y la participación social. Para arreglos de convivencia las categorías son: viviendo sólo en pareja (hogar de dos), viviendo con pareja y otros, viviendo con otros (sin incluir pareja), y viviendo solo. La categoría "viviendo solo" fue construida a partir de la variable "tamaño del hogar", cuando se identificaba a un sólo miembro en el hogar. La categoría "vivir en pareja" fue construida a partir de la variable de situación conyugal/ estado civil y del tamaño del hogar en las tres encuestas. En este estudio se considera indiferentemente el estado civil y la situación conyugal para referir a la convivencia con la pareja. Esto debido a que estudios anteriores (44) han reportado que las dos variables tienen igual importancia en el estudio de la condición de salud y sobre todo en la supervivencia de las personas mayores.

Chile utiliza la variable "estado civil" y se utilizó la categoría "casado" y "conviviente" para identificar a los que viven en pareja. Costa Rica utiliza "estado conyugal" y se utilizaron las categorías unido y casado. En España, la encuesta utilizó "estado marital"[28] con categorías: casado viviendo con esposo(a) y pareja registrada en la encuesta. La categoría viviendo solamente con pareja se refiere a las personas que contestaron tener pareja o estar casadas y con dos personas en el tamaño del hogar. La categoría "viviendo en pareja y con otros" [29] comprende a los individuos que identificaron vivir en pareja y con un tamaño del hogar superior a dos miembros. La variable "viviendo con otros" se basa en los hogares con dos o más integrantes que declararon un estado diferente de vivir en pareja o estar casado. La variable de participación social varía en cada encuesta (ver en ANEXO 4.7 las categorías utilizadas en cada encuesta) por lo que se construyó un indicador resumen relativo a si participaba o no en alguna actividad recientemente.

Por último, las variables independientes de ajuste - utilizadas en el análisis son las siguientes: sexo y edad, esta última como variable continua desde los 60 años. Y, por último, nivel educativo: primaria o

[28] De la traducción de la variable "marital status"; categorías "married living together with spouse" y "registered partnership".
[29] "Otros" puede incluir hijos y/o otros parientes como también no parientes.

menos y secundaria o más. No se incluyó la variable de cohorte de nacimiento porque la estructura por edades no comprende todas las cohortes de nacimiento.

Estrategia metodológica

La metodología utilizada se basa en la estimación de modelos de transición entre múltiples estados (Multi-state transition models). Estos modelos son utilizados en el análisis de supervivencia y permiten calcular probabilidades de transición entre estados de salud por medio de un proceso estocástico. También permiten explorar simultáneamente el efecto de variables sobre las transiciones entre estados y, por último, estimar la duración en un estado especifico como la esperanza de vida en años saludables, en mala salud o la esperanza total, que en el contexto de estos modelos es el tiempo esperado de vida independientemente del estado ocupado.

En este estudio utilizamos un modelo de tipo “Illness death model with recovery” con tres estados; dos estados transitorios, estado ”1” que refiere al estado saludable y estado “2” que identifica al estado no saludable, y un estado terminal (absorbing) “3” que no tiene retorno, y corresponde a la defunción. Los estados “1” (saludable) y “2” (no saludable) están censurados en el intervalo de dos encuestas, es decir, no se conoce el momento exacto en el que se realizó la transición entre los estados, pero se conoce el intervalo de tiempo donde se realizó la transición, que corresponde a las fechas de realización de la encuesta.

Los estados “1” y “2” son recurrentes; los individuos pueden entrar y salir tantas veces sean observados, y el estado “3” (muerte) sólo permite la entrada a este estado una sola vez. Adicionalmente, para el estado “3”, ciertas encuestas proveen la fecha exacta de esta transición porque la información de las defunciones proviene de registros civiles como es el caso de Chile, mientras otras encuestas, como es el caso para Costa Rica y España, proveen información retrospectiva sobre las fechas de muertes en el hogar (320,323). No obstante, los datos de mortalidad de Costa Rica de la encuesta indican un bajo subregistro de defunciones (1%) (324). En este estudio utilizamos modelos mixtos (325) con el tiempo censurado en intervalos para los estados transitorios: estado “1” y estado “2” y el tiempo exacto de ocurrencia para el estado terminal “3”.

Los modelos se estimaron con el paquete en R "msm", versión 1.6.7 (325) para la estimación de los hazards (o probabilidad instantánea[30] (113)) de las transiciones entre estados y el hazard ratio de las variables explicativas. Estos modelos incluyen la edad como variable continua dependiente, lo que implica que las probabilidades de transición entre estados aumentan o disminuyen de forma loglineal con la edad, siguiendo por lo tanto una distribución Gompertz. En este caso la función de probabilidad se estima por medio de una aproximación "piecewise" constante condicionado a la edad (326). Esto quiere decir que la probabilidad instantánea de transición entre estados es constante dentro de cada intervalo de edad. El valor de las edades usados con los modelos multiestado de supervivencia son transformados de manera lineal para evitar problemas en las estimaciones por valores muy elevados (326), centrado estas edades a la edad mínima del estudio (60 años).

La esperanza de vida estimada, en años saludables o no saludables, corresponde a años de ocupación en estados específicos, también conocido como "sojourn time". Se realizó por medio del uso paquete en R "elect", versión 0.2. El paquete estima las esperanzas de vida marginal, que es el tiempo total de vida esperado independientemente del estado inicial ocupado, y el tiempo esperado de ocupación en cada estado[31]. En este estudio nos limitamos a estimar la esperanza de vida marginal total, esperanza de vida marginal en estado saludable (estado "1") y esperanza de vida marginal en estado no saludable (estado "2"). Este paquete estima la esperanza de vida según las variables de estudio (sexo, educación, participación social y arreglos de convivencia) por medio de regresión multinomial sobre las prevalencias de estados basales. Por último, los intervalos de confianza fueron calculados utilizando simulaciones basados en la estimación de la "maximum likelihood"[32].

Análisis estadístico

Las variables de estudio fueron incorporadas a partir de la formulación de cuatro modelos de supervivencia de tres estados. Las covariables incluidas en los modelos son: Edad, como variable

[30] El "hazard" es entendido como la probabilidad instantánea de ocurrencia de un evento por cada unidad de tiempo. En este estudio el hazard de las transiciones entre estados de salud sobre la escala de edad es entendido como la probabilidad instantánea de experimentar un estado "j", a la edad "y" condicionado a que el individuo estuvo previamente en un estado "i" a la edad "x".

[31] El tiempo esperado en un estado específico sería, por ejemplo: la esperanza de vida de una persona que comenzó el tiempo de observación en estado saludable de continuar en el estado saludable. Otra esperanza específica sería la esperanza de vida de una persona en estado saludable de transitar a un estado no saludable.

[32] *Maximum likelihood* es la probabilidad máxima de ocurrencia de un evento que se calcula por medio de la maximización de integrales que combinan todas las situaciones posibles. Es utilizada generalmente para estimar probabilidades de transición paramétricas. Para más información sobre su cálculo en las estimaciones de esperanza de vida, ver Van den Hout (327).

continua, sexo, educación, participación social y arreglos de convivencia como variables "dummies". El primer modelo incluye la edad y el sexo como variables explicativas, siendo la categoría de referencia "hombres". El segundo modelo incorpora la educación al modelo, la categoría de referencia refiere a los estudios primarios o menos (sin estudios). El tercer modelo incluye la variable de participación social, cuya categoría de referencia es no tener ninguna participación social. El cuarto y último modelo incluye la variable de arreglos de convivencia, siendo la categoría de referencia "convivencia solo en pareja". El segundo, tercer y cuarto modelo incluyen sexo y edad como variable de control, mientras que el tercer y cuarto modelo incluyen igualmente la variable de control de educación.

Cada uno de los modelos comprende cuatro posibles tipos de probabilidades de transición entre los tres estados estudiados: saludable, no saludable y muerte, estados que, recordemos codificamos como estados "1", "2" y "3", respectivamente. La probabilidad de un estado "1" al estado "2" es un deterioro. La probabilidad de ocurrencia entre el estado "2" el estado "1" corresponde a una mejora de salud. Y la probabilidad desde el estado "1" al estado "3" y desde el estado "2" al estado "3" son probabilidades de muerte desde un estado saludable y desde un estado no saludable, respectivamente. Obsérvese que la probabilidad de muerte desde un estado saludable puede incluir una transición no observada al otro estado intermedio (no saludable) porque los intervalos de tiempo entre las encuestas son los suficientemente grandes para permitir estados latentes que no fueron observados (327). Pero el caso inverso se puede producir también, de una transición del estado no saludable a la muerte que esconde una transición durante el intervalo al estado saludable, sin embargo en el proceso de la funcionalidad, el recorrido más usual es la transición desde saludable a un empeoramiento de la salud (3).

Por último, las estimaciones de las esperanzas de vida según variables explicativas se realizaron tomando las prevalencias de las variables en la línea basal. Las esperanzas de vida se estimaron desde los 60 años hasta los 90 años, con sus respectivos intervalos de confianza por medio de simulaciones (25 replicaciones). Sin embargo, sólo se explican ampliamente los resultados obtenidos de la esperanza de vida a los 60 años para facilitar la comparación entre países y el efecto de las variables explicativas de estudio: sexo, educación, arreglos de convivencia y participación social, los cuales se observan en las TABLAS 4.4, 4.5, 4.6 y 4.7.

4.3. Resultados

Composición de la Población

La población de los tres países en la línea basal ilustra diferencias en la composición etaria de las personas mayores entre los países; Costa Rica concentra la población con edades más longevas;

alrededor del 40% tiene 80 años o más y, como es de esperarse, estas personas pertenecen a las cohortes más antiguas. Le sigue España; con un porcentaje de octogenarios y más del 20%. En cambio, Chile concentra un contingente poblacional más joven ;70% de la población está en el rango de edades de 60-70 y apenas un 9% de población mayor de 80 años y más. Es conveniente recordar que el porcentaje de población en Costa Rica de 80 años y más, incluye una sobre representación de la muestra de personas de 90 años y más que no refleja la real composición de la población En Costa Rica.

Los tres países muestran un perfil educativo caracterizado principalmente por estudios de primaria o menos (alrededor de más del 60%), siendo Costa Rica el país con mayor porcentaje de este nivel educativo (87%) y Chile con más población instruida, en número relativos (38% con estudios secundarios o más) y menor proporción de personas mayores sin estudios. En particular, se observa el más alto porcentaje de población sin estudios en España 31%, comparado con un 8% en Chile y un 20% en Costa Rica.

TABLE 4. 1.- Chile, Costa Rica y España: Distribución de la Población de 60 años y más, según grupos quinquenales, nivel educativo, participación social y arreglos de convivencia.

Indicadores Demográficos	Chile (EPS)	%	Costa Rica (CRELES)	%	España (SHARE)	%
Población 60+	5.238	100,0%	2.631	100,0%	5.068	100,0%
Sexo						
Hombres	2.605	49,7%	1.199	45,6%	2.403	47,4%
Mujeres	2.633	50,3%	1.428	54,3%	2.665	52,6%
Grupos de edad						
[60,65)	2.528	48,3%	291	11,1%	1.118	22,1%
[65,70)	1.023	19,5%	448	17,0%	1.026	20,2%
[70,75)	697	13,3%	448	17,0%	954	18,8%
[75,80)	494	9,4%	432	16,4%	845	16,7%
[80,85)	279	5,3%	403	15,3%	610	12,0%
[85,90)	149	2,8%	321	12,2%	368	7,3%
[90,+)	68	1,3%	288	10,9%	147	2,9%
Cohorte de nacimiento						
[1895,1915)	63	1,2%	245	9,3%	51	1,0%
[1915,1920)	146	2,8%	273	10,4%	118	2,3%
[1920,1925)	267	5,1%	398	15,1%	357	7,0%
[1925,1930)	479	9,1%	419	15,9%	623	12,3%
[1930,1935)	686	13,1%	446	17,0%	908	17,9%
[1935,1940)	870	16,6%	444	16,9%	873	17,2%
[1940,1945)	1.140	21,8%	399	15,2%	996	19,7%
[1945,1950)	883	16,9%	7	0,3%	719	14,2%
[1950,+)	704	13,4%	-		423	8,3%
Educación						
Sin estudios	426	8,1%	532	20,2%	1.562	30,8%
Primaria	2.791	53,3%	1.761	66,9%	1.972	38,9%
Secundaria	1.614	30,8%	189	7,2%	1.040	20,5%
Terciaria	372	7,1%	149	5,7%	332	6,6%
Otros	-		-		17	0,3%
N/R	35	0,7%			145	2,9%
Participación Social						
Con participación	1.898	36,2%	1.117	42,5%	2.126	41,9%
Sin participación	2.835	54,1%	845	32,1%	2.793	55,1%
N/R[1]	505	9,6%	669	25,4%	149	2,9%
Hombres, Arreglos de convivencia	2.605		1.199		2.403	
Viviendo en pareja	379	14,5%	280	23,4%	1.401	58,3%
Viviendo con pareja y otros	1.600	61,4%	509	42,5%	624	26,0%
Viviendo con otros	447	17,2%	257	21,4%	171	7,1%
Viviendo en solitario	179	6,9%	153	12,8%	207	8,6%
Mujeres, Arreglos de convivencia	2.633		1.428		2.665	
Viviendo en pareja	286	10,9%	162	11,3%	1.246	46,8%
Viviendo con pareja y otros	887	33,7%	339	23,7%	471	17,7%
Viviendo con otros	1.207	45,8%	756	52,9%	440	16,5%
Viviendo en solitario	253	9,6%	171	12,0%	508	19,1%

[1] En Costa Rica a la población que poseia proxy no se le preguntó por su participación en actividades sociales

Se observa un diferencial educativo entre hombres y mujeres (Ver TABLA 4.2) en España, muestra una mayor escolaridad para los hombres (estudios secundarios o más) mientras que las mujeres tienen mayor porcentaje de la categoría sin estudios y estudios primarios. El resto de los países no mostraron importantes diferencias en este indicador por sexo.

TABLE 4. 2.- Chile, Costa Rica y España: Población de 60 años y más, por sexo y nivel educativo.

Nivel Educativo	Chile (EPS)	%	Costa Rica (CRELES)	%	España (SHARE)	%
	5.238	100,0%	2.631	100,0%	5.068	100,0%
Hombres	2.605		1.202		2.403	
Sin estudio	205	7,87%	263	21,9%	664	27,63%
Primaria	1.397	53,63%	779	64,8%	887	36,91%
Secundaria	793	30,44%	89	7,4%	581	24,18%
Terciaria	192	7,37%	71	5,9%	193	8,03%
Otros					9	0,37%
N/R	18	0,69%			69	2,87%
Mujeres	2.633		1.429		2.665	
Sin estudio	221	8,39%	269	18,82%	898	33,70%
Primaria	1.394	52,94%	982	68,72%	1.085	40,71%
Secundaria	821	31,18%	100	7,00%	459	17,22%
Terciaria	180	6,84%	78	5,46%	139	5,22%
Otros					8	0,30%
N/R	17	0,65%			76	2,85%

Con respecto a la participación social, Costa Rica y España tienen los porcentajes más altos de participación en actividades sociales, y Costa Rica tiene el porcentaje más alto de no respuesta (25%) a esta pregunta[33]. No obstante, se aprecia que, dentro de los países, es más frecuente la no participación en actividades sociales en Chile y España (en el primero hay un 54% de no participación versus un 36% de participación y en España un 55% versus un 42%) mientras que en Costa Rica hay una tendencia a la participación social (32% versus 42%).

El patrón de convivencia de la población ilustra diferencias importantes entre los países; en los países de América Latina estudiados, las mujeres mayores conviven en su mayoría con otros (hijos y/o otros parientes) y los hombres co-residen mayoritariamente en hogares extendidos (pareja y otros), en

[33] La pregunta de participación social en Costa Rica excluyó a las personas mayores que tenían proxis.

España tanto las mujeres y los hombres mayores conviven principalmente con la pareja (hogar de dos). Respecto a los mayores que viven en solitario, se observan dos casos opuestos; en Costa Rica hay un porcentaje similar entre hombres y mujeres, mientras que, en España, el porcentaje de mujeres que viven en solitario duplica con creces el porcentaje de hombres en solitario. Estos resultados corresponden con estudios previos sobre la composición del hogar en América Latina (60,61,75) y en el sur de Europa (46,50,245).

Efecto de las variables explicativas

Los efectos de las variables de estudio sobre las distintas transiciones de salud en estudio (deterioro, mejoras de salud y mortalidad) se ilustran en la TABLA 4.3. Los resultados incluyen el intervalo de confianza y la loglikelihood del ajuste de los modelos. La tabla tiene resultados para los cuatro modelos con los correspondientes "hazard ratios" para la edad, el sexo, la educación, la participación social y los arreglos de convivencia de las personas mayores de 60 años en Chile, Costa Rica y España.

Edad cronológica

El efecto de las transiciones de salud de las personas mayores entre diferentes estados en observan en la siguiente TABLA (4.3). El modelo Nº1 con la inclusión de edad y sexo muestra valores similares en los tres países para las tres transiciones de salud con diferencias significativas ($p<0.05$); con cada incremento anual de edad existe una probabilidad de deterioro de 5-7%. Mientras que, en mejoras de salud, se aprecia una menor propensión de mejoras de salud al incrementar la edad, siendo igual la probabilidad en Chile y España (HR:.96) y un poco más pronunciada en Costa Rica (HR.93).

En lo referente a la mortalidad, el riesgo de morir de los adultos mayores desde un estado saludable y no saludable incrementa con la edad en los tres países de estudio; el riesgo desde un estado no saludable es ligeramente superior en España (HR: 1.10) y similar en Chile y Costa Rica(HR:1.07). La probabilidad de morir desde un estado saludable presenta valores similares al riesgo de mortalidad desde no saludable.

Sexo

El riesgo de las mujeres respecto a los hombres en cada una de las transiciones muestra un perfil general; las mujeres mayores de 60 años son más propensas que los hombres a experimentar un deterioro en su salud, tienen menor probabilidad de tener mejoras de salud y experimentan un riesgo de morir inferior que sus contrapartes masculinas. Los modelos para cada uno de los países indican que las mujeres en Chile y en Costa Rica tiene un riesgo de deterioro de 32-35% más que los hombres y en España este riesgo es superior, alcanzando más del 50%.

En mejoras de salud, las mujeres mayores en Costa Rica tienen la menor probabilidad de tener cambios favorables en su salud; 26% menos mejoras de salud que los hombres (HR:.74). Mientras que, en España y Chile, esta probabilidad es menos pronunciada; 16% en España y un incipiente 2% en Chile.

El riesgo de mortalidad para las mujeres mayores es siempre menor que el reportado para los hombres en los tres países. No obstante, en Costa Rica, el diferencial de mortalidad entre hombres y mujeres es mucho menor que el observado en los otros dos países; la probabilidad de morir para las mujeres mayores desde un estado no saludable es 10% inferior que el riesgo de los hombres mayores, mientras que, en Chile y España, este riesgo refleja un 35% (HR:.65) y 48%(HR:.52). Por último, la probabilidad de morir para las mujeres desde un estado saludable en los tres países muestra cifras similares que rondan entre 40-50% por debajo del riesgo que los hombres (Chile, HR:.51; Costa Rica y España, HR:.60).

Educación

Tener mayor educación (secundaria o más), respecto a lo que tienen primaria o menos, reportó disminuir el riesgo de deterioro, aumentar las mejoras de salud (excluyendo España) y, respecto a la mortalidad se aprecian diferencias en la direccionalidad y magnitud del efecto de la educación en las transiciones de salud. Las personas mayores con más instrucción en Costa Rica reportaron un riesgo de deterioro 20% inferior que las personas mayores con menor educación (HR:.79). Sin embargo, la magnitud del efecto que tiene la educación sobre la disminución del deterioro es inferior en los otros dos países; 6-16% menos deterioro en Chile y en España (HR:.86 y HR:.94, respectivamente).

En cuanto a mejoras de salud, se observa que en Costa Rica los mayores con más educación tienen la mayor probabilidad de tener progresos de salud (alrededor del 60%), entretanto estos mayores en Chile sólo reportan un 3% más de mejoras de salud y en España prácticamente no existen diferencias en las transiciones de salud entre niveles educativos (HR:.99).

El riesgo de mortalidad en los mayores más educados respecto a los que tienen primaria o menos es particularmente inferior en Costa Rica (HR:.82) para los que mueren desde un estado no saludable. Sin embargo, el riesgo de morir para estos mayores desde el estado no saludable, que es usualmente la transición más frecuente descrita en el proceso de discapacidad, reporta no tener diferencias importantes en Chile y en España, en tanto que en Costa Rica los mayores con estudios secundarios muestran una mayor mortalidad (HR:1.06) pero sin ser significativas las diferencias respecto a las personas con estudios primarios o menos.

Participación social

El modelo con la inclusión de la participación social reportó el mejor ajuste (mayor disminución de la loglikelihood) en comparación con el resto de los modelos. La participación en actividades sociales en las personas mayores disminuye el deterioro (excluyendo Chile), aumenta los progresos en salud y retrasa el riesgo de mortalidad en los tres países con diferencias significativas. En chile no se observó que la participación tuviera algún efecto en la transición al deterioro. En Costa Rica, los mayores con participación tienen un 24% menos riesgo de tener un empeoramiento de salud que los que no participan, mientras que la participación en actividades sociales en España, sólo reduce este riesgo un 6% en las personas mayores.

En cuanto las mejoras de salud, se observa que, en los tres países, la participación incrementa los progresos en la salud, siendo esta asociación más pronunciada en Costa Rica (HR:1.80) y con menor intensidad en chile (HR:1.07). Por último, el riesgo de mortalidad se reduce de un 3% en Chile a un 6% en España, en tanto que en Costa Rica los mayores que participan tienen 40% menos mortalidad que los que no participan.

TABLE 4. 3.- Hazards Ratios e intervalos de confianza para las variables de estudio sobre las transiciones de salud de las personas mayores de 60 años.

Fuente	EPS		CRELES		SHARE	
Modelo 1: Edad y sexo	Chile (n=5.238)		Costa Rica (n=2.631)		España (n=5.068)	
Edad	HR	95 % IC	HR	95 % IC	HR	95 % IC
State 1 - State 2	1,06	(1,05 - 1,07) *	1,05	(1,04 - 1,06) *	1,07	(1,06 - 1,08) *
State 2 - State 1	0,96	(0,95 - 0,97) *	0,93	(0,92 - 0,94) *	0,96	(0,95 - 0,96) *
State 1 - State 3	1,09	(1,08 - 1,10) *	1,06	(1,04 - 1,09) *	1,10	(1,08 - 1,11) *
State 2 - State 3	1,07	(1,06 - 1,08) *	1,07	(1,06 - 1,08) *	1,09	(1,08 - 1,10) *
Sexo						
Hombres (ref)	HR	95 % IC	HR	95 % IC	HR	95 % IC
Mujeres						
State 1 - State 2	1,32	(1,31 - 1,32) *	1,35	(1,33 - 1,36) *	1,52	(1,51 - 1,53) *
State 2 - State 1	0,98	(0,97 - 1,00) *	0,74	(0,73 - 0,76) *	0,84	(0,83 - 0,85) *
State 1 - State 3	0,51	(0,50 - 0,52) *	0,60	(0,57 - 0,62) *	0,60	(0,59 - 0,62) *
State 2 - State 3	0,65	(0,65 - 0,65) *	0,90	(0,88 - 0,92) *	0,52	(0,52 - 0,52) *
-2*loglikelihood	27163.46		9149.86		25557.54	
Modelo 2 : Educación	Chile		Costa Rica		España	
Primaria o inferior (ref)	HR	95 % IC	HR	95 % IC	HR	95 % IC
Secundaria o superior						
State 1 - State 2	0,86	(0,85 - 0,86) *	0,79	(0,73 - 0,85) *	0,94	(0,94 - 0,94) *
State 2 - State 1	1,03	(1,02 - 1,03) *	1,58	(1,43 - 1,74) *	0,99	(0,99 - 0,99) *
State 1 - State 3	1,01	(1,01 - 1,01) *	0,82	(0,68 - 0,99) *	1,06	(1,06 - 1,07) *
State 2 - State 3	1,01	(1,00 - 1,02) *	1,06	(0,92 - 1,23)	0,99	(0,99 - 0,99) *
-2*loglikelihood	27147.04		9138.548		25545.22	
Modelo 3: Participación social	Chile		Costa Rica		España	
No tener participación social (ref)	HR	95 % IC	HR	95 % IC	HR	95 % IC
Tener participación social						
State 1 - State 2	1,00	(0,99 - 1,00)	0,76	(0,76 - 0,77) *	0,94	(0,93 - 0,94) *
State 2 - State 1	1,07	(1,06 - 1,08) *	1,80	(1,78 - 1,82) *	1,24	(1,23 - 1,24) *
State 1 - State 3	1,03	(1,01 - 1,04) *	0,87	(0,86 - 0,88) *	0,85	(0,85 - 0,86) *
State 2 - State 3	0,97	(0,95 - 0,99) *	0,60	(0,58 - 0,63) *	0,94	(0,94 - 0,94) *
-2*loglikelihood	27135.46		9027.711		25405.21	
Modelo 4: Arreglos de convivencia	Chile		Costa Rica		España	
Vivir solo con pareja (ref)	HR	95 % IC	HR	95 % IC	HR	95 % IC
Vivir con pareja y otros						
State 1 - State 2	0,98	(0,97 - 0,99) *	1,01	(1,01 - 1,01) *	1,03	(1,03 - 1,04) *
State 2 - State 1	1,00	(0,98 - 1,02)	1,00	(0,98 - 1,02)	0,94	(0,94 - 0,95) *
State 1 - State 3	1,09	(1,07 - 1,11) *	1,26	(1,23 - 1,28) *	1,14	(1,13 - 1,14) *
State 2 - State 3	1,08	(1,06 - 1,10) *	0,95	(0,94 - 0,97) *	1,05	(1,04 - 1,06) *
Vivir con otros (sin pareja)						
State 1 - State 2	0,96	(0,96 - 0,96) *	1,02	(1,01 - 1,04) *	1,06	(1,04 - 1,09) *
State 2 - State 1	0,99	(0,99 - 1,00) *	1,00	(1,00 - 1,01)	0,89	(0,86 - 0,92) *
State 1 - State 3	1,19	(1,19 - 1,20) *	1,58	(1,55 - 1,60) *	1,29	(1,25 - 1,34) *
State 2 - State 3	1,16	(1,15 - 1,18) *	0,91	(0,91 - 0,91) *	1,10	(1,06 - 1,15) *
Vivir solo						
State 1 - State 2	0,93	(0,91 - 0,96) *	1,03	(0,98 - 1,08)	1,10	(1,04 - 1,16) *
State 2 - State 1	0,99	(0,93 - 1,06)	1,00	(0,94 - 1,06)	0,84	(0,78 - 0,90) *
State 1 - State 3	1,30	(1,25 - 1,36) *	1,98	(1,80 - 2,17) *	1,47	(1,36 - 1,59) *
State 2 - State 3	1,16	(1,26 - 1,36) *	0,86	(0,83 - 0,90) *	1,16	(1,08 - 1,25) *
-2*loglikelihood	27140.63		9117.157		25527.56	

Nota: Los modelos Nº 3 y 4 incluyen las variables control: edad, sexo y educación.El modelo Nº2 sólo incluye las variables edad y sexo.

* Significancia p<0,05

Arreglos de convivencia

Los arreglos de convivencia ilustraron varios efectos sobre las transiciones de salud dentro de cada uno de los países de estudio, pero en general esta variable no mostró diferencias resaltantes sobre las transiciones de salud en los países de Latinoamérica, no siendo así en España; en Chile no se mostró un efecto importante entre los diferentes grupos de arreglos de convivencia sobre la probabilidad de mejoras de salud.

Sin embargo, los mayores que viven solamente en pareja reportaron tener mayor deterioro que cualquier otra forma de convivencia (vivir con pareja y otros, HR:.98; vivir con otros, HR:.96 o vivir en solitario, HR:.93) y también menor mortalidad. En Costa Rica los arreglos de convivencia sólo mostraron relevancia en la mortalidad; existe un mayor riesgo de morir en los mayores que viven en pareja en comparación con los demás arreglos de convivencia. Y, por último, en España, se aprecia que vivir en pareja aumenta las mejorías de salud, retrasa el deterioro y disminuye el riesgo de mortalidad en los mayores de 60 años.

Esperanza de vida total según sexo, educación, participación social y arreglos de convivencia.

Diferencias de esperanza de vida entre países

Los resultados de las estimaciones de esperanza de vida de los 60-90 años por país se muestran en la FIGURA 4.1 y los valores a los 60 años se muestran en la TABLA 4.4. Al comparar la esperanza de vida total para las mujeres a partir de los sesenta años en los tres países se aprecia un año más de esperanza de vida y más años en buena salud (cuatro años) en España que los otros dos países. Las mujeres mayores de los dos países latinoamericanos tienen un perfil similar y concentran menor número de años que las mujeres mayores en España.

TABLE 4. 4.- Esperanza de vida, años de vida en buena salud y años de vida en mala salud por sexo, según países. Chile, Costa Rica y España.

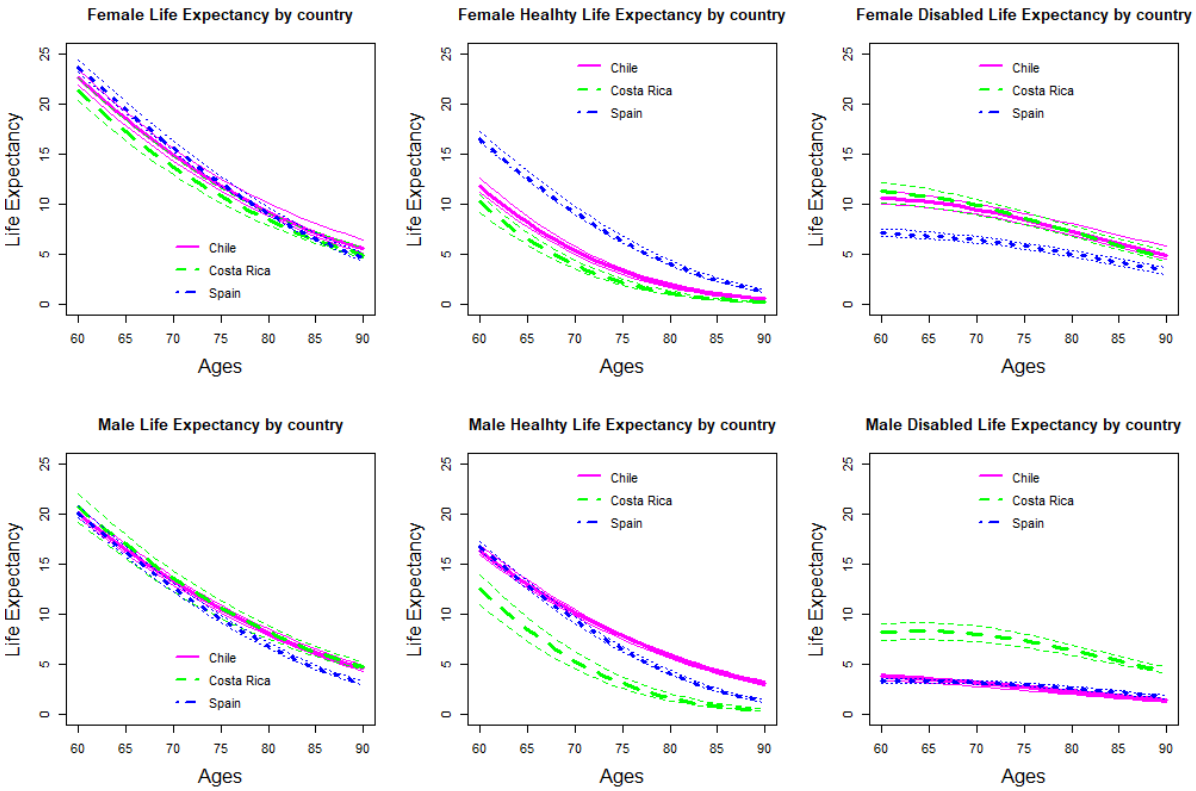
País	Esperanza	Mujeres	(95% IC)	Hombres	(95% IC)	% Años saludables	
	TLE 60	22,91	(22,03 - 23,89)	18,32	(17,51 - 18,94)	**Mujeres**	**Hombres**
Chile	HLE 60	12,02	(11,39 - 12,81)	10,59	(9,78 - 11,29)	52,47%	57,82%
	DLE 60	10,89	(10,20 - 11,49)	7,73	(6,97 - 8,27)		
	TLE 60	21,82	(20,57 - 22,66)	20,94	(19,02 - 22,06)		
Costa Rica	HLE 60	10,29	(9,42 - 12,89)	12,46	(10,73 - 13,6)	47,16%	59,50%
	DLE 60	11,54	(10,13 - 12,89)	8,48	(7,31 - 9,29)		
	TLE 60	23,88	(23,31 - 24,36)	20,46	(19,96 - 20,91)		
España	HLE 60	16,74	(16,24 - 17,19)	16,91	(16,64 - 17,45)	70,10%	82,65%
	DLE 60	7,15	(6,83 - 7,56)	3,42	(3,32 - 3,69)		

TLE: Esperanza de vida total; HLE: Esperanza de vida en salud;DLE: esperanza de vida en mala salud

Sin embargo, en el caso de los hombres hay un patrón diferente; los hombres en Costa Rica tienen mayor esperanza de vida que los hombres en España y en Chile, aunque esta mayor longevidad de los hombres mayores costarricenses concentra mayor número de años en mala salud que lo observado en los hombres mayores en Chile y en España.

La esperanza de vida a edades avanzadas (80+) muestra una tendencia a la convergencia entre los tres países, sin embargo, se observa en la composición de la población que existe poca población después de los 80 años lo que dificulta poder estimar un patrón robusto de la esperanza de vida en los últimos grupos de edades.

FIGURA 4. 1.- Estimación de la Esperanza de vida en las edades 60-90, años de vida en buena salud y años de vida en mala salud para hombres y mujeres. Chile, Costa Rica y España



Note: Life expected calculated with "msm" and "elect" R packages, 25 simulaciones.

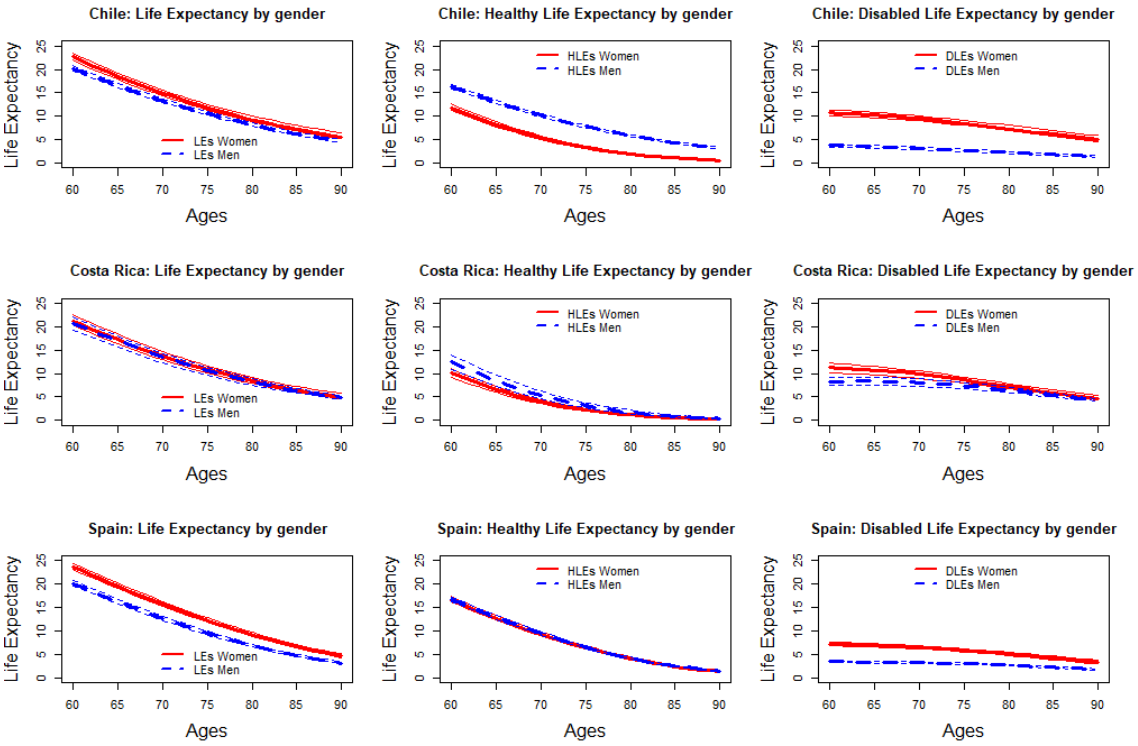
En general, se aprecia que las personas mayores en Costa Rica, reportan más años en mala salud y menor número de años en buena salud respecto a Chile y España, patrón que se repite tanto para hombres y mujeres; las mujeres de 60 años costarricenses vivirán menos del 50% de su vida restante en un estado saludable mientras que los hombres lo harán en un 40%.

Por otro lado, se observan similitudes en los años en buena salud entre las mujeres en Chile y Costa Rica, en tanto que, los hombres en Chile y España tienen un perfil de trayectorias funcionales parecido.

Diferencias de años de vida por sexo entre países

La estimación de la esperanza de vida por sexo desde los 60 hasta los 90 años dentro de cada uno de los países ilustra una disminución de la brecha de años entre hombres y mujeres a edades muy longevas. Las mujeres mayores tienen mayor esperanza de vida que los hombres mayores con la excepción de Costa Rica; país donde los mayores prácticamente no muestran diferencias en el número de años total de vida por sexo. Sin embargo, las diferencias persisten en los años en buena salud; los hombres tienen aproximadamente dos años más de buena salud que las mujeres y éstas tienen tres años más en mala salud.

FIGURA 4. 2.- Estimación de la Esperanza de vida en las edades 60-90, años de vida en buena salud y años de vida en mala salud por sexo dentro de cada país. Chile, Costa Rica y España.



Note: Life expected calculated with "msm" and "elect" R packages, 25 simulaciones.

En Chile y España, las mujeres mayores viven más que los hombres y ellas también muestran más años en mala salud. No obstante, las personas mayores en España ilustran igual esperanza de vida saludable tanto para hombres y mujeres, patrón no observado en los dos otros países.

Años de vida según años educativos

Las estimaciones por nivel educativo mostraron que la educación sólo tiene un efecto relevante en la esperanza de vida de los mayores en Costa Rica. Los datos de Chile y España mostraron que los mayores indistintamente de su nivel educativo comparten similares años de esperanza vida total. La pequeña diferencia existente equivale a una fracción de más años en buena salud para los mayores más instruidos (aproximadamente 0,70 en las mujeres chilenas y 0,50 en los hombres; en España la diferencia es inferior, 0,20 años).

TABLE 4. 5.- Esperanza de vida total, años de vida saludable y años de vida en mala salud por nivel educativo, sexo, según país; Chile, Costa Rica y España.

Sexo	Esperanza	Chile	(95% IC)	Costa Rica	(95% IC)	España	(95% IC)	% Años saludables		
								Chile	Costa Rica	España
Mujeres 60+	TLE Primaria o menos	22,85	(22,08 - 23,54)	21,61	(20,07 - 22,98)	23,96	(23,08 - 24,46)			
	TLE Secundaria o más	23,01	(21,92 - 23,73)	23,27	(20,89 - 25,73)	23,85	(22,98 - 24,48)			
	HLE Primaria o menos	11,74	(11,0 - 12,48)	9,73	(8,53 - 11,05)	16,68	(16,01 - 17,31)	51,4%	45,0%	69,6%
	HLE Secundaria o más	12,52	(11,5 - 13,27)	13,77	(11,3 - 16,00)	16,84	(16,2 - 17,54)	54,4%	59,2%	70,6%
	DLE Primaria o menos	11,11	(10,3 - 11,78)	11,87	(10,42 - 13,36)	7,27	(6,67 - 7,59)			
	DLE Secundaria o más	10,48	(9,85 - 11,11)	9,50	(7,58 - 11,72)	7,01	(6,53 - 7,44)			
Hombres 60+	TLE Primaria o menos	18,29	(17,24 - 19,62)	20,7	(19,28 - 22,44)	20,45	(19,58 - 20,73)			
	TLE Secundaria o más	18,35	(17,39 - 19,32)	22,44	(20,10 - 25,47)	20,25	(19,85 - 20,98)			
	HLE Primaria o menos	10,40	(9,24 - 11,45)	11,91	(10,98 - 13,64)	16,94	(16,14 - 17,3)	56,9%	57,5%	82,8%
	HLE Secundaria o más	10,91	(10,2 - 11,69)	15,79	(13,38 - 18,43)	16,91	(16,57 - 17,52)	59,5%	70,4%	83,5%
	DLE Primaria o menos	7,88	(7,12 - 8,41)	8,79	(7,19 - 10,09)	3,5	(3,26 - 3,91)			
	DLE Secundaria o más	7,88	(6,91 - 7,95)	6,65	(5,09 - 8,31)	3,33	(3,03 - 3,61)			

TLE: Esperanza de vida total; HLE: Esperanza de vida en salud;DLE: esperanza de vida en mala salud

En Costa Rica, por el contrario, se evidencia una brecha importante entre niveles educativos de los años esperados de vida a los 60 años; en esperanza de vida total existe un diferencial de 1,66 años para las mujeres y una brecha un poco superior para los hombres (1,74 años). Sin embargo, aunque se aprecia que las mujeres y hombres más instruidos de 60 años en Costa Rica tendrán aproximadamente 4 años más de años saludables que las mujeres y hombres con menor instrucción, los hombres con más educación reportan ganar más porcentaje de años en buena salud que las mujeres. Diferencial que se mantiene con diferencias significativas hasta los 80 años para ambos sexos (ver ANEXO 4.2 y 4.3)

Años de vida según participación social

Se estimaron las esperanzas de vida para los mayores de 60 años con estudios primarios (población mayoritaria entre los mayores) según participación social para cada país de estudio. Los resultados ilustran que la participación social incrementa la esperanza de vida en los tres países con diferentes magnitudes; los mayores en Costa Rica ilustran un incremento de seis años para las mujeres y 5 años para los hombres en la esperanza de vida, seguido por los mayores en España, quienes tienen un año más de vida para ambos sexos. En Chile, por el contrario, la contribución en la esperanza de vida de participar en alguna actividad sólo mostró el aumento de una pequeña fracción (0,20) de año para ambos sexos.

TABLE 4. 6.- Esperanza de vida total, años de vida saludable y años de vida en mala salud por participación social y sexo, según país; Chile, Costa Rica y España

Sexo	Esperanza de vida	Chile (95% IC)	Costa Rica (95% IC)	España (95% IC)	% Años saludables		
					Chile	Costa Rica	España
Mujeres 60+	TLE con participación	23,19 (22,13 - 24,11)	28,20 (25,50 - 29,21)	25,05 (24,36 - 25,53)			
	TLE sin participación	22,94 (22,31 - 23,80)	21,86 (20,32 - 23,00)	23,90 (23,29 - 24,48)			
	HLE con participación	12,43 (11,4 - 13,4)	14,05 (12,48 - 15,10)	17,86 (17,36 - 18,36)	54%	50%	71%
	HLE sin participación	11,99 (11,3 - 12,8)	8,06 (7,38 - 9,10)	16,41 (15,88 - 17)	52%	37%	69%
	DLE con participación	10,76 (10,02 - 11,6)	14,15 (12,15 - 15,61)	7,2 (6,64 - 7,75)			
	DLE sin participación	10,94 (10,25 - 11,5)	13,80 (12,24 - 14,83)	7,49 (6,96 - 7,9)			
Hombres 60+	TLE con participación	18,59 (17,77 - 19,35)	25,61 (23 - 27,75)	21,47 (20,61 - 22,25)			
	TLE sin participación	18,42 (17,55 - 19,28)	20,79 (20,60 - 21,82)	20,25 (19,77 - 20,94)			
	HLE con participación	11,05 (10,12 - 12,1)	16,36 (14,68 - 17,87)	18,04 (17,28 - 18,55)	59%	64%	84%
	HLE sin participación	10,69 (9,81 - 11,6)	10,58 (9,16 - 11,98)	16,65 (16,19 - 17,3)	58%	51%	82%
	DLE con participación	7,54 (6,93 - 8,15)	9,24 (7,46 - 10,55)	3,43 (3,04 - 3,84)			
	DLE sin participación	7,73 (6,81 - 8,28)	10,21 (8,96 - 11,25)	3,59 (3,26 - 3,83)			

TLE: Esperanza de vida total; HLE: Esperanza de vida en salud;DLE: esperanza de vida en mala salud

Por consiguiente, este aumento de años de vida significó mayor duración de la vida en buena salud en la población de 60 años en los países; en Costa Rica, la participación social incrementó los años de vida en esta población en aproximadamente seis años tanto para hombres y mujeres. Mientras que, este incremento fue inferior pero sustancial en España; las mujeres y hombres participes en actividades sociales tienen aproximadamente un 1,5 más años en buena salud que los que no participan (3% y 2% más años saludables, correspondientemente). En cuanto a Chile, las personas mayores en ese país apenan incrementaron sus años en buena salud en una pequeña fracción (0,30 en hombres y 0,40 en mujeres).

Años de vida según arreglos de convivencia

La esperanza de vida según el patrón de convivencia entre los tres países de estudio indicó diferencias en la incidencia de estos patrones sobre la salud. En Chile, los mayores que viven en pareja y otros (hogar extendido) reportan la mayor esperanza de vida a los 60 años tanto hombres y mujeres. En Costa Rica las mujeres mayores reportan una esperanza de vida prácticamente sin variaciones según arreglos de convivencia, sin embargo, los hombres mayores reflejan variaciones en la supervivencia; los que viven en pareja tienen mayor longevidad que otra forma de convivencia. España por otro lado, muestra que los mayores que viven solamente con la pareja tienen mayor supervivencia que los demás arreglos de convivencia, sin distinción del sexo.

TABLE 4. 7.- Esperanza de vida total, años de vida saludable y años de vida en mala salud según arreglos de convivencia y sexo, por país; Chile, Costa Rica y España

Sexo	Esperanza de vida	Arreglos de convivencia	Chile	(95%IC)	Costa Rica	(95% IC)	España	(95% IC)	% Años saludables		
									Chile	Costa Rica	España
Mujeres 60+	Esperanza de vida total	Viviendo con pareja	24,11	(22,61 - 25,81)	21,65	(19,26 - 23,36)	24,90	(24,18 - 25,40)			
		Viviendo con pareja y otros	23,34	(22,41 - 24,84)	21,65	(20,65 - 22,82)	24,11	(23,66 - 24,56)			
		Viviendo con otros	22,58	(21,65 - 23,39)	21,58	(20,04 - 22,35)	23,32	(22,66 - 23,90)			
		viviendo solo	21,82	(21,10 - 23,02)	21,41	(19,66 - 22,75)	22,54	(21,63 - 23,40)			
	Esperanza de vida en años *saludables*	Viviendo con pareja	12,08	(10,50 - 13,38)	9,98	(7,98 - 12,42)	17,42	(16,6 - 17,98)	50,1%	46,1%	70,0%
		Viviendo con pareja y otros	11,87	(11,07 - 12,87)	9,84	(8,69 - 11,23)	16,74	(16,23 - 17,28)	50,9%	45,5%	69,4%
		Viviendo con otros	11,64	(11,19 - 12,43)	9,66	(8,20 - 10,38)	16,06	(15,41 - 16,65)	51,6%	44,8%	68,9%
		viviendo solo	11,40	(10,46 - 12,91)	9,44	(7,91 - 11,45)	15,4	(14,75 - 16,36)	52,2%	44,1%	68,3%
	Esperanza de vida en años *no saludables*	Viviendo con pareja	12,03	(11,08 - 13,71)	11,67	(9,95 - 13,34)	7,48	(6,98 - 8,07)			
		Viviendo con pareja y otros	11,47	(10,33 - 12,66)	11,82	(11,16 - 13,34)	7,37	(7,01 - 7,74)			
		Viviendo con otros	10,94	(9,84 - 11,71)	11,92	(10,70 - 12,95)	7,26	(6,66 - 7,53)			
		viviendo solo	10,42	(9,53 - 11,44)	11,97	(10,6 - 13,59)	7,14	(6,42 - 7,59)			
Hombres 60+	Esperanza de vida total	Viviendo con pareja	19,09	(18,22 - 20,25)	21,32	(19,09 - 22,96)	20,96	(20,17 - 21,79)			
		Viviendo con pareja y otros	18,36	(17,54 - 18,99)	20,85	(19,94 - 21,97)	20,10	(19,69 - 20,71)			
		Viviendo con otros	17,64	(16,53 - 18,47)	20,24	(18,71 - 21,81)	19,25	(18,17 - 19,89)			
		viviendo solo	16,93	(15,43 - 17,98)	19,49	(18,05 - 21,54)	18,41	(17,26 - 18,99)			
	Esperanza de vida en años *saludables*	Viviendo con pareja	10,78	(9,74 - 11,7)	12,41	(10,6 - 13,73)	17,4	(16,66 - 18,14)	56,5%	58,2%	83,0%
		Viviendo con pareja y otros	10,43	(9,70 - 11,04)	12,01	(10,71 - 13,76)	16,62	(16,09 - 17,28)	56,8%	57,6%	82,7%
		Viviendo con otros	10,08	(8,89 - 10,92)	11,53	(10,34 - 12,61)	15,84	(14,97 - 16,31)	57,1%	57,0%	82,3%
		viviendo solo	9,71	(8,23 - 10,48)	10,98	(9,80 - 12,30)	15,08	(14,10 - 15,74)	57,4%	56,3%	81,9%
	Esperanza de vida en años *no saludables*	Viviendo con pareja	8,31	(7,49 - 9,1)	8,90	(7,63 - 10,76)	3,56	(3,25 - 3,95)			
		Viviendo con pareja y otros	7,93	(7,34 - 8,62)	8,84	(7,42 - 9,53)	3,48	(3,16 - 3,85)			
		Viviendo con otros	7,56	(6,82 - 8,62)	8,71	(7,83 - 10,13)	3,41	(3,05 - 3,82)			
		viviendo solo	7,21	(5,87 - 8,31)	8,51	(6,96 - 10,26)	3,33	(2,83 - 3,75)			

Los años en buena salud según arreglos de convivencia varían y muestran, con cierta peculiaridad, que las personas mayores en Chile viviendo en solitario tienen mayor porcentaje de años en buena salud que los demás arreglos de convivencia, tanto para hombres como para mujeres. La forma de convivencia que le sigue con más porcentaje de años saludable es la co-residencia con otros, luego la convivencia con pareja y otros (que pudiera denotar la co-residencia en hogares extendidos) y por último la convivencia con la pareja. En Costa Rica y España, las personas mayores que conviven sólo en pareja tienen mayor porcentaje en buena salud comparado con las demás formas de convivencia.

4.4. Discusión

Este estudio comparativo de las trayectorias funcionales en Chile, Costa Rica y España, utilizando tres diferentes fuentes de datos y la aplicación de "multistate models" para la estimación de la esperanza de vida total, años de vida saludable y años en mala salud, provee nuevas evidencias de los diversos patrones de salud entre América Latina y Europa, considerando diferencias por sexo, nivel educativo, participación social y patrones de convivencia.

La mayor supervivencia de las mujeres es un elemento transversal entre los tres países de análisis; las mujeres siempre exhiben más años de vida que los hombres. La educación tiene un efecto diferencial en la supervivencia entre los países, sin embargo, en todos los países incide en el aumento de años

saludables. La participación social por otro lado, aumenta el porcentaje de años saludables en los tres países y al mismo tiempo, beneficia la supervivencia en las personas mayores de 60 años, principalmente en Costa Rica y, en menor medida, en España.

Por último, las distintas formas de arreglos de convivencia indicaron que la co-residencia con la pareja en las personas mayores incrementa la supervivencia en los tres países, sin embargo, hay un escenario diverso en el efecto que tienen los grupos de arreglos de convivencia en las trayectorias funcionales de las personas mayores.

Esperanza de vida por sexo entre países

Patrón general

La mayor supervivencia de las mujeres en los tres países latinoamericanos concentra menor porcentaje de años saludables que lo observado en España; las estimaciones ilustran que las mujeres chilenas después de los 60 años vivirán aproximadamente la mitad de los años que les quedan por vivir en buena salud y en igual proporción de tiempo en mala salud, mostrado en otros estudios (310). Mientras que las mujeres mayores en Costa Rica tendrán menos tiempo de vida saludable (47%). En tanto que las mujeres de la misma edad en el país de Europa del sur tendrán más del 70% (y los hombres más del 80%) de los años remanentes por vivir en buena salud.

El mayor porcentaje de años no saludables en las mujeres (respecto a los hombres) a pesar de su mayor supervivencia es un patrón general reportado en todos los países alrededor del mundo con datos disponibles (272,282,301,305,328). Por un lado; la sobresaliente longevidad de las mujeres se da por el rápido descenso de las tasas de mortalidad de las féminas (descenso de la mortalidad materna) en la primera fase de la transición de la mortalidad dando lugar a la feminización de la población mayor (329). Por otro lado, el mayor porcentaje en mala salud de las mujeres se explica principalmente por desigualdades socioeconómicas; las mujeres tienen peores salarios, menor participación en la actividad laboral y menor nivel educativo que los hombres (104,330–332), y por otro lado, otros estudios reportan que existen diferencias especificas por edad y sexo en comportamientos y estilos de vida, como ejemplo el consumo de tabaco, obesidad y el uso de medicamentos (310,333).

Diferencias entre y dentro de los países

En general, la población mayor de Costa Rica tiene un patrón particular, reporta una esperanza de vida a los 60 años similar entre hombres y mujeres (menos de un año de diferencia, ver TABLA 4.3) y muestra una supervivencia muy parecida a la española, la cual es considerada una de las más altas entre los países europeos (334). Esta alta supervivencia ha sido evidenciada en otros estudios

(321,335), los cuales identifican ciertas localidades que integran la llamada zona azul ,entre ellas la región de Nicoya en Costa Rica. Esta región comprende cinco cantones (Carrillo, Santa Cruz, Nicoya, Hojancha y parte de Nandayure), lugar donde existe una extrema longevidad en una localidad geográfica homogénea (336).

Nuestro estudio confirma que los hombres costarricenses tienen una ventaja en supervivencia sobre sus pares en Chile, y reporta niveles de longevidad cercanos con otros países del mundo en el top ranking de longevidad, incluyendo a España, Suecia, Canadá, Francia, Japón y Suiza (265,334). La mayor supervivencia masculina en Costa Rica trae como consecuencia una brecha por sexo en la esperanza de vida más corta que la observada en otros países como Japón (321) y Estados Unidos (337). No obstante, no se aprecia una situación favorable en las mujeres costarricenses; las mujeres de este país tienen los porcentajes más bajos de años saludables en comparación con los países aquí estudiados y también respecto a México, Puerto Rico y Estados Unidos (21).

La ventaja observada en España en cuanto a la esperanza de vida y los años de vida saludable de las mujeres respecto a Chile y Costa Rica, sobre todo en años saludables, podría deberse principalmente a un efecto de cohorte, sin embargo, no descartamos que existan otros elementos en escena como el tipo de alimentación, en especial la dieta mediterránea y el gasto público en el sistema nacional de salud de cada país. Sobre el primer aspecto, estudios apuntan que la reducción de la mortalidad y morbilidad es atribuible en gran mayoría a cambios en el ciclo de vida temprano (27,338,339). Este es el caso de las cohortes beneficiadas con las mejoras sanitarias y avances en la salud observadas durante la mitad de la década de los años 50´s. Los datos de las encuestas estudiadas ilustran, en Chile y España, una estructura de cohorte parecida (ver TABLA 4.1); las cohortes más antiguas (usualmente mujeres) son del mismo año de nacimiento mientras que las cohortes más antiguas de Costa Rica pertenecen a cohortes dos décadas más tempranas, cuando todavía no se experimentaba las mejoras sanitarias.

Referente al segundo aspecto, numerosos estudios apuntan a que la dieta mediterránea es considerada un factor importante en la reducción de la morbilidad y la mortalidad tanto para las capacidades funcionales (340) como para la salud mental (341). En contraste, en Chile, se muestran altas tasas de obesidad, lo que es más frecuentes en las mujeres, repercutiendo en la diferencia de años saludables entre hombres y mujeres (342)

En el tercer aspecto, se infiere que en España, los beneficios de la ampliación de la cobertura de salud, decretada universal y con gratuidad en 1986[34] (285), lo cual es extendido en gran parte de los países europeos (343), sigue mostrando sus beneficios sobre la salud de los mayores en España, posicionando este país en el grupo de países con mayor esperanza de vida. Estudios mostraron que para el periodo 1985-2000, en España hubo una compresión de la discapacidad sobre todo para las mujeres (344). De igual manera, en todos los países europeos, hubo un descenso de las tasas de mortalidad con diferentes intensidades y periodos, con excepción de los países de Europa del este, quienes no muestran información continua sobre defunciones, limitando la comparación de tendencias en un largo periodo (345). Tendencia que también es evidenciada en Estados unidos con una compresión de la mortalidad y morbilidad (31,32,99).

En contraste, los países de América Latina, en especial los que comprende este estudio, exhiben diferencias en el sistema de salud nacional, por lo que no es clara la contribución que tiene este sobre la esperanza de vida. En el caso de Chile, existe un sistema mixto de salud a partir de los años 80´s, compuesto por una parte pública denominada Fondo Nacional de Salud "FONASA" y otra parte privada, Instituciones de Salud Previsional "ISAPRES" (346). Aunque, la mayor parte de la cobertura es asumida por la parte pública, el Estado invierte relativamente poco en salud (287); la inversión del gasto público en el sistema de salud nacional no es lo suficientemente amplia para cubrir las necesidades de la población en materia de salud primaria y preferencial, siendo las personas de bajos recursos las menos favorecidas. Esto repercute en amplios diferenciales de los años en buena salud de la población adulta mayor chilena por grupos socioeconómicos (307) y para las mujeres, quienes reportan mayor desventaja socioeconómica, como es evidenciado en nuestro estudio con tasas más bajas de escolaridad que los hombres.

En tanto que, en Costa Rica, aunque, el sistema de atención sanitaria es universal y gratuito a partir de los 70´s (286) y tiene una percepción favorable sobre su funcionamiento (347,348), concentra importantes desigualdades territoriales en morbilidad y en el acceso de atención primaria (349). En Costa Rica al igual que en España concentran aproximadamente 20% de su población en zonas rurales mientras que Chile tiene 10% (350). En este sentido, el menor porcentaje de años saludables de las mujeres en Costa Rica, en comparación con los otros dos países, podría estar asociado con las desigualdades geográficas del acceso a la salud.

[34] con excepción del turismo

Educación y los años de vida saludable.

En nuestro estudio, la educación mostró tener mayor relevancia en Costa Rica que en los otros dos países. Los resultaron reportaron que la educación en este país tiene mayor efecto en las trayectorias funcionales que en la supervivencia; las personas mayores, tanto hombres como mujeres, con mayor nivel educativo tienen un incremento importante de sus años saludables y, con menor intensidad, una mayor supervivencia.

Los hombres y mujeres mayores costarricenses tendrán 4 años saludables adicionales y 2 años más de vida que los mayores menos instruidos. Sin embargo, los riesgos relativos de tener más educación versus lo que tienen menor instrucción en la mortalidad no arrojaron diferencias significativas en este país.

Estos resultados difieren de los encontrado en las personas mayores en Chile y España, quienes reportaron que la educación incrementa los años saludables, en una modesta proporción (alrededor del 3% en las mujeres y 2% en los hombres chilenos; y apenas un 1% en hombres y mujeres mayores españoles) y no se evidencia un aumento de la supervivencia; los mayores en estos dos países tienen una esperanza de vida similar entre niveles educativos para hombres y mujeres. Esto podría indicar que no hay diferencias en el acceso a la salud por nivel educativo de las personas mayores en estos dos países. Sin embargo, no se descartan otros factores como eventos de "*tempo"* (295) en el curso de vida que pudieran tergiversar los resultados.

Estudios que utilizan la misma fuente europea (20,183), mostraron que la educación es más importante para beneficios en las trayectorias de salud en las mujeres, mientras que en los hombres, la educación tiene un efecto más importante en el aumento de la supervivencia. Los resultados de nuestro estudio muestran diversos patrones; efectivamente la educación incrementa los años saludables y este efecto se da indistintamente tanto para hombres y mujeres. No obstante, en algunos países, este efecto es menos pronunciado y no tendrá incidencia en el retraso de la mortalidad como en el caso de chile y España.

Esto pudiera deberse a dos razones, la primera es que las prevalencias de estados de salud según la estructura educativa de las personas mayores particularmente pertenecientes cohortes nacidas después de ciertos periodos importantes (recesión económica o guerra) no presentan grandes diferencias como en la población española de 60 años y más. La mayoría de esta población pertenece a cohortes nacidas después de 1945-55, cohortes que experimentaron eventos en su ciclo de vida que no vivieron cohortes anteriores. Dichas cohortes fueron beneficiadas paulatinamente con el progreso de las condiciones de vida en general del país después del periodo postguerra: mayor supervivencia la

nacer, disminución de enfermedades infecciosas, acceso a agua potable, mejor acceso al sistema de salud, avances en medicina, tratamientos y prevención de enfermedades, aumento del desarrollo económico, estilos de vida más saludables, entre otros (52).

Este resultado fue mostrado en otro estudio (251) describiendo el caso de Japón(el cual se encuentra en el grupo de países con mayor longevidad), donde no se encontró un efecto significativo de la educación en el aumento de la supervivencia porque todos los grupos educativos mostraron una esperanza de vida similar (284). Hecho mostrado por un reciente estudio en el caso de España, en el cual se muestra que las diferencias entre grupos educativos contribuyen muy poco en la variación de los años de vida esperados de la población (351)

Segundo, otros estudios ilustraron que la educación tiene un efecto sobre las trayectorias de funcionalidad y deterioro cognitivo (140,141) pero este efecto alcanza un pico de mayor incidencia y luego disminuye a edades avanzadas (326); a mayor edad la educación pierde su efecto, reflejando que tener un mayor nivel de instrucción tiene beneficios para evitar factores de riesgo y retrasar el deterioro de la salud (o deterioro cognitivo) en la tercera edad (60-75) pero una vez alcanzado edades avanzadas (75-80+) o un estado no saludable agudo, la educación pierde su factor de protección.

Participación social y sus beneficios en la supervivencia.

Considerando la composición de la población mayor según la participación, encontramos que, entre los tres países, los porcentajes de participación no superan el 43% y Costa Rica es el único entre los países estudiados con mayor participación en números relativos. Los factores que explican la baja participación entre los adultos está relacionado en parte con las condiciones socioeconómicas y las condiciones de salud que inciden en la posibilidad de estos grupos de interactuar socialmente con su entorno(352) .

No obstante, la participación en actividades sociales reportó diferentes patrones en la supervivencia y años saludables entre los países; en Chile la participación en actividades sociales no presentó ventajas en la supervivencia y aumentó en una pequeña fracción los años de vida saludable (apenas 2% de aumento en las mujeres y 1% en los hombres). En España, por el contrario, la participación social incrementó en más de un año la supervivencia tanto para hombres como para mujeres. Mientras que el porcentaje de años saludables incrementó en la misma medida que en la población mayor chilena, 2-3% para ambos sexos.

En tanto que, en Costa Rica, por un lado, se aprecia una ventaja de supervivencia importante para las mujeres (7 años y medio más de vida) y, en menor medida para los hombres (aproximadamente 5 años

más de vida). Por otro lado, los mayores costarricenses que participan en actividades sociales también experimentaron un 13% más de años saludables en su esperanza de vida.

Los beneficios de la participación social en los adultos mayores de los países de estudios son consistentes con estudios previos que indican que este recurso social incrementa las capacidades funcionales, la calidad de vida y bienestar en lo referente a la percepción de la salud (353) y la supervivencia a edades más longevas (354), y por otro lado, la participación social como el voluntariado, la participación en equipos deportivos y participación en clubes, entre otras actividades, reduce los futuros costos de cuidado de larga duración (355). Adicionalmente, las actividades o el tiempo compartido con amistades también reportan tener un efecto positivo, aún mayor que el observado en las actividades sociales, en la supervivencia en la población mayor (356).

Patrones de convivencia, supervivencia y años saludable

La distribución de los arreglos de convivencia de la población mayor en los países de análisis es consistente con estudios previos; en la región Latinoamericana los hombres mayores generalmente viven con su pareja y otros (hogares extendidos) y las mujeres viven mayormente con sus hijos (60,61). Mientras que, en España al igual que en Italia y generalmente en los países del sur de Europa, las mujeres son más propensas a vivir solas(por su mayor supervivencia) y los hombres mayormente co-residen con sus parejas (46,50). Los patrones de convivencia también ilustran las estrategias de cuidado en la vejez, la cual está fundamentalmente encabezada por las familias en los tres países (357–359).

Nuestro estudio mostró que los arreglos de convivencia tienen efectos diferenciados en los países de análisis; por un lado, los riesgos relativos indicaron que las formas de convivencia en España, tienen un efecto sobre las trayectorias funcionales y en mayor medida en la supervivencia y, por otro, lado, en Chile y en Costa Rica sólo se observó una mayor incidencia del patrón de convivencia en la mortalidad.

Se aprecia que la convivencia en pareja tiene un efecto positivo en la supervivencia tanto para hombres como para mujeres como ha sido reportado por otros estudios (44,59,76,253,360); las personas mayores que viven solamente en pareja tienen una mayor esperanza de vida que los que viven en cualquier otro arreglo de convivencia en los tres países (aproximadamente 2 años más de vida en Chile y 2,5 en España). Con la excepción de Costa Rica, cuya esperanza de vida para las mujeres de 60 años tiene poca variación por arreglos de convivencia.

Adicionalmente, hay un patrón heterogéneo en las trayectorias funcionales según arreglos de convivencia; en España, la convivencia en pareja aumenta, en una pequeña proporción, el porcentaje de años saludables en las personas mayores. Mientras que, en Chile los que viven en solitario, tienen más porcentaje de años saludables, seguido de la convivencia en pareja y otros, y por último la convivencia en pareja. No hay variaciones importes en el porcentaje de años saludables por arreglos de convivencia en Costa Rica.

Por último, los arreglos de convivencia reflejan estrategias de cuidado y redes de apoyo diversas en torno a la familia en los tres países. El cuidado de los mayores recae en los lazos familiares y, particularmente, las mujeres son la principal fuente de cuidado (357,361–363) y también el primer grupo en necesidad de cuidado, creando relaciones intergeneracionales de cuidado entre las mujeres del hogar y aumentando la desigualdad intrafamiliar de género y generacional (364).

No obstante, en España, hubo un cambio de legislación en 2007, en el marco de la llamada "ley de Dependencia"[35] y, aunque algunos puntualizan que el cuidado de los mayores dependientes en España sigue siendo netamente informal (358), estudios recientes mostraron cambios en el organización del cuidado de los mayores después de la implementación de dicha ley; aumentó el cuidado por parte de individuos fuera del hogar, lo que pudiera indicar que las esposas recibieron ayuda desde el servicio social y otros trabajadores, surgiendo en escena una combinación de cuidados informales, por miembros fuera del hogar, y cuidado formal, por parte del servicio social (365).

Esto incide en los resultados de España, los arreglos de convivencia tienen un efecto en los cambios de salud; si bien los hombres conviven principalmente con su pareja y las mujeres viven solas, existe ayuda externa fuera del hogar para la provisión de cuidado. Mientras que en el caso de los países latinoamericanos, existe un incentivo a actividades comunitarias (366,367) para el estímulo del envejecimiento activo pero la convivencia en hogares con múltiples miembros ocasionando hacinamiento pudiera resultar no tan positivo para las personas mayores (357).

[35] Dependencia entendida como las personas que precisan de la atención de una o varias personas para la realización de las actividades básicas de la vida diaria. Ley promovida con la intención de promover un modelo de atención a la necesidad de dependencia (116).

Alcance y limitaciones del estudio

En este estudio resaltamos que algunas preguntas no son del todo comparables; Las preguntas de participación social en los tres países abarcan diferentes actividades y existen diferencias en el fraseo de las actividades de limitaciones funcionales (ver ANEXO 4.1). El objetivo del estudio no busca la comparación de cada indicador de las ADLs, AIDL o actividades avanzadas de la vida diaria, el estudio busca estimar las tasas de incidencias entre los tres estados de salud que son claves para la estimación de los años saludables de vida entre las dos regiones por medio de nuevas herramientas metodológicos para su cálculo como los modelos "multistate".

La comparación de años de vida saludables para los países de estudio no se pudo comparar ampliamente con estudios previos en el tema por diferencias entre la metodología, indicadores y fuentes. Por lo que se tiene previsto para estudios posteriores realizar estimaciones con diferentes métodos para poder identificar qué diferencias son atribuibles a la fuente, al indicador y a la metodología utilizada.

Por último, las transiciones censuradas en el intervalo de las observaciones como el cambio de un estado saludable a la muerte, lo que pudiera ocultar una transición a un estado no saludable en el intervalo del tiempo no supone una limitación para la estimación de las probabilidades de transición o estimación de la esperanza de vida puesto que en la matriz de transiciones están definidas las transiciones posibles y por medio de los valores iniciales calculados con el uso de la "*maximun likelihood*" el paquete "msm" en R puede calcular estimaciones más próximas a los datos observados. Ver Van den Hout (327) para un análisis exhaustivo del método.

Comparación de resultados e indicadores

Es posible comparar nuestros resultados de Chile con el estudio realizado por Moreno, Albala y Lera et al. (310) en los adultos mayores; su estudio utiliza el mismo indicador de las limitaciones funcionales para referir a un estado no saludable en los chilenos pero utiliza otra fuente longitudinal (SABE) con sólo dos rondas para el periodo 2004-2005 y 2009-2010. Nuestros resultados se asemejan a los encontrados en su estimación de la esperanza de vida con dos años de diferencia en la esperanza total a los 60 años; 16.4 y 20.4 (comparado con nuestro estudio: 18.3 y 22.9) con porcentajes de años saludables de 61.6% y 48.0% (57.8 y 52.5) para hombres y mujeres, respectivamente. La diferencia entre los resultados radica en el periodo de referencia de las estimaciones, aunque también se podría considerar que las mujeres y hombres chilenos han aumentado su supervivencia, en tanto que sólo las mujeres han aumentado sus años en buena salud.

En referencia a Costa Rica, los resultados son contrastados con Rosero-Bixby (324) y Payne (21), estudios que utilizan la misma encuesta CRELES y derivan resultados próximos a los nuestros. El primer autor estima la esperanza total para hombres y mujeres a partir de los 60 años, con una metodología diferente, sin embargo, se aprecia una aproximación en los cálculos de la esperanza de vida, sobre todo en la masculina, con un año para hombres y dos años para las mujeres por arriba de nuestras estimaciones (hombres 21.9 y mujeres 24.3). El segundo estudio calcula los años de vida saludables y años totales de vida en estado según el estado de salud inicial a partir de los 65 años, con modelos "Multistate". El estado saludable se estimó con otro indicador de salud (al menos una limitación ADL). Sus resultados reportan valores de la esperanza de vida más bajos que los estimados en este estudio, pero más similares que los reportados por Rosero-Bixby (aproximadamente un año menos tanto para hombres como para mujeres). En cuanto a los años saludables, sus resultados reportan un mayor número de años en buena salud (12 años saludables para mujeres y 14 años para hombres). Esta comparación con estudios previos nos permite identificar que en el caso de Costa Rica la diferencia sobre: a) la estimación de la esperanza de vida se debe a la metodología utilizada y b) la diferencia en los años de vida saludables se debe al indicador de salud utilizado, resultado más años de vida saludable en el otro estudio por el uso de un indicador de salud menos restrictivo.

Los resultados de los años de vida saludable en nuestras estimaciones sobre todo para España, difieren de los publicados en estudios previos (332,351) y estadísticas oficiales (181,282,368), debido principalmente al empleo de metodologías e indicadores diferentes para el cálculo de la esperanza de vida. Los otros estudios utilizan prevalencias de salud por medio de la implementación del método Sullivan (369–372) y no consideran los cambios de la funcionalidad en el tiempo, como son las tasas de incidencia. Estos estudios utilizan las prevalencias de estados de salud según diferentes indicadores en encuestas (12,37,372) y los registros de mortalidad de registros vitales.

En consecuencia, sus resultados muestran una menor proporción de años saludables y mayor esperanza de vida, en tanto, que nuestros resultados ilustran una mayor proporción de años saludables y menor esperanza de vida tanto para hombres como para mujeres en el caso de España. Esta diferencia es inherente principalmente a la fuente utilizada para realizar las estimaciones lo que incide en un diferente panorama del estado de salud, supervivencia y brechas de género (373,374); la información de mortalidad de las otras fuentes proviene de los registros de mortalidad oficiales los cuales refieren a toda la población, incluyendo a la población institucionalizada mientras que, en nuestro estudio contamos solamente con la información de corte longitudinal suministrada en hogares privados. Esto trae como consecuencia que la información de mortalidad de las encuestas esté subestimada o sobre estimada en algunos casos porque las personas que se mueven de hogares a

instituciones de cuidado muchas veces pudieran aparecer como defunciones en las encuestas. Sin embargo, la mortalidad registrada en las encuestas mayormente resulta en esperanzas de vida más bajas que las estimadas con registros vitales (375) por un sub-registro de las muertes en las encuestas y el efecto de la atrición en las siguientes rondas de observación (376–378).

Sumado a esto, el indicador utilizado en este estudio refiere a la combinación de tres indicadores de limitaciones funcionales que miden la incapacidad del adulto mayor para relacionarse con su entorno en la cotidianidad (298), lo que podría considerarse como un indicador más robusto y restrictivo para medir impedimentos o limitaciones en las actividades de la vida diaria; desde una condición leve hasta pre-clínica (342). Estudios reportan que la utilización de uno u otro indicador para medir el estado saludable también incide en las diferencias de la esperanza de vida y años saludables (373,374,379), inclusive el mismo indicador utilizado en una encuesta en diferentes países tiene variaciones en los resultados debido a la implementación de la pregunta de salud en los cuestionarios y percepción de las limitaciones funcionales (13,14).

En cuanto los indicadores utilizados como variable explicativa en la estimación de la esperanza de vida, se hace un llamado de atención a los resultados de Costa Rica sobre la participación social (modelo 4). El número de años total y años saludables pudieran estar sesgados por la no respuesta de las personas que utilizaron proxy para contestar la encuesta; estas personas no aplicaron para contestar la pregunta de participación social, no ocurriendo así para los otros países de estudio. En este sentido no podemos identificar el verdadero efecto de la participación social en las trayectorias de funcionalidad y la supervivencia de la población mayor en Costa Rica.

5. Conclusions and Discussion

This dissertation contains analytical contributions in the study of health conditions in the old age population in selected European and Latin American countries. Several methodological tools were used to allow an approximation of elderly health state trajectories: health deterioration, health improvement and mortality. Health dynamics in the ageing pattern is characterized by an increase in deterioration with age. However, this process may be delayed depending on environmental conditions (2,6,35,380). This is why our interest lies in studying factors that may mediate in health improvements and a better state of well-being, understood as an absence of functional limitations in their daily activities. This study therefore explores the influence of factors associated with their personal characteristics (sex, birth cohort and educational level) and immediate environment, such as their living arrangements, daily activities (such as social participation) as well as variables associated with the household (the ability to cover monthly expenses) on changes in their health.

The first chapter describes transitions between health states in 19 European countries using the European Union Statistics on Income and Living Conditions (EU_SILC) survey, through the implementation of hierarchical or mixed effects (multi-level) models of survival analysis, to respond to the first research objective that is aimed at describing health changes in health improvements, deterioration and mortality among European countries. This chapter describes the influence of individual factors as well as living arrangements on the health dynamics of the older population, with the intention of illustrating, with a comparative perspective, health patterns in the European context.

The methodology used allows to describe the variability of health changes according to the study countries and main demographic characteristics (birth cohort, sex and educational level). Countries were selected according to the information collection criteria; this is because other studies have emphasized that it is not appropriate to produce country comparisons with EU-SILC survey data between countries that use different data collection techniques because of their impact on results (381). In this regard, the selected countries share the same survey method for the collection of information (Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Estonia, Greece, Spain, Hungary, Ireland, Italy, Lithuania, Luxemburg, Latvia, Malta, Poland, Portugal, Romania and Slovakia).

Overall, variation in analysed risks is accounted by heterogeneity across the 19 European studied countries, which showed different patterns of health changes; results reported, respectively, a 37%, 46% and 41% variation in the probability of health deterioration, health improvement and mortality due to heterogeneity among countries. This reflects that the reference risk (of a male individual, belonging to the 1924-1933 birth cohort, with primary school studies and living with a partner) in

transitioning between health states varies substantially according to the country of residence, whereby the probabilities of transitioning to better health and death are the most heterogeneous.

Looking at the country effects, we note that they were largest in the Baltic and Eastern European countries, countries that reported the highest mortality and risk of health deterioration, although there are more favourable situations among this group of countries, as is commented on below. In this chapter we identify the influence of the different coexisting living arrangements among the countries studied, as well as their variation by groups of birth cohorts, sex and educational levels. In addition, as it is not possible to identify which countries had significant differences with the reference category, another methodological tool was used in the survival model. This is described in more detail in the second chapter and applied to a smaller sample of countries in the third chapter.

The third chapter responds to the second research objective: analysis the determinants of health changes according to individual characteristics and those of the immediate environment. In this sense, the effect of the socio-economic context on the studied health transitions (deterioration, improvement and mortality) is further analyzed. Multistate models in nine European countries in different regions (Eastern Europe, Western Europe and Southern Europe) examine the extent to which the likelihood of health changes increase or decrease according to individual and household-level socioeconomic status indicators, such as educational level and ability to make ends meet[36]. The effect of the type of living arrangement on health patterns according to country of residence and gender is also analyzed. The countries, which are a sub-sample of the initial sample of 19 countries used in the first chapter, were selected according to their geographical location and demographic similarities, i.e. for Southern Europe: Spain, Italy, Portugal; Western Europe: Austria and Belgium; Eastern Europe: Czech Republic, Hungary Poland; and for the Baltic region: Latvia.

The sample of countries studied reported that the patterns of co-residence have a different impact on the health trajectories of the elderly. Our results reveal that co-residing with children for those living with a partner is a protective factor against health deterioration, and, in turn, increases the chance for health to improve, although not all European countries share this pattern.

In addition, gender differences exist in health transitions between countries. Despite the general pattern that women's health deteriorates faster than men's health, there are countries where women

[36] The reference risk for this study was the population residing in Spain, with primary studies, living as a couple for the period 2008-2011, without problems to cover monthly expenses.

have a more favorable health situation than their male counterpart. This is particularly the case in Eastern Europe. Finally, in terms of education, more years of schooling contributes to reducing the gender gap in healthy years, with a higher chance of health improvements for women. Likewise, with more years of schooling health improvements increase and mortality risks decrease for older people living with others.

The fourth chapter presents a comparative study of elderly health trajectories between two Latin America countries (Chile and Costa Rica) and one European country (Spain). In this study, variables concerning the immediate environment of the individual are considered, namely the type of living arrangement and social participation. The analysis was performed to respond to the fourth research objective, i.e. to compare health changes in different demographic regimes, considering also gender, education, living arrangements and social participation, to ascertain if there are similarities and divergences between the countries of study.

In this chapter “multistate modelling” was again applied, as in chapter three. A comparison of the life expectancy of the three countries was made using three different surveys: The "Social Protection Survey" (EPS, for its initial in spanish) in Chile, the "Costa Rica: Longitudinal Study of Healthy Ageing" (CRELES) and the "The Survey of Health, Ageing and Retirement in Europe" (SHARE), taking only the data from Spain.

The results, comparing these three countries showed that greater female survival is a cross-cutting element in the three countries with different trends in healthy life years, while men, with a lower life expectancy than women, have generally a greater proportion of remaining healthy years. The increase in the educational level has a positive effect on the increase in healthy life years in each of the three countries. In relation to survival, effects were different according to country. While social participation as associated with healthier life years in the three countries, it only led to greater survival in Costa Rica. Finally, the influence of the type of living arrangement on the three health transitions in each country was quite diverse.

Lastly, the second chapter, mainly methodologically focused, as well as the distinct type of models used over the course of the three analytical chapters, answer the second objective of the study regarding the exploration of available methodologies for the study of health trajectories in the elderly population. All chapters provide a variety of tools in the survival analysis for the study of elderly health conditions for which two types of health indicators were used, coming from four different surveys. As a result, analyses covered 21 countries from two major world regions. In the case of the second chapter, it covers an introduction to multi-state models that has been sparsely used for the study of health transitions, as it requires longitudinal data. The chapter describes the basic concepts used in

multi-state modelling and provides an overview of the main studies in the field of demography and epidemiology that used this technique.

Summary of findings and discussion

Health changes in the elderly population: Health deterioration, health improvement and mortality in Europe

In the study of health changes among elderly, different approaches of survival analysis have been used. As a result, a wide diversity in health patterns in European countries has been documented. In the first chapter, that used fixed and random effects in a sample of 19 countries, large country-variability in the reference risk was observed. The variations in health transitions according to the countries studied are considerably large, reflecting a significant heterogeneity of health changes among European countries, with the elderly populations of the Eastern European and Baltic countries showing the greatest differences with respect to the reference risk.

The variation of the reference risks between the countries shows that the Eastern European countries have the highest risk of experiencing deterioration in health. This is particularly the case of Slovakia and Latvia, which show a risk of deterioration that is 75% above the sample average, followed by Estonia with a 45% higher risk. On the other hand, Bulgaria, as well as the Southern European country of Greece, shows an opposite pattern, as the elderly in these countries have the lowest relative risk of experiencing deterioration in health, approximately 50% less than the average of the sample.

The probability of health improvements upholds important country differences. The countries with the highest likelihood for favorable changes in their functional limitations are generally southern European countries: Malta, Cyprus and Spain with the inclusion of Luxembourg. These countries exceed 50% in the probability of health improvement. Conversely, people over 50 who are resident in Eastern European countries observe the lowest chances to improve their health status and, as expected, also the highest mortality risks, with the exception of Estonia.

The heterogeneity of health transitions between European countries reflect the pattern of life expectancy and healthy years reported by official statistics (181,282,368) and by previous studies that indicate the existence of substantial inequalities in the health of the majority of the elderly population in European countries (20,104,183,382). These differences are associated with contextual factors, including housing and living conditions, care policies, developments in medical technology and/or access to public services (160,273,383), that influence the acceleration or delay in the process of becoming disabled among older people (2,4,35,384).

The less favorable situation is illustrated by the countries of Eastern Europe, as seen by their higher mortality rates and therefore lower life expectancy than other European countries (181). The differences in mortality between countries are attributable to the gap between, on the one hand, health and care programs associated with the economic progress that is made in Western European countries, and, on the other hand, stagnation in Eastern European countries. Additionally, different trends in mortality due to cause of death are observed in these countries, such as the higher prevalence of cardiovascular and man-made diseases that have alcohol, tobacco and traffic accidents as risk factors (385).

However, there is a convergence between the mortality patterns of Eastern Europe and the rest of Europe since the fall of the Berlin Wall, although with variations in the timing of the start of this convergence between countries (275). The Czech Republic has pioneered this trend; official statistics show that they experienced continuous progress in life expectancy in recent decades, followed by Poland, Slovakia and Hungary and more recently by Russia and Ukraine (180), while the Baltic countries report the least favorable trend in mortality patterns (385).

Gender differences between countries.

In the third chapter, gender differences were identified between countries. Gender differences showed that women are more likely to experience deterioration in their health status, are less likely to improve their health and have a lower risk of mortality than their male counterparts, confirming the gender paradox where women report more years of life than men, but also proportionally more years in poor health (163,386).

In our study we make particular reference to Portugal, a country where older women reported the greatest risk of deterioration compared to men when compared to other countries. This result could reflect gender differences in attitude about health status; on the one hand, women are more aware of their health problems, attend medical consultations more frequently. This leads them to identify a poor state of health more frequently than men, while men report in a lower percentage a poor state of health (387). On the other hand, the knowledge of pathologies and/or health conditions and medical control, could protect them to some extent from early mortality (386).

However, this pattern is not the same in terms of health improvements among the countries of study; the Eastern European countries: Czech Republic, Hungary and Poland, with the inclusion of Austria, illustrated that older women are more likely to experience better health than men. This trend is linked to lifestyles and risk factors in the causes of mortality. Studies show that 40-60% of the gender mortality gap is associated with tobacco use and 20-30% due to alcohol consumption in Eastern

European countries, while these causes are only accountable for 10- 20% of mortality in the rest of Europe (275). This shows that trends in long-term mortality and morbidity were less favorable for men than for women in Eastern European countries (385).

Additionally, previous studies indicate that gender differences in health changes are associated with public spending of countries in the health care of the elderly (171,272,273); countries with a low investment in care and health of their ageing population illustrate the widest gender gaps of years with functional limitations.

Living arrangements and health.

The first and third chapters illustrate by different approaches a similar pattern in the probabilities of transitioning between health states according to living arrangements. As results showed, older people living with their partner and children are less likely to have their health deteriorate than those only living with a partner. In terms of health improvements, the two types of living arrangements also increase the chances of having a favorable change in the state of health, while living alone and those living with others reported lower chances of health improvements and greater propensity to deteriorate health status. However, the third chapter reports a difference in the effect of living with others on the deterioration of health. This type of living arrangement reported less health deterioration in the elderly, which indicates that in the set of nine countries in this chapter, the effect of living with others is different from that observed in the sample of the 19 countries studied in the first chapter.

Differences between European countries.

The effect of different living arrangements was initially studied in the first chapter to describe the variation of these patterns among European countries using random effects. The third chapter then went into more depth by taking a selection of countries according to different regions and calculating transition probabilities according to socioeconomic characteristics.

Random effects among 19 countries

The results of the mixed effects illustrated that the variation of the effect of each living arrangement group[37] on health is wider in the transition to health deterioration (8%) than what was observed for health improvements (5%) and mortality (1%).

The countries of southern Europe have the most diverse pattern of health changes according to living arrangement. With regard to health improvements, Spain and Italy, countries with a similar an ageing profile and composition of living arrangements among the older population (see ANNEX 1.4, part 3.1-3.2), illustrate opposite patterns in health improvements; older people in Italy, living with their partner and children reported a 10% higher improvement in their health status than the average of the sample, while in Spain this risk is 7% lower.

At the same time, older people living alone in Spain and Portugal reported a greater propensity to improve their functional limitations (7%), while in Italy and Greece this effect was below the sample average. Malta and Greece are also countries with the highest risk of worsening health status (around 14%). Meanwhile, Romania and Latvia observed a different pattern to the countries in their region by reporting the lowest values of health deterioration, suggesting that some countries in Eastern Europe are atypical. Older people living with their partner and children in Slovakia showed more propensity (5-10%) to improve their health status than the overall risk, as did people living alone in the Czech Republic.

In countries with strong family ties, older people increase the likelihood of improving their health status when living with their children, as is the case in Italy. However, it does not represent a factor of protection against health deterioration or an increase in health improvements in other countries in southern Europe, such as in Spain and Portugal. In these countries, living with a partner and children represents a lower probability of health improvements than older people living only with a partner.

Additionally, it was observed that the influence of living arrangement patterns on the functional trajectories of the elderly produces greater variability by educational level and by birth cohort than by gender in models with three hierarchical levels. The results indicated that, even controlling for educational level, cohort and sex within European countries, differences in the influence of living

[37] In mixed models, the risk for each living arrangement group.

arrangements in health changes persist. While, regarding the risk of mortality among countries, it was noted that education decreases the variability of the effect of coexistence patterns on this transition.

Transition probabilities between countries (case study between nine countries)

The analysis of the effect of living arrangements on health using "multistate models" in a smaller sample of countries reported that, taking as a reference the risk of those who live as a couple in Spain, most of the countries with the exception of Hungary and Latvia reported that living with the couple and children delays the deterioration in the health of the older population compared to living with a partner, however, only in Italy were the differences significant. On the other hand, the probabilities of health improvements showed that this living arrangement has health benefits for the elderly in Italy, Hungary and Latvia.

These results show an effect of the composition of the elderly population according to living arrangement patterns in the countries studied (46,51,62). Living arrangement patterns that are clearly differentiated by gender and between European countries (see ANNEX 3.1) and that are a reflection of the different attitudes of single, divorced and widows of younger generations, as for the elderly, marriage was the norm (51). The general sex-specific pattern indicates that older women are more likely to live alone because they have a higher chance than men to become widow and men are more likely to live as a couple.

The older population in European countries that is least likely to improve health when living with a partner and children are the countries that show the lowest percentages of this living arrangement, as is the case in Austria and Belgium. In these countries more than half of the older population lives only with a partner and less than 20% with a partner and children. Pattern that is similar in the Czech Republic, while the opposite occurs in Italy, Spain and Poland where the proportion of the elderly living with a partner and children and those who live only with a partner are quite similar, around 35%.

With regard to living alone, it was observed that Portugal and the Czech Republic were the only two countries where the elderly living alone reported a more favorable situation around health improvements compared to the elderly living with a partner.

Even though, there is the notion that living alone brings adverse effects on the health status of elderly, empirical evidence does not support that fact, with exception of some morbidity causes among men (59) . Studies indicate that surviving at older ages living alone (predominantly women) in good health is due to a selection effect (44,51,63,72); the partner who dies first has worse health conditions, and as a result only a selective group of people survive in good health at an advanced age.

Recent studies have shown that living alone is expected to be more frequent and will occur in a more favorable health situation (62,388). In this case, those who live in single-person households in the Czech Republic, mostly women (30% compared to 14.7% of men in this form of living arrangement) could be associated with the recent progress in life expectancy in this country (180) and also with a younger population structure among the elderly in that country, as is generally observed in Eastern European populations (see ANNEX 1.4, part 1.1-1.2).

However, it is important to interpret these results taking special account of the type of data source used (which refers only to private household), the selective movements to institutions and to relatives´ households (who are always the ones with the worst health conditions) and the social support opportunities available for the elderly among countries as for instance, frequent contact with relatives even if they don't live in the same household (59).

Living with others in Poland and Belgium is associated with health disadvantages. Older people living with others in Poland are less likely to have favorable health changes (-5%), while older people living with others in Belgium will have a 26% higher risk of health deterioration, compared to older people living with a partner in the respective countries. While in Poland, elderly face raising demands for both finance and planning social care program and the informal care by family´s members is the only form of delivering support for elders (389,390), the results for Belgium are associated with a sample selectivity, as the State has an important long-term care program for the elderly, allowing caregivers to care for the dependent older people at their homes (391). The Belgian health system is characterized as a mixed one which provides care and substantial support to informal care (392). Therefore, those living in private households without a partner and children may be receiving formal care or informal care (from other family members). Although, there is evidence that the informal care has more difficulties in accessing support through the health system (41) .

The countries of southern Europe are well-known for their strong family ties and intergenerational solidarity networks that provide support and care to their older members, which also response to the unsatisfied demand for elderly social care programs. In addition to this, a significant investment is required in the adaptation of elderly-friendly environments in the home and in the community, such as assistive devices for the elderly to help them adapt to the biological process of ageing. On the other hand, in Eastern Europe, particularly the countries that made up the former Soviet Union, economic difficulties and a failed welfare system affect the entire population (274) that has led to high mortality rates and fewer health improvements. However, a younger age composition in these countries may be why some countries observed lower rates of health deterioration.

Living arrangement and gender patterns.

Differences by gender and living arrangements illustrated that, regardless of living arrangements, women are always more likely to experience health deterioration than men. However, the results of the interactions in the multi-state models illustrated that, particularly, women who live alone reported significant differences with respect to the reference category (living as a couple). Older women who live alone are less likely to improve their health than women who live as a couple, but in a peculiar way these women showed a lower risk of deterioration than those who live with a partner. This indicates that older women in single-person residences delay the deterioration of their health due to a selection effect previously mentioned, however, once they experience a worsening of their health, the probability of having an improvement in their condition is low. Regarding the risk of mortality, living together as a couple is a protective factor that delays mortality in women, which is also shown by previous studies (44,76,360,393). Additionally, and without exception, women in any living arrangement have greater survival than men.

Socio-economic effects on health

Education

Having an educational advantage yielded more benefits for women in terms of health improvements than for men. The analysis in the third chapter indicated that older women with completed secondary school education are more likely to have health improvements than men with the same educational level. On the other hand, in terms of the transition of health deterioration and mortality, educational level did not report relevant differences between men and women.

Previous studies have shown that people with higher educational levels have more material resources and psychosocial skills to face situations of vulnerability and unfavorable health conditions. Those who are more educated tend to avoid situations and attitudes of risk in health, receive timely and adequate medical assistance because they have more access to medical coverage and follow medical treatments more precisely (394,395). In this sense, the effect of education has a long impact on health, prolonging life expectancy (27), especially among women (396).

On the other hand, educational level according to living arrangements showed a significant effect on the elderly living with others (without a partner or children). The elderly in this living arrangement and with at least secondary school studies reported having a significant percentage of health improvements (35%) and lower mortality (-18%) than those with the same living arrangement but with primary studies or less. These results indicate that, in the absence of the partner, education protects

not only against health deterioration but also increases the probability of health improvements and decreases the risk of mortality among older people.

Covering monthly expenses

The variable "making ends meet" showed as expected, that elderly who declared that they could not cover their monthly expenses are less likely to experience improvements in their health, and, at the same time, are at greater risks of health deterioration. These results are consistent with previous studies confirming that at older ages socioeconomic disadvantages lead to more years in disability or poor health (27,159,184,251,396). The increase in income that allows access to goods and services, such as covering monthly expenses, has a positive effect on health. However, once most of the required material conditions are satisfied, there appears to be a ceiling effect where these favorable conditions no longer generate health benefits with increasing age (171).

The socioeconomic analysis of health changes was concluded by attempting to identify how the economic crisis affected health changes. To do so, we evaluated the effect of the periods in which the survey information was collected. The results indicated that in the 2006-2008 period (pre-crisis), the elderly experienced high probabilities of both health deterioration and health improvement compared to the 2009-2011 reference period (which approximates the years of the crisis), demonstrating that the health indicator used (GALI) had great variations in how the older people reported their state of health. In this sense, the literature indicates that in periods of economic recession there is evidence of high rates of suicide and mental health deterioration as well as mixed results in the rates of self-report of health status (277), as observed in this study. However, other studies indicate that the health indicator used to measure health changes could show variations in health changes that are attributable to the implementation of the question in the survey (195,397).

Latin America and Europe: Different patterns in health trajectories among the elderly. Case studies: Chile, Costa Rica and Spain.

The general pattern shows converging survival levels and healthier years between Europe and Latin America and more years of life left at 60 years for the female population in all three countries. However, Latin American countries have a lower percentage of healthy years than in Spain: sixty-year-old Chilean women will have half of the remaining years to live in good health (50%), while women in Costa Rica will have slightly less in good health (47%), while women in Spain reported 70% in good health. As for men in that same age range, approximately 60% of healthy years were expected among older Latin Americans while Spaniards this is 80%. These results are in contrast with previous studies on functional trajectories in Chile (310) and Costa Rica (21), while official statistics and previous studies in Spain (98,398,399) show similar values.

The greater survival of women with a lower percentage of healthy years of life in reference to men is a general pattern observed in all countries around the world (24,29,103,177,183,272,282,301,305,328,396,400,401) . The outstanding female longevity that leads to the feminization of the elderly population is associated with biological, social, contextual factors as well as different lifestyles between men and women.

On the other hand, the highest percentage in women's poor health is broadly explained by inequalities in socio-economic conditions. Additionally, the presence of gender roles (40,189,329,374,402–407) in the older female generations led to low rates of schooling and labor participation (104,330–332). Women are also more likely to identify the presence of diseases sooner than men, affecting a greater report of diseases, functional limitations or ill health according to the health indicator used (330).

Gender

Life expectancy at 60 in Costa Rica is similar between men and women, with one year of difference, while Chile exhibits the most pronounced gender gap with around 4.5 years and Spain with 3.5 years. Estimates of years of life reflect a similar pattern for men among Costa Rica (20,94) and Spain (20,46), while men in Chile have 2 years lower life expectancy (18,32). In the case of women, Spain observes the highest life expectancy (23.88) up to two years more than the other two countries (Chile: 22,91 y Costa Rica: 21.82).

When comparing estimates with previous studies of Chile for 2010 (310) and in Costa Rica for the same reference period as our study (21,265,324), the results are close to ours, considering our conservative estimates with respect to the other studies. For Chile, our results show two more years of life expectancy, which is explained by the more recent reference period used (2017). This indicates an increase of approximately two years in the survival of the Chilean population of 60 years (2 years for men and 2.5 years for women) in a period of 7 years. Regarding the results of Costa Rica, previous studies show figures of one year more[38] (21) or about two years less[39] (324) than what is estimated in this study. However, United Nations estimates more years of life expectancy for the two countries[40], just as for Spain (282).

[38] Life expectancy at 60 years for Costa Rica using the CRELES survey: 21.9 for men and 23.4 for women (324)
[39] Life expectancy at 65 years for Costa Rica using the CRELES survey: 19 for men and 20 for women (21)
[40] Life expectancy at age 60 for Chile in 2016: for men: 21.3 and for women 25.3. For Costa Rica in 2010: 21.6 for men and 24.7 for women.

Our results show a trend similar to official statistics, these indicate that men at age 60 in Costa Rica have a life expectancy similar to men in Spain, a country in southern Europe that is located in the top of the longevity ranking that also includes Italy, France and Japan (265). On the other hand, Costa Rica observes a smaller gender gap than that observed in Chile and Spain and even in other countries with greater longevity, like Japan (321). However, it can be seen that the smaller gender gap does not bring more health benefits for women; Costa Rican women have the lowest percentages of healthy years compared to the two other countries studied and also with respect to other countries in America such as Mexico, Puerto Rico and the United States (21).

Spain's advantage in life expectancy and healthy years in the case of women in relation to the Latin American countries studied could be influenced by a set of factors, including a cohort effect, as well as food (in reference to the Mediterranean diet) and country differences in public spending in the national health system.

Regarding the first factor, previous studies indicate that the reduction in mortality and morbidity is attributable to changes in the first phase of the life cycle (27,338,339) as is the case of the cohorts benefiting from sanitary improvements (e.g. public hygiene, access to drinking water) and advances in medical treatments (e.g. spread of penicillin use) observed in the mid-1950s, after periods of war. The cohort structure of the older population in Chile and Spain showed a similar pattern; the oldest cohorts refer to the same year of birth while the oldest cohorts in Costa Rica belong to cohorts born two decades earlier when health improvements were not yet experienced.

The second element relates to the diet of the population. Numerous studies have suggested that the Mediterranean diet is considered a relevant factor in the reduction of morbidity and mortality for both functional capacities (340) as mental health (341). Contrary to this pattern is the situation in Chile where high rates of obesity (especially among women) has led to differences in healthy years between Chilean men and women (342).

Finally, public spending in Spain shows that the benefits of expanding health coverage, decreed universal and free in the mid-1980s (285), as in most European countries but with different periods of implementation (343), has had a long-term impact on the health of the elderly, contributing to a higher life expectancy of Spaniards compared to other countries in the region. As a result, previous studies have shown an important compression in disability among elderly and to a greater extent for women (344) in the period 1985-2000. In addition, mortality rates declined during this period in most European countries (345), like in the United States (31,32,99), albeit in different magnitude but with the exception of Eastern European countries.

The countries of Latin America that were studied, in contrast, differ in their National Health System. In Chile, there has been a mixed health system since the 1980s, composed of a public part (FONASA) and a private one (ISAPRES) in which the State invests relatively little. In general, investment in health is not sufficient to meet the needs of the population in terms of primary and preferential health (287). This has had an impact on those with fewer resources and has created socioeconomic differences in healthy years of the older Chilean population (307). Differences are also observed for women who report greater socioeconomic disadvantage, as we observed in our study where more women had low educational attainment than men (see TABLE 4.2).

In the case of Costa Rica, the health system is universal and free (286) as in Spain and although there is a positive perception regarding its functioning (347,348), there are also important territorial inequalities in morbidity and access to primary health care (349). While in Chile the rural population amounts to 10%, in Costa Rica, as in Spain, it represents approximately twice that percentage (350). In this sense, we can conclude that the lower percentage of healthy years of Costa Rican women compared to the other two countries could be associated with geographical inequalities in health care access, although previous studies indicate that in Spain important territorial differences in life expectancy and healthy years also exist (98,399).

Education

Results showed that education is more relevant in Costa Rica than in the other two countries. Education has an impact on health trajectories and showed no influence on survival in Costa Rica. Older people, both men and women, with a higher educational level have a significant increase in their healthy years and, to a lesser extent, in survival.

In contrast, a higher educational level in Chile and Spain is only associated with a small increase in healthy years among elderly (respectively, about 3% in women and 2% in men in Chile and only 1% in Spanish men and women). No increase in survival is observed as in these two countries, a likely result given the small educational differences a life expectancy among both men and women.

Previous studies using the same European source showed that for all European countries, education was relevant in women's health trajectories, showing a positive association, while in men this effect is only observed with regard to survival. Our results report various trends in the countries of study: education increases healthy years for both men and women as seen in Costa Rica, while in the other two countries, education does not have an impact in the delay in mortality (increase in life expectancy) as evidenced in Chile and Spain (also in Japan). Similar trends have been reported in the United States

and Japan, the former with a relevant effect of education on survival and the latter without a differential effect of life expectancy according to educational groups (251).

The educational differences in survival in the countries can be explained by the diverse prevalence of health states according to the educational level of the elderly. Particularly cohorts born after certain important periods (economic recession or war) do not have large educational differences, as observed in the Spanish population aged 60 years and older. For the most part, this population belongs to the birth cohorts of 1945-55, cohorts that experienced life-course events that older cohorts did not experience. The aforementioned cohorts gradually benefited from the progress of the country's general living conditions after the post-war period, such as: greater survival at birth, decrease in infectious diseases, access to drinking water, expansion of health care coverage, advances in medicine, treatments and disease prevention, increased economic development, healthier lifestyles, among others (52).

This trend is also exemplified in countries like Japan, country with the lowest mortality in the world (408). An earlier study (251) did not report significant differences in increasing life expectancy between educational groups in Japan as all educational groups observed similar life expectancies. Another study confirms our findings in the Spanish case (351). Although, it covers a lower age range, it reported, like we do, that differences between educational groups do not contribute to the variation in the population’s expected years of life.

Finally, there are findings illustrating that education certainly has an effect on the trajectories of and functionality and cognitive impairment as well (140,141) but this effect reaches a peak of higher incidence and then disappears in advanced ages (326). The same applies to the effect of the material resources explained previously. At an older age, education loses its effect, reflecting that having a higher level of education has benefits to avoid risk factors and delay the deterioration of health (or cognitive impairment) in the elderly (60-75) but once they reach ages advanced (75-80 +) or an acute unhealthy state, education loses its protection factor.

Social participation

Among the three countries, social participation has values around 40%, being Chile the country where the elderly have the lowest percentage of participation (35%) with Costa Rica and Spain both exhibiting values of about (42%). The low percentage of participation among the elderly could be related to the socioeconomic situation and health conditions that affect the possibility of these groups to interact socially with their environment (352).

When analysing the impact of participation in survival patterns and healthy years among countries, we found that in Chile the participation of older people in social activities did not show survival benefits and increased healthy years by only a small percentage in women. In Spain, it increased the number of healthy years by the same percentage for both sexes (around 2%) as well as a significant increase in survival (by one year) in both men and women. Social participation in Costa Rica, on the one hand, significantly increased survival, especially benefiting women (7.5 years of life versus 5 years for men). Both sexes also experienced 10% of healthier years.

There is evidence that illustrates the benefits of social participation in elderly health by increasing the functional capacities, quality of life and well-being in relation to the perception of health (353) and prolongs survival to older ages (354). Additionally, specific activities such as volunteering, participation in sports teams and in clubs, among other activities, reduce future long-term care costs (355), while activities or shared time with friends report has a greater positive effect on elderly survival (356) than is observed for social activities.

Diverse patterns of living arrangements between Latin America and Europe.

The distribution of living arrangements of the elderly population in the countries of analysis is consistent with previous studies; in the Latin American region older men generally live with their partners and others (extended households) and women live mostly with their children (60,61). On the other hand, in Spain, like is typical in the countries of southern Europe, women are more likely to live alone (because of their greater survival) and men mostly co-reside with their partners (46,50). Living arrangement patterns also throw light on old-age care strategies, which is still mainly done by families in the three countries (357–359).

The patterns of living arrangements show different effects in the three countries that reflect a regional pattern. On the one hand, the relative risks indicate that forms of co-residence have an effect on functional trajectories in Spain, but even more so on survival. On the other hand, in Chile and Costa Rica, living arrangement patters only affect mortality.

Living as a couple showed to have a positive effect on survival for both men and women, as has also been observed in other geographical areas (44,59,76,253,360). Older people who live exclusively as a couple have a greater life expectancy compared to those who live in any other living arrangement in the three countries (approximately 2 more years in Chile and 2.5 more in Spain). Costa Rican women are the exception, as their life expectancy at age 60 shows little variation according to living arrangements.

The trajectories from one health state to another, show a heterogeneous pattern according to living arrangements in the elderly living in Spain and in Chile, while the observed differences in the percentage of healthy years in Costa Rica were not significant. In Spain, living together as a couple increases, in a small proportion, the percentage of healthy years in the elderly, while in Chile those living alone, have a higher percentage of healthy years, followed by living together as a couple with others, and finally living together as a couple.

Living arrangement patterns contain similar informal care strategies and support networks around the family in the three countries as caring for the elderly rests on family ties, whereby the main source of care are especially women (79,357,361–363) who are also the main group in need of care. This, in turn, generates intergenerational care relationships between women within the home and increases gender and generational intra-family inequality (364).

However, recently there has been an incipient change in informal care strategies in Spain (365), in part due to a lingering economic crisis but also due to the introduction of legislation in 2007 to promote personal autonomy and attention of people who are dependent on others as a result of physical and/or mental limitations (409)[41], although some studies indicate that the care of the elderly dependent in Spain remains mainly informal (358), recent research points to changes in the organization of care for the elderly after the legislative change. Results show that care by individuals, kin and non-kin, who come from outside the home has increased. This has led to an increase in multiple care arrangements between informal care from both inside and outside the home as well as formal care, for instance through social services (365).

Consequently, as regards to Spain, we demonstrate that, given their older age, men live mainly with their partners who are their main caregiver when they become dependent. Meanwhile women are more likely to live alone and as a result obtain more help from outside the home for the provision of care (79). In the case of Latin American countries, in the absence of external care assistance, there is an incentive for activities that come from the community (366,367) to stimulate elderly well-being and a healthy life. However, coresiding in large households that suffer from overcrowding could have an adverse effect on elderly health (357).

[41] In the framework of the so-called “Dependency Act”.

Strengths and weaknesses

Below, a description is provided of the limitations and achievements from each of the analytical chapters of the thesis. These are grouped into three points of interest that emanate from the use of different data sources, namely health indicators, the applied methodological approaches and the resulting estimates.

Indicators

The first chapter covers 28 European countries for the period 2004 to 2014, covering more than 930,000 records from 8 data files (see ANNEX 1.12). The initial description of the sample was made on the data of the 28 countries. However, the analysis of the health transitions in Chapters 1 and 3 on the European context did not include the Nordic countries and the Netherlands since they use their permanent population registers system for the collection of information on people and households in the EU-SILC survey, while the selected countries (19 countries in the first chapter and 9 countries in the third) use the survey module (see ANNEX 1.2) but with differences in the implementation of the health indicator. We also excluded countries as France, United Kingdom and others, as we could not find key variable to link and follow individuals across the four waves.

In this sense, the indicator used to measure the state of health in these two chapters, was based on the *"GALI"* index, which measures in general the functional limitations of the population. However, this indicator present higher rates of attrition and missing values in countries which used a population register for collecting the information. It was therefore not possible to carry out a broader comparative perspective in the European region. We raise this problem, because it is well known that these countries have a different pattern of living arrangements in Europe, which would be interesting to explore in future analyses.

Another relevant point in this study, derived from the previous point, refers to the variation in the wording of the GALI question and its response categories in the countries of study (36), what makes this indicator not always comparable between countries nor in estimating differences by gender and educational level (195,397). However, there are studies that support the validity and reliability of its use (12,182) and there are others that point to important differences among European countries in indicators like healthy life expectancy due to discrepancies in the implementation of the question between countries and differences in the way the question is interpreted due to cultural differences (13,207,410).

In this regard, we identify possible biases in the results for Cyprus, Estonia, Greece, Lithuania, Latvia, Malta, Portugal and Slovakia, countries that changed the wording in the middle of the time series

analysed (36). However, despite the differences that the indicator has between the countries in the sample, we consider that the methodology used and the analysis performed are a good approximation to describe the patterns in the changes in health states of the elderly and the effect of individual and environmental factors on these trajectories between different European countries.

In the comparative analysis of the fourth chapter between Chile, Costa Rica and Spain, we indicate that some questions are not entirely comparable: questions regarding social participation (see ANNEX 4.7) and the phrasing of questions on functional limitations in basic activities of daily living (ADL), instrumental activities of daily living (IADL) and functional mobility (see ANNEX 4.1). Nevertheless, taking these differences into account, the analysis illustrates a comparative approach to health dynamics between two regions: Latin America and Europe.

In this chapter a different health indicator was used to measure the health status due to the high variability between health states in the younger age groups (50-60), as observed in TABLE 3.2). This second health indicator combines three indicators of functional limitations that measure the inability of the elderly to interact with their environment in everyday life (298). We therefore consider that this indicator, when compared to the GALI (used in the first two analytical chapters), could be more robust to measure the impediments or limitations in ADL; from a mild to a pre-clinical condition (342).

Studies report that the use of one or another indicator to measure healthy status also affects the differences in life expectancy and healthy years (373,374,379), even the same indicator used in a survey in different countries has variations in the results due to the implementation of the health question in the questionnaires and perception of functional limitations (13,14).

Finally, we call attention to the results of Costa Rica on the influence of social participation (model 4) in health changes. The total number of years and healthy years could be biased by the non-response of the people who used proxy to answer the survey. These people were not asked the question of social participation, which did not happen for the other countries of study (Chile and Spain). This therefore limits the possibility to identify the true effect of social participation in the trajectories of functionality and survival of the elderly population in Costa Rica.

Estimations

Regarding the calculations of mortality risks, we do not rule out that the estimates of mortality in the first and third chapters are underestimated or overestimated. We therefore did not go deeper into analyzing mortality. This was first because of an under-registration of deaths in the surveys (183,375), particularly in EU-SILC (201); and second, due to the moving out of elderly from their home to care

institutions in countries where the provision of formal care is widely implemented by the state, as is the case in western and eastern European countries (84,411). This transfer of the elderly population to care institutions is not reported in the surveys so these people are lost in the follow-up.

In the fourth chapter, the calculation of censored transitions in the interval of two observations in mortality, such as the change from a healthy state to death that could hide a latent transition to an unhealthy state in the interval of time does not suppose a limitation for the estimation of the transition probabilities or of life expectancies. This is because in the matrix of transitions the possible transitions are defined and by means of the initial calculated values through the "maximum likelihood", the transition probabilities better approximate the real probabilities. See Jackson (325) for the calculation of hazards and Van den Hout (327) for a thorough analysis of the method and application of the statistical packages in R.

Finally, we observe that the hazard ratios of the age variable within the model in the third and fourth chapters demonstrated different patterns in health deterioration (see TABLE 3.3 and TABLE 4.3) using the multistate methodology but with different assumptions[42]. The results indicate that the health deterioration decreases with age in the third chapter, but the opposite pattern is observed in the fourth chapter, which is closer to what is expected: i.e. that health deterioration increases with age (35). The difference in the estimates may be due to an effect of the number of observations and length of the observation interval between survey rounds. The survey used in the first estimate (EU_SILC) only has four observations with a year of separation between each observation in a period of 4 years, while the second estimate corresponds to five observations spaced from two to three years in a period of 13 years. The observation interval of the first survey used for one year could be a very small time interval to observe a change in health status over a period of four years. Additionally, attrition contributes to a reduction of the sample at the end of the period causing the number of events to decrease at the end of the observation period.

[42] In the first model a stratified hazard cox was used according to the type of transition with the implementation of the Nelson-Aalen estimator for the calculation of the cumulative hazard of each transition, while in the second model an exponential model with Gompertz distribution was used, including initial values of the transition probabilities using "maximum likelihood" which is the maximum probability that the occurrence of a particular transition can reach. This element allows estimating transitions to censored states and possible non-observed latent transitions.

Diverse results in life expectancy estimates

Continuing with the estimates of the fourth chapter, the results can be compared maintaining the differences in methodology, data source and reference period in previous studies for three countries.

Chile

In the case of Chile, the results are compared with the study carried out by Moreno, Albala y Lera et al. (310) in older adults, who use the same health indicator in another longitudinal statistical source (SABE) and the same multistate methodology with the same statistical program. This study uses two rounds for the period 2004-2005 and 2009-2010, so its transition probabilities refer to an interval of five years, while our study uses a longer period of 13 years with five rounds (2004, 2006, 2009, 2015, 2017).

The estimates of this study are close to ours, with two years of difference in total life expectancy at 60 years; 16.4 and 20.4 (compared to 18.3 and 22.9 in our study) with percentages of healthy years of 61.6% and 48.0% (vs. 57.8 and 52.5) for men and women, respectively. The difference between the results lies in the length of the reference period used in each study (cited study 2005-2010 and our study 2004-2017). This time difference allows us to identify a higher increase in healthy life expectancy in Chilean women.

Costa Rica

Estimates regarding Costa Rica are compared with Rosero-Bixby (324) and Payne (21). Although these studies used the same survey, they applied different methodological approaches. However, their results were similar to our study. The first author estimates the total life expectancy for men and women from the age of 60 and obtained results that are one year above our estimates for men (21.9 years) and two years for women (24.3 years). The second study, calculated in addition to the life expectancy also healthy life years at age 65 years, estimated on the basis of at least one ADL limitation (an indicator close to that of our study). His results report lower life expectancy values (one year less for both sexes) than those estimated in this study and a greater number of healthy years at age 65 (12 years for women and 14 for men). This indicates that, in the case of Costa Rica, the difference in years in life expectancy is due to the variation in the methodology used and the difference in healthy years is due to the health indicator used, our health indicator being more restrictive.

Spain

The results of Spain show differences with the estimates in previous studies (332,351) and official statistics that use the same SHARE survey (181,282,368) due to the fact that different methodologies

and indicators were applied for the calculation of total and healthy life expectancy. These studies use health prevalences through the implementation of the Sullivan method (369–372), but do not consider the variation of health change trajectories between ages over time, as incidence rates would capture. Instead, they use prevalence of health states according to different health indicators in the surveys (12,37,372) for the estimation of healthy years, and the use of mortality records from vital statistics for the calculation of life expectancy. On the other hand, in our study we use survey data for the information on both health and mortality.

We therefore use the panel-type data of respondents with more than two observations to observe the change in their health status or the occurrence of death. In this way, the incidence rates are calculated, followed by the hazards and the respective expected remaining years of life. Consequently, our estimates of life expectancy are lower than those reported in official sources. This difference is inherent mainly in the source of mortality used to make the estimates, which affects a different image of survival and probably gender gaps (373,374). However, we report the same proportion of healthy years for both men and women [43] (368).

Vital mortality records refer to the entire population, including the institutionalized population, while in our study we only use the longitudinal information that was provided by private households that participated in the survey. This causes the mortality information of the surveys to be underestimated or over-estimated in some cases because people who move from homes to care institutions may often appear as deaths in the surveys or there is simply no information in this regard, generating that this population is excluded for not having a second observation. The most frequent pattern is that the death count in surveys generally estimates lower life expectancies than those estimated with vital records (375) due to a under-registration of deaths in surveys and the effect of attrition in consecutive observation rounds that ultimately reduce the initial sample, affecting the representativeness of the study population (114,376–378).

Consequently, the obtained healthy life years for the studied countries could not be properly compared with previous studies due to differences between the methodology, indicators and sources. A suggestion for future research is therefore to make estimates with different methods to identify which differences are attributable to the source, the indicator and the methodology used.

[43] Using the indication of at least one “ADL” limitation.

Finally, two scenarios are highlighted around the representativeness of the surveys used in this thesis. The first is sub-representation; although the four surveys used in this study (EU-SILC, SHARE, EPS and CRELES) are initially representative of the older population[44] according to countries, by following people with at least two observations for the calculation of incidence rates, the sample decreases and in the end we are left with a sub-sample of the initial sample that may not reflect the population of interest for each of the countries under study, especially those in poorer health and less favorable socioeconomic status groups due to the effect of attrition (114). The second scenario is over-representation; the Costa Rican survey (CRELES) has an important over-representation of the 80-year-old population (present in the sample design) that could influence the estimates from that age.

Relevance and future lines of research

Methodological or Empirical Relevance

This thesis includes a series of methodological contributions for the study of the health trajectories of the elderly population. Methodologies that allow an approach to health dynamics, their evolution in the course of the life course and their variability according to individual factors and their immediate environment. Through the different chapters this thesis has shown light on how various factors delay or accelerate favorable and harmful changes in health during a period of exposure. To do so, four different techniques were applied in survival analysis using longitudinal data.

In the first chapter, using the classic Cox model, the probabilities of changes in health among the elderly are described. Subsequently, with the inclusion of the analysis of variance with the "mixed effects" models[45], we were able to identify how health transition averages can vary according to individual factors between European countries. The results illustrated a fairly heterogeneous image of health patterns in the European continent.

The second and third chapters show in a very general way the application of multistate models"[46] that are frequently used to study the various trajectories of events in the life course in the field of epidemiology, such as disease progression and associated risk factors. The use of these models can also identify how the occurrence of one event can influence the occurrence of another, such as the

[44] EU-SILC is representative from the age of 16 for 37 European countries, SHARE is representative for the population of 50 years and over for 27 European countries, EPS is representative for the Chilean population of 15 years and CRELES is representative for the population of Costa Rica 60 years and over.
[45] Models calculated with "survival" and "coxME", R packages
[46] Models calculated with "survival" and "mstate", R packages

occurrence of health deterioration that reduces the risk of mortality. This application also allowed us to rectify the results illustrated in the first chapter, as similar results were obtained.

In the last chapter life expectancy was estimated by applying another "multistate" model approach"[47]. This application includes an alternative to frequently used methods for estimating total and healthy years of life (Sullivan method). It also allows testing the influence of exogenous variables on life expectancy because the estimates are calculated by taking into account initial states health (see chapter two and the methodological section in chapters three and four).

Comparative relevance at regional level

Finally, in addition to the methodological contributions, the set of analytical chapters shows a regional comparison of health changes, understood as functional trajectories, in a large number of countries. The main purpose of this thesis focused on identifying health changes, according to functional trajectories, among older people within the European and Latin American continent, as well as the factors associated with their immediate environment, specifically, the influence of living arrangements in the changes of health states.

As a result, this study provides important findings on various trends in the influence of living arrangements on health in different contexts, taking into account personal characteristics. In this sense, the thesis contributes to demographic studies on health and ageing by reporting evidence such as that living with a partner and children (a poorly studied coexistence group) benefits health improvements and delays the deterioration of health of the elderly in Europe, with some regional differences, for instance between Spain and Italy. In contrast, in Latin America we find that living patterns do not have a relevant effect on health changes, but on elderly survival. In addition, education showed to have an influence when living with others, as the most educated people in this living arrangement are more likely to experience health improvement and lower mortality. Finally, according to gender differences, our study reveals that the "gender paradox" was not observed in some Eastern European countries, as women are more likely to improve their health than men due to risk factors and different lifestyles.

In this sense, this thesis contributes to the knowledge of the health patterns of the elderly according to their main socio-economic characteristics and those of their immediate surroundings. These

[47] Models calculated with "msm" and "elect", R packages

findings make it possible to identify the demand for future care and plan the investment of relevant resources and long-term policies to meet the growing older population with differentiated demands according to more vulnerable groups, which include support for families that are the main source for help in a large number of countries. The investment of public policy resources for active and healthy ageing must also take into account the need to adapt public and common infrastructure that permits a friendly environment for people whose functional capacities deteriorate as a consequence of increasing age.

Future lines of research

Future lines of research should aim at making comparisons between lower levels of geographic aggregation within countries with the intention of identifying intra-national differences in health patterns, considering also the influence of exogenous variables. This interest is driven by the great territorial diversity present in the countries studied, as it is the case of Spain and Chile, as well as among Eastern European countries.

Additionally, it is pertinent to continue exploring other factors that may influence the health improvements of the elderly population, by identifying age group differences. Taking into account that the older population is a heterogeneous group it itself, a pending objective is to study the most advanced age groups who have particular characteristics when compared to the younger cohorts in terms of living arrangements, educational level, marriage trajectories, childhood and youth conditions, as well as lifestyles.

In this investigation, the functional trajectories defined by two indicators were studied to measure the state of health according to the functional limitations of daily life: the first indicator used was the "GALI" being a more general indicator and the second indicator was a combination which included ADLs, IADLs and functional mobility. In this sense, it is very important to study another dimension of health such as cognitive impairment and frailty conditions such as sarcopenia. Both health conditions are closely linked to disability and dependence of the elderly population, which makes its study of great relevance as a next step after the study of functional limitations.

Last but not least, it is of particular interest to make comparative estimates with the different methods used in this thesis in order to provide insight into the effectiveness of the methodological tools distinguishing the type of data source used. That is, the relevance of the method in the calculation of the transition probabilities according to the type of source used. In this study it was observed that the different approaches illustrated similar results, however, when changing the type of data source, slight variations in the estimates were shown.

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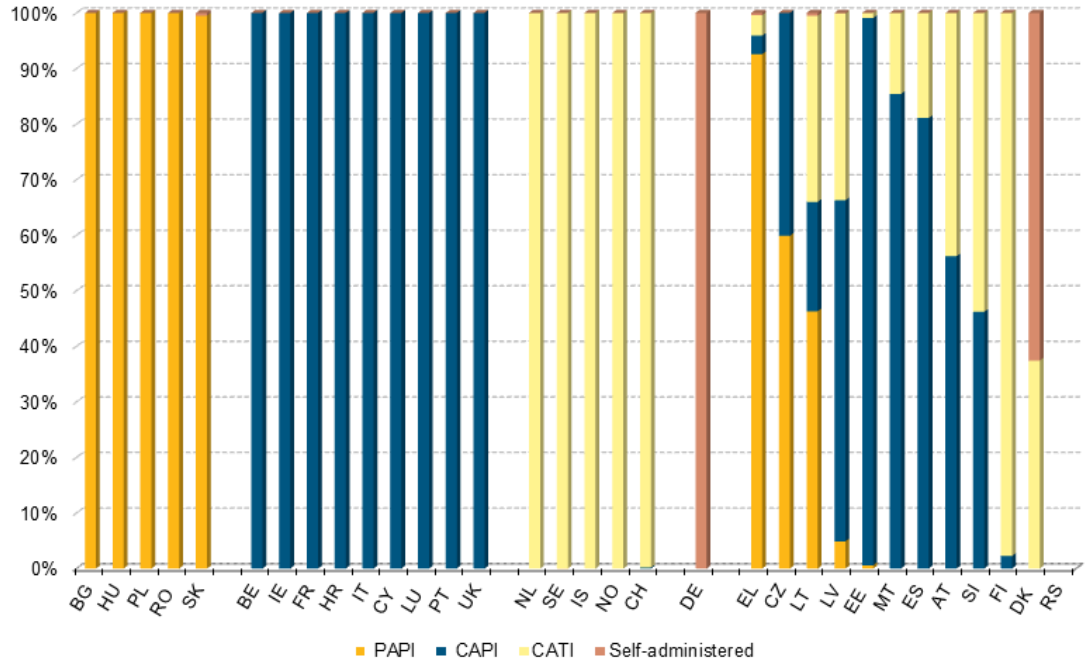
ANNEXES

ANNEX 1. 1. TABLE 1.- Population Distribution at baseline

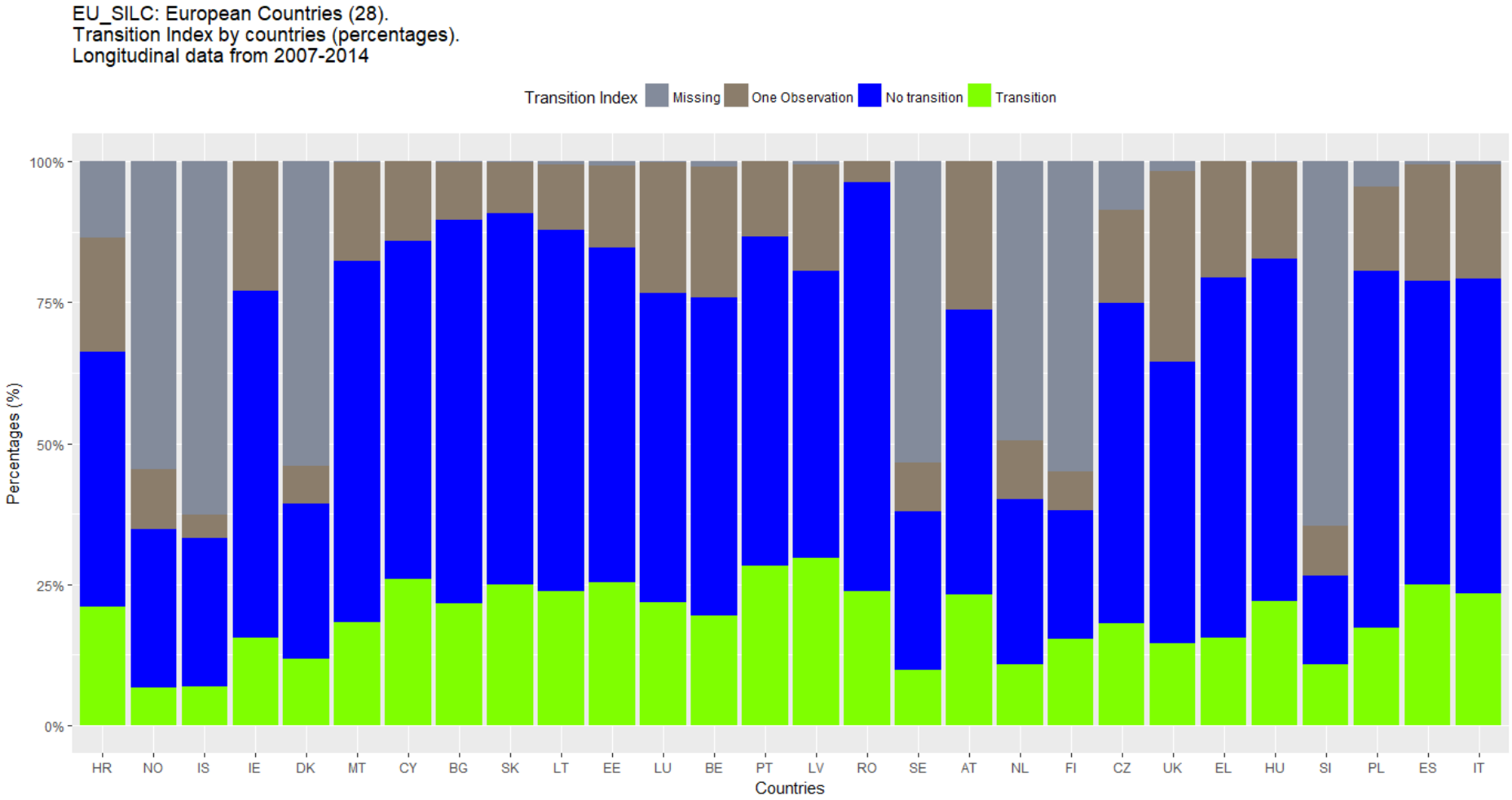
	Population 50+	Follow up		
Countries	Base	2	3	4
AT	13.443	10.539	9.121	7.989
BE	12.389	9.827	8.766	7.967
BG	11.032	10.242	9.321	8.474
CY	7.200	6.668	6.165	5.798
CZ	19.733	18.221	17.190	16.441
EE	8.990	8.015	7.296	6.696
EL	15.586	13.476	11.891	10.458
ES	32.083	26.363	22.930	20.528
HU	20.661	17.832	15.765	13.942
IE	6.361	5.766	3.898	2.212
IT	49.866	41.249	36.259	31.859
LT	11.101	10.349	9.633	9.043
LU	8.376	6.802	5.751	5.039
LV	12.463	10.585	9.458	8.599
MT	7.492	6.578	5.939	5.418
PL	27.523	24.793	22.788	21.317
PT	12.817	11.787	10.954	10.352
RO	10.754	10.538	10.272	10.034
SK	8.172	7.729	7.230	6.719
Sum	296.042	257.359	230.627	208.885

ANNEX 1. 2.- FIGURE 1.-EU-SILC Data collection procedures by country



Source: EUROSTAT(412).
Note: PAPI refers to Paper-Assisted Personal Interview, CAPI: Computer-Assisted Personal Interview, CATI: Computer-Assisted Telephone Interview. For the country abbreviations, see TABLE 1.1.

ANNEX 1. 3. FIGURE 2.- Sample distribution according to transition index, by country



ANNEX 1. 4. TABLE 2.- Population distribution by demographic characteristics

Countries (table part 1.1)			Western countries												Southern countries							
			AT		BE		IE		LU		CY		EL		ES		IT		MT		PT	
EU-SILC Survey sample			Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)
Total Population	568.837		25.246	8.129	23.932	6.144	11.989	2.503	19.720	5.673	16.459	5.116	27.981	5.900	62.114	19.919	90.524	26.785	14.490	3.232	24.105	7.980
Aged 50+	258.824		10.671	4.650	10.211	3.598	5.785	1.674	6.800	2.720	6.671	3.377	13.508	4.620	27.042	12.401	42.474	18.151	6.572	2.606	12.038	5.426
50+ (%)	45,5%		42,3%	44%	42,7%	35%	48,3%	29%	34,5%	40%	40,5%	51%	48,3%	34%	43,5%	46%	46,9%	43%	45,4%	40%	49,9%	45%
Sex																						
Female	**143.524**		54,5%	43%	52,2%	36%	52,8%	29%	49,8%	41%	52,8%	52%	53,2%	34%	54,0%	46%	53,9%	43%	53,6%	41%	55,4%	45%
Male	**115.300**		45,5%	44%	47,8%	34%	47,2%	29%	50,2%	39%	47,2%	49%	46,8%	34%	46,0%	45%	46,1%	42%	46,4%	38%	44,6%	45%
Age Groups																						
[50,60)	**96.351**	**37,2%**	38%	40%	40%	29%	35%	21%	46%	36%	38%	43%	32%	24%	35%	36%	34%	35%	42%	27%	33%	41%
[60,70)	**78.295**	**30,3%**	33%	46%	31%	36%	31%	30%	33%	40%	32%	53%	28%	34%	29%	48%	30%	46%	32%	41%	31%	46%
[70,85)	**84.178**	**32,5%**	29%	46%	29%	42%	34%	35%	21%	49%	29%	59%	40%	42%	36%	54%	36%	48%	26%	58%	36%	48%
Cohort																						
[1.924,1.933)	**55.196**	**21,3%**	21%	46%	19%	44%	26%	38%	12%	49%	18%	58%	28%	43%	26%	54%	25%	46%	13%	59%	22%	46%
[1.934,1.943)	**69.865**	**27,0%**	29%	47%	26%	40%	28%	31%	24%	46%	26%	57%	28%	39%	26%	51%	28%	48%	28%	51%	31%	49%
[1.944,1.903)	**89.523**	**34,6%**	35%	43%	38%	32%	34%	25%	41%	38%	36%	49%	30%	28%	33%	41%	32%	39%	42%	33%	33%	44%
[1.954,1.963)	**44.240**	**17,1%**	16%	37%	17%	27%	12%	16%	24%	32%	19%	37%	14%	21%	15%	32%	15%	34%	18%	24%	14%	39%
Educational Attaiment																						
Primary	**131.048**	**50,6%**	33%	47%	46%	39%	65%	32%	46%	43%	59%	56%	68%	37%	69%	49%	71%	46%	82%	42%	69%	46%
Secondary	**88.855**	**34,3%**	53%	42%	29%	34%	18%	24%	36%	40%	24%	44%	16%	30%	10%	37%	21%	37%	9%	26%	5%	38%
Tertiary	**31.951**	**12,3%**	14%	41%	25%	29%	16%	20%	17%	31%	14%	37%	10%	21%	12%	33%	7%	31%	7%	28%	6%	33%
Missing	**6.970**	**2,7%**	0%		1%		1%		1%	35%	3%		5%		9%		1%		2%		21%	
Living Arrangement																						
Living in a couple	**108.743**	**42,0%**	51%	45%	54%	37%	42%	29%	45%	40%	49%	54%	46%	36%	37%	48%	35%	46%	36%	43%	47%	46%
With partner and Children	**68.874**	**26,6%**	18%	42%	17%	28%	19%	24%	31%	37%	31%	45%	29%	30%	34%	42%	34%	40%	36%	30%	26%	43%
With others	**35.907**	**13,9%**	8%	47%	8%	37%	12%	34%	9%	46%	9%	49%	11%	40%	17%	49%	13%	43%	15%	47%	14%	48%
Living Alone	**45.300**	**17,5%**	23%	41%	21%	37%	26%	30%	15%	42%	11%	51%	15%	33%	13%	47%	17%	41%	13%	50%	13%	45%
Marital Status																						
Married	**174.250**	**67,3%**	66%	44%	69%	34%	62%	28%	73%	39%	80%	51%	74%	34%	71%	45%	69%	43%	73%	36%	72%	45%
Never Married	**15.319**	**5,9%**	7%	40%	6%	33%	15%	29%	5%	42%	3%	46%	4%	31%	8%	43%	8%	40%	11%	42%	6%	39%
Separated	**18.119**	**7,0%**	11%	44%	12%	36%	5%	32%	11%	43%	4%	45%	3%	28%	4%	42%	4%	39%	3%	38%	4%	46%
Widowed	**51.135**	**19,8%**	16%	43%	13%	40%	18%	32%	11%	46%	13%	53%	19%	39%	17%	51%	18%	44%	13%	56%	18%	49%
Missing	**1**	**0,0%**																				

Countries (table part 1.2)			Eastern countries												Baltic countries					
			BG		CZ		HU		PL		RO		SK		EE		LT		LV	
EU-SILC Survey sample			*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*
Total Population	568.837		19.888	4.912	32.991	8.203	40.086	10.716	55.633	12.347	20.550	5.183	20.557	5.718	19.882	5.906	20.268	5.479	22.422	8.253
Aged 50+	258.824		10.260	3.702	17.007	5.882	18.079	7.166	24.141	8.184	10.554	3.784	7.728	2.991	8.079	3.178	10.408	4.037	10.796	5.262
50+ (%)	45,5%		51,6%	36%	51,6%	35%	45,1%	40%	43,4%	34%	51,4%	36%	37,6%	39%	40,6%	39%	51,4%	39%	48,1%	49%
Sex																				
Female	**143.524**		56,0%	37%	57,5%	35%	59,1%	39%	56,6%	34%	55,0%	36%	58,3%	37%	58,3%	38%	56,7%	38%	62,4%	48%
Male	**115.300**		44,0%	35%	42,5%	34%	40,9%	40%	43,4%	34%	45,0%	36%	41,7%	41%	41,7%	41%	43,3%	40%	37,6%	50%
Age Groups																				
[50,60)	**96.351**	**37,2%**	33%	26%	37%	27%	44%	34%	44%	28%	36%	32%	45%	39%	37%	38%	36%	30%	33%	45%
[60,70)	**78.295**	**30,3%**	32%	34%	34%	36%	29%	43%	27%	36%	30%	39%	30%	42%	30%	43%	30%	42%	30%	53%
[70,85)	**84.178**	**32,5%**	35%	47%	29%	43%	27%	45%	29%	42%	34%	37%	25%	35%	34%	38%	34%	45%	37%	49%
Cohort																				
[1.924,1.933)	**55.196**	**21,3%**	21%	51%	20%	42%	17%	45%	18%	43%	18%	39%	17%	35%	21%	37%	21%	47%	23%	48%
[1.934,1.943)	**69.865**	**27,0%**	27%	41%	27%	41%	24%	44%	24%	39%	29%	38%	25%	40%	29%	42%	29%	44%	30%	52%
[1.944,1.903)	**89.523**	**34,6%**	35%	30%	39%	30%	36%	39%	38%	31%	32%	35%	39%	41%	33%	41%	31%	36%	30%	50%
[1.954,1.963)	**44.240**	**17,1%**	18%	23%	14%	23%	22%	31%	20%	25%	20%	31%	19%	36%	18%	36%	19%	25%	17%	43%
Educational Attaiment																				
Primary	**131.048**	**50,6%**	43%	43%	21%	38%	38%	43%	37%	38%	52%	37%	22%	34%	28%	37%	34%	44%	34%	48%
Secondary	**88.855**	**34,3%**	39%	31%	70%	34%	48%	39%	53%	32%	39%	34%	64%	39%	48%	41%	45%	37%	48%	50%
Tertiary	**31.951**	**12,3%**	17%	29%	9%	29%	15%	33%	10%	32%	7%	38%	13%	44%	24%	40%	19%	33%	18%	47%
Missing	**6.970**	**2,7%**	1%		0%		0%		0%		2%		0%		0%		1%		0%	
Living Arrangement																				
Living in a couple	**108.743**	**42,0%**	40%	37%	50%	35%	41%	41%	38%	34%	54%	37%	31%	41%	43%	40%	49%	41%	37%	51%
With partner and kids	**68.874**	**26,6%**	26%	30%	17%	29%	21%	37%	31%	32%	11%	35%	37%	40%	22%	41%	22%	34%	18%	50%
With others	**35.907**	**13,9%**	18%	42%	9%	36%	16%	41%	16%	39%	12%	35%	15%	36%	18%	40%	14%	42%	23%	51%
Living Alone	**45.300**	**17,5%**	16%	37%	23%	36%	21%	38%	15%	32%	23%	33%	17%	34%	17%	34%	16%	36%	23%	41%
Marital Status																				
Married	**174.250**	**67,3%**	65%	34%	65%	34%	58%	40%	69%	33%	65%	37%	67%	40%	57%	40%	70%	39%	50%	51%
Never Married	**15.319**	**5,9%**	3%	34%	3%	29%	4%	36%	4%	30%	3%	28%	5%	36%	9%	39%	3%	27%	6%	44%
Separated	**18.119**	**7,0%**	6%	33%	11%	31%	13%	37%	4%	32%	5%	32%	6%	38%	12%	40%	8%	36%	16%	45%
Widowed	**51.135**	**19,8%**	25%	43%	21%	39%	25%	41%	22%	37%	28%	35%	21%	34%	22%	37%	19%	42%	28%	48%
Missing	**1**	**0,0%**																		

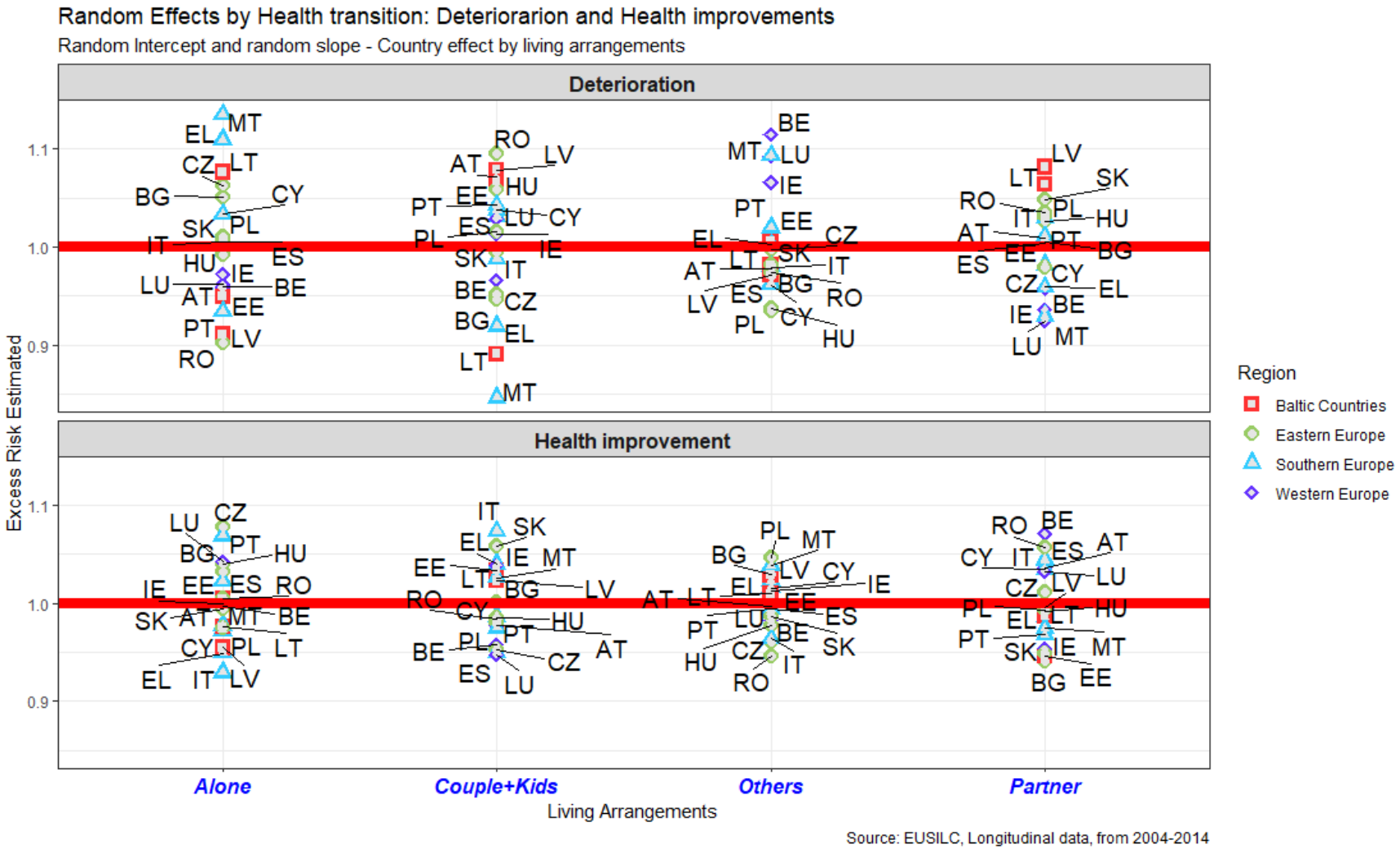
Countries (table part 2.1)			Western countries												Southern countries							
			AT		BE		IE		LU		CY		EL		ES		IT		MT		PT	
EU-SILC Survey sample			*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*
Employment status																						
Retirement	**129.128**	**49,9%**	61%	45%	49%	40%	23%	34%	39%	46%	48%	56%	53%	39%	36%	52%	47%	47%	35%	44%	54%	47%
domestic tasks and care	**26.276**	**10,2%**	9%	45%	11%	37%	23%	32%	22%	40%	12%	56%	17%	35%	24%	49%	16%	45%	35%	43%	10%	45%
Permanent Disabled	**10.688**	**4,1%**	1%	25%	4%	27%	6%	28%	5%	45%	1%	33%	2%	30%	4%	41%	2%	31%	3%	58%	2%	37%
Employee	**64.605**	**25,0%**	27%	39%	25%	29%	22%	19%	26%	33%	33%	42%	22%	23%	24%	35%	22%	33%	18%	20%	26%	41%
Others	**6.758**	**2,6%**	1%	50%	1%	26%	1%	41%	0%	44%	1%	54%	1%	24%	4%	47%	7%	44%	2%	51%	3%	41%
Unemployed	**7.807**	**3,0%**	2%	44%	5%	37%	3%	31%	1%	52%	2%	44%	2%	29%	5%	44%	2%	41%	1%	42%	4%	46%
Missing	**13.562**	**5,2%**	0%		4%	26%	22%	29%	6%	27%	3%	44%	4%	43%	4%	47%	5%	39%	6%	43%	3%	52%
Household Size																						
Two members	**113.318**	**43,8%**	51%	45%	54%	37%	46%	30%	45%	41%	49%	54%	46%	37%	39%	48%	39%	46%	42%	44%	43%	46%
Three members	**50.628**	**19,6%**	15%	42%	15%	32%	14%	28%	21%	39%	19%	49%	21%	32%	24%	45%	24%	42%	22%	36%	20%	46%
Four members	**28.101**	**10,9%**	6%	40%	7%	27%	8%	23%	12%	38%	12%	43%	12%	28%	15%	41%	14%	39%	15%	30%	10%	43%
Five and more	**20.614**	**8,0%**	5%	47%	4%	28%	6%	24%	8%	39%	9%	43%	7%	36%	9%	45%	6%	40%	8%	31%	7%	44%
One member	**45.305**	**17,5%**	23%	41%	21%	37%	26%	30%	15%	42%	11%	51%	15%	33%	13%	47%	17%	41%	13%	50%	13%	45%
Missing	**858**	**0,3%**	0%		0%		0%		0%		0%		0%		0%		0%		0%		7%	
Ends meet																						
Easely	**81.283**	**31,4%**	65%	43%	63%	33%	48%	27%	84%	39%	27%	46%	20%	31%	44%	43%	30%	39%	34%	34%	24%	42%
With Difficulty	**177.536**	**68,6%**	35%	44%	37%	39%	52%	31%	16%	46%	73%	52%	80%	35%	56%	48%	70%	44%	66%	43%	76%	46%
Missing	**5**	**0,0%**																				
Warm home																						
No	**43.065**	**16,6%**	3%	39%	8%	36%	4%	34%	1%	57%	34%	55%	20%	36%	8%	50%	11%	45%	17%	47%	38%	46%
Yes	**215.758**	**83,4%**	97%	44%	92%	35%	96%	29%	99%	40%	66%	48%	80%	34%	92%	46%	89%	42%	83%	38%	62%	44%
Missing	**1**	**0,0%**																			1	

Countries (table part 2.2)			Eastern countries												Baltic countries					
			BG		CZ		HU		PL		RO		SK		EE		LT		LV	
EU-SILC Survey sample			*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*
Employment status																				
Retirement	**129.128**	**49,9%**	60%	41%	61%	39%	47%	43%	51%	37%	69%	37%	59%	38%	51%	38%	54%	44%	57%	50%
Fullfilling domestic tasks and care	**26.276**	**10,2%**	1%	37%	0%	29%	1%	42%	1%	32%	5%	37%	0%	44%	1%	40%	1%	33%	1%	59%
Permanent Disabled	**10.688**	**4,1%**	2%	44%	6%	27%	9%	33%	10%	31%	1%	30%	4%	17%	6%	21%	6%	36%	3%	26%
Employee	**64.605**	**25,0%**	27%	22%	28%	25%	22%	31%	23%	25%	23%	30%	30%	40%	32%	42%	30%	28%	28%	47%
Others	**6.758**	**2,6%**	1%	33%	0%	41%	1%	41%	7%	34%	0%	26%	1%	46%	0%	75%	0%	38%	0%	42%
Unemployed	**7.807**	**3,0%**	6%	32%	2%	34%	3%	43%	3%	32%	1%	38%	3%	43%	4%	46%	4%	34%	6%	52%
Missing	**13.562**	**5,2%**	3%	53%	3%	51%	18%	44%	4%	51%	1%	73%	4%	51%	6%	45%	5%	58%	4%	55%
Household Size																				
Two members	**113.318**	**43,8%**	42%	37%	54%	35%	45%	41%	40%	35%	48%	38%	34%	41%	47%	40%	50%	41%	40%	51%
Three members	**50.628**	**19,6%**	18%	33%	15%	31%	18%	40%	20%	34%	14%	36%	20%	40%	19%	40%	19%	36%	18%	49%
Four members	**28.101**	**10,9%**	10%	33%	5%	28%	10%	37%	11%	32%	8%	33%	14%	38%	10%	38%	9%	37%	9%	51%
Five and more	**20.614**	**8,0%**	14%	37%	3%	35%	6%	40%	14%	35%	8%	36%	15%	38%	8%	44%	7%	40%	10%	55%
One member	**45.305**	**17,5%**	16%	37%	23%	36%	21%	38%	15%	32%	23%	33%	17%	34%	17%	34%	16%	36%	23%	41%
Missing	**858**	**0,3%**	0%		0%		0%		0%		0%		0%		0%		0%		0%	
Ends meet																				
Easely	**81.283**	**31,4%**	7%	28%	37%	32%	13%	38%	23%	32%	14%	35%	22%	41%	47%	42%	17%	35%	14%	50%
With Difficulty	**177.536**	**68,6%**	93%	37%	63%	36%	87%	40%	77%	35%	86%	36%	78%	38%	53%	37%	83%	40%	86%	49%
Missing	**5**	**0,0%**																		
Warm home																				
No	**43.065**	**16,6%**	53%	36%	9%	40%	14%	39%	23%	35%	22%	37%	9%	37%	3%	43%	30%	42%	26%	44%
Yes	**215.758**	**83,4%**	47%	36%	91%	34%	86%	40%	77%	33%	78%	36%	91%	39%	97%	39%	70%	37%	74%	50%
Missing	**1**	**0,0%**																		

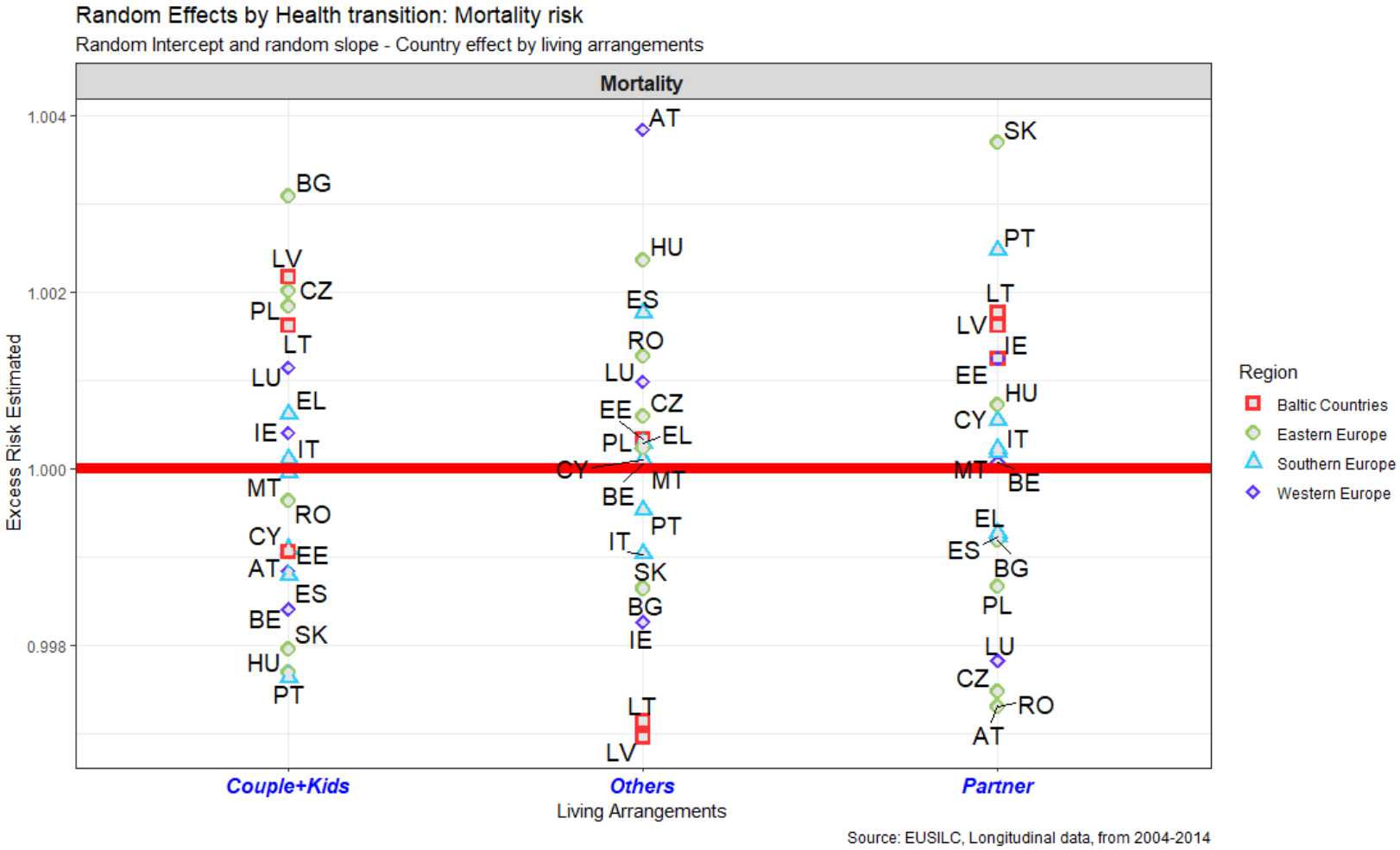
Countries (table part 3.1)				Western countries												Southern countries							
				AT		BE		IE		LU		CY		EL		ES		IT		MT		PT	
EU-SILC Survey sample				*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*
Deterioration	Total	%	(Health Trans)																				
Living Arrangement	191.351		74.560		43%				26%		52%		46%		33%		43%		42%		55%		32%
Partner	81.544	42,6%	32.375	53%	43%	55%	33%	42%	25%	30%	57%	48%	49%	45%	34%	37%	45%	35%	45%	38%	55%	38%	32%
Alone	29.329	15,3%	13.907	21%	48%	19%	39%	23%	33%	14%	63%	10%	60%	12%	47%	11%	54%	15%	52%	20%	58%	13%	40%
Both(partner and children)	57.809	30,2%	18.569	20%	36%	18%	24%	23%	20%	44%	45%	35%	37%	34%	25%	37%	37%	39%	35%	22%	49%	35%	27%
Others	22.669	11,8%	9.709	7%	45%	7%	37%	11%	33%	12%	54%	7%	49%	9%	38%	14%	47%	11%	44%	20%	58%	14%	36%
Health Improvement																							
Living Arrangement	156.393		61.698		46%		47%		37%		26%		55%		30%		49%		42%		39%		32%
Partner	65.924	42,2%	26.811	49%	49%	53%	50%	40%	35%	33%	24%	52%	56%	47%	30%	38%	51%	37%	43%	36%	42%	37%	34%
Alone	32.022	20,5%	11.021	26%	42%	25%	42%	32%	34%	19%	22%	14%	46%	19%	24%	15%	44%	21%	33%	24%	35%	18%	27%
Both(partner and children)	33.610	21,5%	15.843	15%	50%	13%	53%	13%	51%	31%	33%	24%	64%	20%	40%	28%	54%	27%	51%	16%	48%	27%	37%
Others	24.837	15,9%	8.023	10%	36%	9%	38%	15%	34%	16%	20%	10%	44%	13%	25%	19%	40%	15%	34%	24%	35%	19%	27%
Death from unhealthy																							
Living Arrangement	156.393		7.530		3%		2%		3%		5%		4%		7%		5%		4%		6%		6%
Partner	65.924	42,2%	3.455	49%	3%	53%	2%	40%	5%	33%	6%	52%	5%	47%	7%	38%	5%	37%	4%	36%	7%	37%	6%
Alone	32.022	20,5%	22	26%	0%	25%	0%	32%	0%	19%	0%	14%	0%	19%	0%	15%	0%	21%	0%	24%	0%	18%	0%
Both(partner and children)	33.610	21,5%	1.364	15%	3%	13%	0%	13%	3%	31%	3%	24%	2%	20%	5%	28%	4%	27%	3%	16%	6%	27%	6%
Others	24.837	15,9%	2.689	10%	12%	9%	4%	15%	6%	16%	9%	10%	10%	13%	15%	19%	11%	15%	8%	24%	11%	19%	12%

Countries (table part 3.2)				Eastern countries												Baltic countries			
				BG		CZ		HU		PL		RO		SK		EE		LT		LV	
EU-SILC Survey sample				*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*	*Total*	*(Health Trans)*
	Total	%	*(Health Trans)*																
Deterioration																			
Living																			
Arrangement	191.351		74.560		28%		31%		42%		30%		46%		42%		47%		38%		34%
Partner	81.544	42,6%	32.375	41%	28%	52%	31%	42%	42%	36%	32%	47%	48%	57%	41%	44%	47%	49%	39%	46%	34%
Alone	29.329	15,3%	13.907	15%	38%	21%	41%	19%	50%	12%	47%	11%	55%	20%	46%	15%	52%	14%	48%	14%	40%
Both(partner and children)	57.809	30,2%	18.569	28%	21%	19%	23%	24%	34%	38%	21%	30%	39%	12%	37%	27%	40%	25%	27%	32%	30%
Others	22.669	11,8%	9.709	16%	31%	8%	32%	14%	43%	14%	38%	12%	51%	11%	44%	14%	51%	12%	43%	8%	42%
Health Improvement																			
Living																			
Arrangement	156.393		61.698		39%		37%		34%		63%		42%		27%		32%		34%		56%
Partner	65.924	42,2%	26.811	40%	38%	49%	39%	40%	36%	38%	64%	48%	41%	52%	30%	43%	32%	49%	36%	45%	58%
Alone	32.022	20,5%	11.021	20%	36%	27%	35%	24%	32%	19%	57%	14%	42%	26%	23%	18%	29%	19%	30%	17%	54%
Both(partner and children)	33.610	21,5%	15.843	20%	46%	13%	41%	18%	41%	25%	72%	22%	48%	9%	30%	19%	40%	17%	42%	27%	59%
Others	24.837	15,9%	8.023	20%	35%	11%	28%	18%	28%	18%	56%	16%	34%	13%	20%	20%	26%	16%	27%	11%	46%
Death from unhealthy																			
Living																			
Arrangement	156.393		7.530		9%		4%		5%		5%		5%		3%		6%		6%		3%
Partner	65.924	42,2%	3.455	40%	10%	49%	5%	40%	6%	38%	6%	48%	5%	52%	3%	43%	7%	49%	7%	45%	2%
Alone	32.022	20,5%	22	20%	0%	27%	0%	24%	0%	19%	1%	14%	0%	26%	0%	18%	0%	19%	0%	17%	0%
Both(partner and children)	33.610	21,5%	1.364	20%	10%	13%	4%	18%	4%	25%	4%	22%	4%	9%	3%	19%	5%	17%	7%	27%	3%
Others	24.837	15,9%	2.689	20%	17%	11%	11%	18%	12%	18%	10%	16%	11%	13%	7%	20%	12%	16%	12%	11%	7%

ANNEX 1. 5. FIGURE 3.- Model 4, Mixed Effects Model, random intercept by countries and random slopes by living arrangements



Note: the red line represents the reference risk (mean effect of slopes) reported by the fixed coefficients for living arrangements group in the 4th model. Countries comprise the estimated excess risk reported by the (exponentiated) standard deviations for slopes by living arrangements within countries.



Note: the red line represents the reference risk (mean effect of slopes) reported by the fixed coefficients for living arrangements group in the 4th model. Countries comprise the estimated excess risk reported by the (exponentiated) standard deviations for slopes by living arrangements within countries. Mixed effect calculated with “survival” and “coxME” R packages

ANNEX 1. 6.TABLE 3.- Analysis of deviance TABLE of the mixed effects models by type of health transition

	Deterioration					Health improvements					Death from Unhealthy				
Model	-2 log L	Chisq	Df	P(>|Chi|)	Sig.	-2 log L	Chisq	Df	P(>|Chi|)	Sig.	-2 log L	Chisq	Df	P(>|Chi|)	Sig.
1	-676245					-543539					-61130				
2 (vs 1)	-674622	3244.1	1	<2e-16	***	-542217	2645.6	1	<2e-16	***	-61087	85.7	1	<2e-16	***
3 (vs 1)	-672273	4698.8	0	<2e-16	***	-539354	5725.8	0	<2e-16	***	-60795	584.7	0	<2e-16	***
4 (vs 3)	-672232	83.1	1	<2e-16	***	-539323	60.7	1	6.6E-15	***	-60795	0.1	1	0.8106	
5 (vs 3)	-672255	46.4	0	<2e-16	***	-539336	24.5	0	<2e-16	***	-60795	0.6	0	<2e-16	***
6 (vs 3)	-672192	126.0	0	<2e-16	***	-539192	287.1	0	<2e-16	***	-60792	5.1	0	<2e-16	***
7 (vs 3)	-672212	39.8	0	<2e-16	***	-539322	260.8	0	<2e-16	***	-60792	0.3	0	<2e-16	***
8 (vs 4)	-672221	18.3	1	1.8E-05	***	-539306	32.2	1	1.4E-08	***	-60792	1.6	1	0.2127	
9 (vs 4)	-672169	104.4	0	<2e-16	***	-539183	246.8	0	<2e-16	***	-60789	4.8	0	<2e-16	***
10 (vs 4)	-672179	19.8	0	<2e-16	***	-539298	229.8	0	<2e-16	***	-60792	6.4	0	<2e-16	***

ANNEX 1. 7. TABLE 4.- Detailed model results for health deterioration transition

Deterioration	**Model= 1** Cox				**Model= 2** Random intercept/ ID				**Model= 3** Random intercept= Country				**Model= 4** Random intercept/ Random Slope Country/Living A.				**Model= 5** Random intercept/ Random Slope Country/sex				**Model= 6** Random intercept/ Random Slope Country/cohort				**Model= 7** Random intercept/ Random Slope Country/education				**Model= 8** Random intercept/ Random Slope Country/Sex/liv				**Model= 9** Random intercept/ Random Slope Country/cohort/liv				**Model= 10** Random intercept/ Random Slope Country/Edu/liv			
Fixed coefficients																																										
Living arrangements	coef	exp(coef)	Pr(>|z|)	**Sig.**	coef	exp(coe	p	**Sig.**	coef	exp(coef)	p	**Sig.**	coef	xp(coe	p	**Sig.**	coef	xp(coe	p	**Sig.**	coef	xp(coef	P	**Sig.**	coef	exp(coef	p	**Sig.**	coef	xp(coe	p	**Sig.**	coef	xp(coef)		**Sig.**	coef	exp(coef	p	**Sig.**
Living with partner(ref)																																										
Living with partner+kids	-0,01	0,99	0,25		-0,01	0,99	0,24		-0,02	0,98	0,05	.	-0,01	0,98	0,69		-0,02	0,98	0,05	.	-0,02	0,98	0,10	.	-0,02	0,98	0,10	.	-0,05	0,95	0,01	**	-0,04	0,96	0,02	**	-0,04	0,96	0,01	*
Living Alone	0,06	1,06	0,00	***	0,06	1,06	0,00	***	0,04	1,04	0,00	***	0,05	1,04	0,05	*	0,04	1,04	0,00	***	0,04	1,04	0,00	***	0,04	1,04	0,00	***	0,04	1,04	0,05	*	0,04	1,04	0,01	**	0,05	1,05	0,01	**
Living with others	0,03	1,03	0,01	**	0,03	1,04	0,00	**	0,01	1,01	0,42		0,04	1,01	0,14		0,01	1,01	0,41		0,01	1,01	0,40		0,01	1,01	0,26		0,01	1,01	0,50		0,02	1,02	0,30		0,02	1,03	0,22	
Sex																																									
Male(ref)																																									
Female	0,12	1,13	< 2e-16	***	0,13	1,13	0,00	***	0,12	1,13	0,00	***	0,12	1,13	0,00	***	0,12	1,13	0,00	***	0,12	1,13	0,00	***	0,12	1,13	0,00	***	0,12	1,13	0,00	***	0,13	1,13	0,00	***	0,12	1,13	0,00	***
Cohort born																																									
Cohort 1924-33(ref)																																									
Cohort 1934-43	0,29	1,34	< 2e-16	***	0,30	1,35	0,00	***	0,31	1,36	0,00	***	0,31	1,36	0,00	***	0,29	1,36	0,00	***	0,29	1,34	0,00	***	0,31	1,36	0,00	***	0,31	1,36	0,00	***	0,32	1,37	0,00	***	0,31	1,36	0,00	***
Cohort 1944-53	0,55	1,73	< 2e-16	***	0,56	1,75	0,00	***	0,59	1,80	0,00	***	0,59	1,80	0,00	***	0,58	1,80	0,00	***	0,58	1,79	0,00	***	0,59	1,81	0,00	***	0,59	1,81	0,00	***	0,61	1,84	0,00	***	0,59	1,81	0,00	***
Cohort 1954-63	0,80	2,22	< 2e-16	***	0,82	2,26	0,00	***	0,85	2,33	0,00	***	0,85	2,33	0,00	***	0,83	2,33	0,00	***	0,83	2,29	0,00	***	0,84	2,33	0,00	***	0,85	2,33	0,00	***	0,87	2,38	0,00	***	0,85	2,33	0,00	***
Educational Attainment																																									
Primary (ref)																																									
Secondary	-0,17	0,84	< 2e-16	***	-0,17	0,84	0,00	***	-0,22	0,80	0,00	***	-0,22	0,80	0,00	***	-0,22	0,80	0,00	***	-0,22	0,80	0,00	***	-0,22	0,80	0,00	***	-0,22	0,80	0,00	***	-0,22	0,80	0,00	***	-0,21	0,81	0,00	***
Tertiary	-0,41	0,66	< 2e-16	***	-0,42	0,66	0,00	***	-0,48	0,62	0,00	***	-0,48	0,62	0,00	***	-0,48	0,62	0,00	***	-0,48	0,62	0,00	***	-0,46	0,63	0,00	***	-0,48	0,62	0,00	***	-0,48	0,62	0,00	***	-0,45	0,64	0,00	***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1																																									
Random Effects																																									
Random Intercept																																									
ID					0,0																																				
Country									0,32			**37%**		0,31		**36%**		0,31		**37%**		0,31		**37%**		0,31		**37%**		**0,31**		36%		0,3118		37%		0,31		36%
Random slopes																																									
Country/living A														0,07		**8%**																									
Country/Sex																		0,05		**5%**										0,032		3%								
Country/Cohort																						0,09		**10%**										0,0777		8%					
Country/Education																										0,08		**9%**										0,07		8%
Country/Sex/liv																														0,077		8%								
Country/Cohort/liv																																		0,0679		7%				
Country/Edu/liv																																						0,07		7%
Loglikelihood	-676245				-674622				-672273				-672232				-672255				-672192				-672212				-672221				-672169				-672179			

Note: Mixed effects calculated with “survival” and “coxME” R packages.

ANNEX 1. 8. TABLE 5.- Detailed model results for health improvement transition

Health Improvements	**Model= 1** Cox				**Model= 2** Random intercept/ ID				**Model= 3** Random intercept= Country				**Model= 4** Random intercept/ Random Slope Country/Living A.				**Model= 5** Random intercept/ Random Slope Country/sex				**Model= 6** Random intercept/ Random Slope Country/cohort				**Model= 7** Random intercept/ Random Slope Country/education				**Model= 8** Random intercept/ Random Slope Country/Sex/liv				**Model= 9** Random intercept/ Random Slope Country/cohort/liv				**Model= 10** Random intercept/ Random Slope Country/Edu/liv			
Fixed coefficients																																								
Living arrangements	coef	xp(coe	Pr(>|z|)		coef	xp(coe	p	**Sig.**	coef	xp(coe	p	**Sig.**	coef	xp(coe	p	**Sig.**	coef	xp(coe	p	**Sig.**	coef	xp(coef	p	**Sig.**	coef	xp(coef	p	**Sig.**	coef	xp(coef	p	**Sig.**	coef	xp(coef	p	**Sig.**	coef	xp(coef	p	**Sig.**
Living with partner(ref)																																								
Living with partner+kids	0,12	1,13	< 2e-16	***	0,12	1,13	0,00	***	0,09	1,10	0,00	***	0,10	1,10	0,00	***	0,09	1,10	0,00	***	0,09	1,09	0,00	***	0,09	1,10	0,00	***	0,07	1,08	0,00	***	0,08	1,09	0,00	***	0,07	1,08	0,00	***
Living Alone	-0,09	0,92	0,00	***	-0,09	0,91	0,00	***	-0,08	0,93	0,00	***	-0,06	0,94	0,01	**	-0,08	0,92	0,00	***	-0,07	0,93	0,00	***	-0,08	0,93	0,00	***	-0,05	0,95	0,01	**	-0,07	0,93	0,00	***	-0,06	0,94	0,00	***
Living with others	-0,15	0,86	< 2e-16	***	-0,16	0,85	0,00	***	-0,14	0,87	0,00	***	-0,12	0,88	0,00	***	-0,14	0,87	0,00	***	-0,14	0,87	0,00	***	-0,13	0,87	0,00	***	-0,14	0,87	0,00	***	-0,13	0,88	0,00	***	-0,13	0,88	0,00	***
Sex																																								
Male(ref)																																								
Female	-0,02	0,98	0,01	**	-0,02	0,98	0,01	**	0,00	1,00	0,94		0,00	1,00	1,00		0,01	1,01	0,56		0,00	1,00	0,93		0,00	1,00	0,96		0,00	1,00	0,82		0,00	1,00	0,91		0,00	1,00	0,94	
Cohort born																																								
Cohort 1924-33(ref)																																								
Cohort 1934-43	0,32	1,38	< 2e-16	***	0,33	1,39	0,00	***	0,35	1,41	0,00	***	0,35	1,41	0,00	***	0,35	1,41	0,00	***	0,32	1,37	0,00	***	0,35	1,41	0,00	***	0,34	1,41	0,00	***	0,33	1,39	0,00	***	0,35	1,41	0,00	***
Cohort 1944-53	0,56	1,75	< 2e-16	***	0,57	1,77	0,00	***	0,61	1,83	0,00	***	0,61	1,83	0,00	***	0,60	1,83	0,00	***	0,59	1,81	0,00	***	0,61	1,83	0,00	***	0,60	1,83	0,00	***	0,60	1,83	0,00	***	0,61	1,83	0,00	***
Cohort 1954-63	0,80	2,23	< 2e-16	***	0,82	2,27	0,00	***	0,87	2,39	0,00	***	0,87	2,39	0,00	***	0,87	2,38	0,00	***	0,85	2,35	0,00	***	0,87	2,39	0,00	***	0,87	2,38	0,00	***	0,86	2,36	0,00	***	0,87	2,39	0,00	***
Educational Attainment																																								
Primary (ref)																																								
Secondary	-0,04	0,96	0,00	***	-0,04	0,97	0,00	***	0,20	1,23	0,00	***	0,20	1,23	0,00	***	0,21	1,23	0,00	***	0,20	1,22	0,00	***	0,21	1,24	0,00	***	0,21	1,23	0,00	***	0,20	1,22	0,00	***	0,22	1,24	0,00	***
Tertiary	0,26	1,30	< 2e-16	***	0,27	1,31	0,00	***	0,39	1,48	0,00	***	0,39	1,48	0,00	***	0,39	1,48	0,00	***	0,39	1,48	0,00	***	0,42	1,53	0,00	***	0,39	1,48	0,00	***	0,39	1,48	0,00	***	0,43	1,54	0,00	***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1																																								
Random Effects																																								
Random Intercept																																								
ID						0,0	0,1%																																		
Country										0,38	**46%**			0,38	**46%**			0,38	**46%**			0,38	**46%**			0,36	**43%**			**0,37**	45%			0,37	45%			0,35488	43%	
Random slopes																																								
Country/living A														0,05	**5%**																									
Country/Sex																		0,04	**4%**											0,0189	2%								
Country/Cohort																						0,11	**11%**											0,11	12%				
Country/Education																										0,08	**8%**											0,07164	7%	
Country/Sex/liv																														0,0623	6%								
Country/Cohort/liv																																		0,049245	5%				
Country/Edu/liv																																						0,05544	6%	
Loglikelihood	-543539				-542217				-539354				-539323				-539336				-539192				-539322				-539306				-539183				-539298			

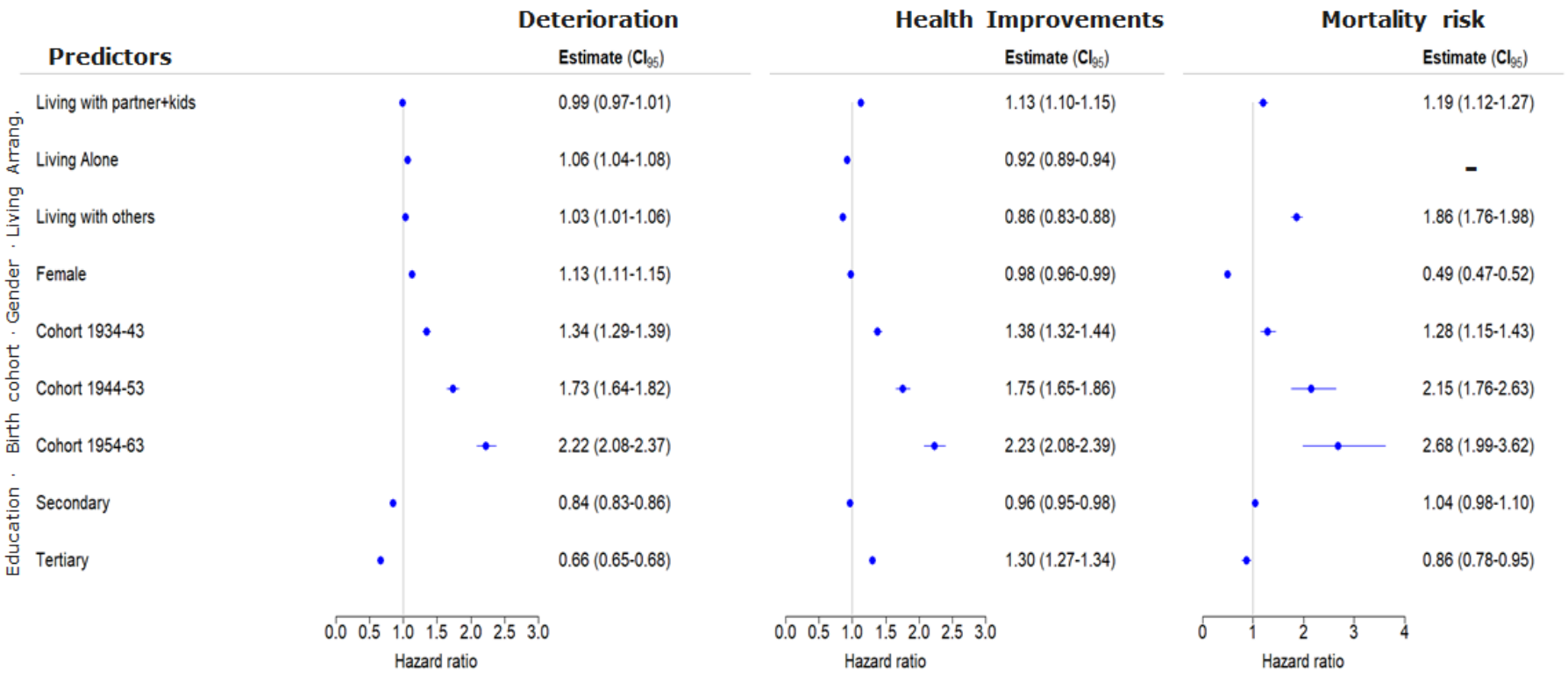
Note: Mixed effects calculated with “survival” and “coxME” R packages.

ANNEX 1. 9. TABLE 6.- Detailed model results for transition from unhealthy to death

Death from unhealthy	**Model= 1** Cox				**Model= 2** Random intercept/ ID				**Model 3** Random intercept= Country				**Model= 4** Random intercept/ Random Slope Country/Living A.				**Model= 5** Random intercept/ Random Slope Country/sex				**Model= 6** Random intercept/ Random Slope Country/cohort				**Model= 7** Random intercept/ Random Slope Country/education				**Model= 8** Random intercept/ Random Slope Country/Sex/liv				**Model= 9** Random intercept/ Random Slope Country/cohort/liv				**Model 10** Random intercept/ Random Slope Country/Edu/liv			
Fixed coefficients																																								
Living arrangements	coef	exp(coef)	z	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.	coef	exp(coef)	p	Sign.
Living with partner(ref)																																								
Living with partner+kids	0,18	1,19	0,00	***	0,18	1,19	0,00	***	0,17	1,19	0,00	***	0,17	1,19	0,00	***	0,17	1,19	0,00	***	0,18	1,19	0,00	***	0,17	1,19	0,00	***	0,18	1,19	0,00	***	0,16	1,17	0,00	***	0,17	1,19	0,00	***
Living Alone	-4,56	0,01	< 2e-16	***	-4,57	0,01	0,00	***	-4,57	0,01	0,00	***	-4,57	0,01	0,00	***	-4,57	0,01	0,00	***	-4,57	0,01	0,00	***	-4,57	0,01	0,00	***	-4,56	0,01	0,00	***	-4,59	0,01	0,00	***	-4,57	0,01	0,00	***
Living with others	0,62	1,86	< 2e-16	***	0,63	1,87	0,00	***	0,56	1,75	0,00	***	0,56	1,75	0,00	***	0,56	1,75	0,00	***	0,56	1,75	0,00	***	0,56	1,74	0,00	***	0,55	1,74	0,00	***	0,51	1,67	0,00	***	0,56	1,74	0,00	***
Sex																																								
Male(ref)																																								
Female	-0,71	0,49	< 2e-16	***	-0,72	0,49	0,00	***	-0,74	0,48	0,00	***	-0,74	0,48	0,00	***	-0,74	0,48	0,00	***	-0,74	0,48	0,00	***	-0,74	0,48	0,00	***	-0,74	0,48	0,00	***	-0,75	0,47	0,00	***	-0,74	0,48	0,00	***
Cohort born																																								
Cohort 1924-33(ref)																																								
Cohort 1934-43	0,25	1,28	0,00	***	0,25	1,29	0,00	***	0,24	1,27	0,00	***	0,24	1,27	0,00	***	0,24	1,27	0,00	***	0,25	1,28	0,00	***	0,24	1,27	0,00	***	0,24	1,28	0,00	***	0,23	1,26	0,00	***	0,24	1,27	0,00	***
Cohort 1944-53	0,77	2,15	0,00	***	0,77	2,15	0,00	***	0,74	2,10	0,00	***	0,74	2,10	0,00	***	0,74	2,10	0,00	***	0,73	2,07	0,00	***	0,74	2,10	0,00	***	0,74	2,10	0,00	***	0,71	2,03	0,00	***	0,74	2,10	0,00	***
Cohort 1954-63	0,99	2,68	0,00	***	0,99	2,69	0,00	***	0,96	2,61	0,00	***	0,96	2,61	0,00	***	0,96	2,61	0,00	***	0,95	2,58	0,00	***	0,96	2,62	0,00	***	0,96	2,62	0,00	***	0,93	2,54	0,00	***	0,96	2,62	0,00	***
Educational Attainment																																								
Primary (ref)																																								
Secondary	0,04	1,04	0,21		0,04	1,04	0,21		-0,13	0,88	0,00	***	-0,13	0,88	0,00	***	-0,13	0,88	0,00	***	-0,14	0,87	0,00	***	-0,13	0,87	0,00	***	-0,13	0,88	0,00	***	-0,14	0,87	0,00	***	-0,13	0,87	0,00	***
Tertiary	-0,15	0,86	0,00	***	-0,15	0,86	0,00	***	-0,30	0,74	0,00	***	-0,30	0,74	0,00	***	-0,30	0,74	0,00	***	-0,30	0,74	0,00	***	-0,30	0,74	0,00	***	-0,29	0,74	0,00	***	-0,29	0,75	0,00	***	-0,30	0,74	0,00	***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1																																								
Random Effects																																								
Random Intercept																																								
ID						0,0	0,4%																																			
Country										0,34	**41%**			0,34	**41%**			0,34	**40%**			0,35	**42%**			0,33	**40%**			**0,34**	41%			0,3518	42%			0,334	40%	
Random slopes																																								
Country/living A														0,01	**1%**																									
Country/Sex																		0,03	**3%**											0,01	1%									
Country/Cohort																						0,09	**10%**											0,0695	7%					
Country/Education																										0,08	**9%**											0,083	9%	
Country/Sex/liv																														0,09	9%									
Country/Cohort/liv																																		0,1053	11%					
Country/Edu/liv																																						0,006	1%	
Loglikelihood		-61130				-61087				-60795				-60795				-60795				-60792				-60792				-60792				-60789				-60792		

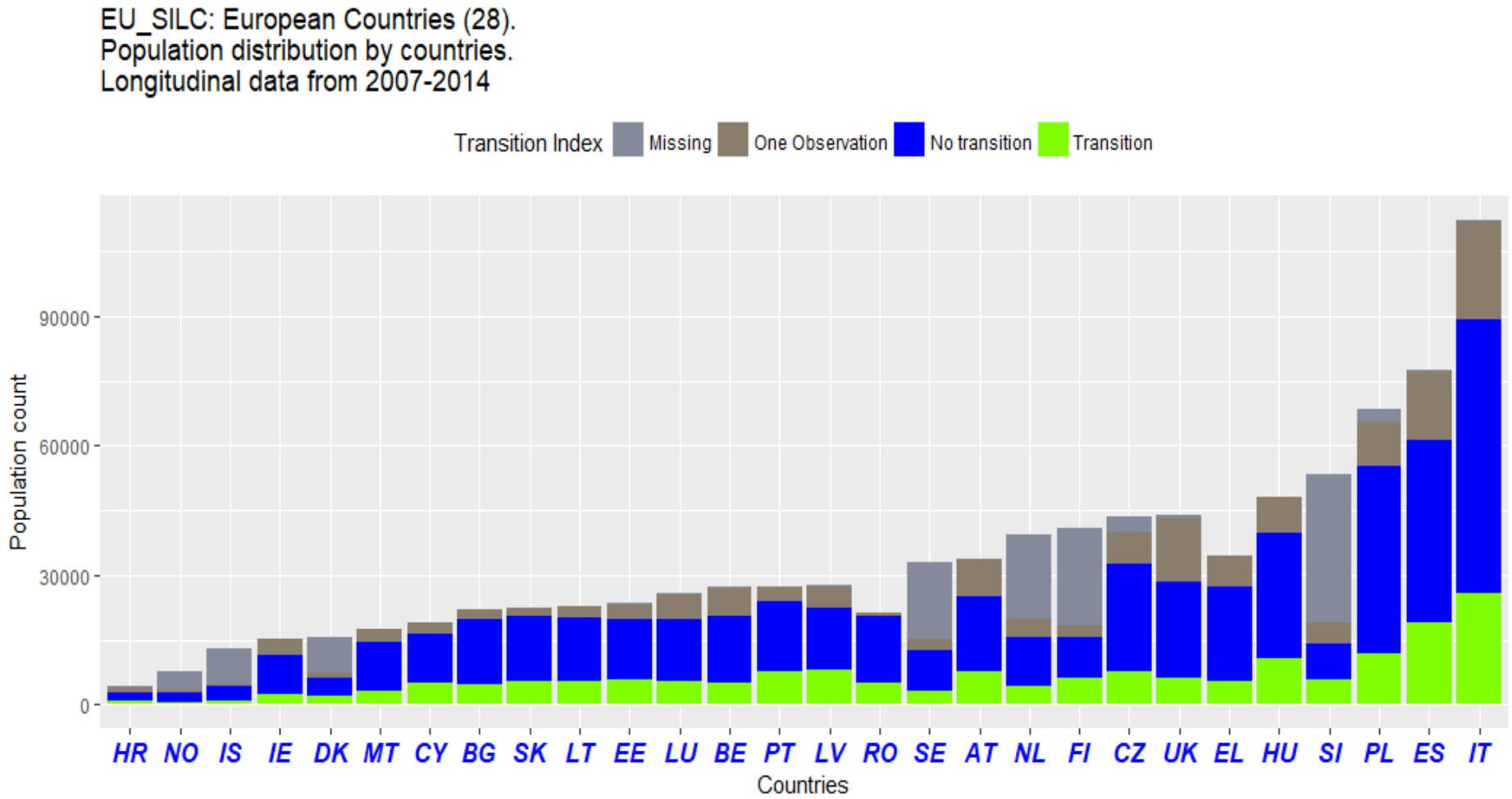
Note: Mixed effects calculated with “survival” and “coxME” R packages.

ANNEX 1. 10. FIGURE 4.- Multistate transition model fitted by Cox Proportional Model with stratified hazard by transition type



Note: The reference categories are: Living with partner, Male, Cohort 1924-33, Primary education.
Hazard ratios are adjusted for the remaining predictors.

ANNEX 1. 11. FIGURE 5.- Population Distribution in absolute numbers

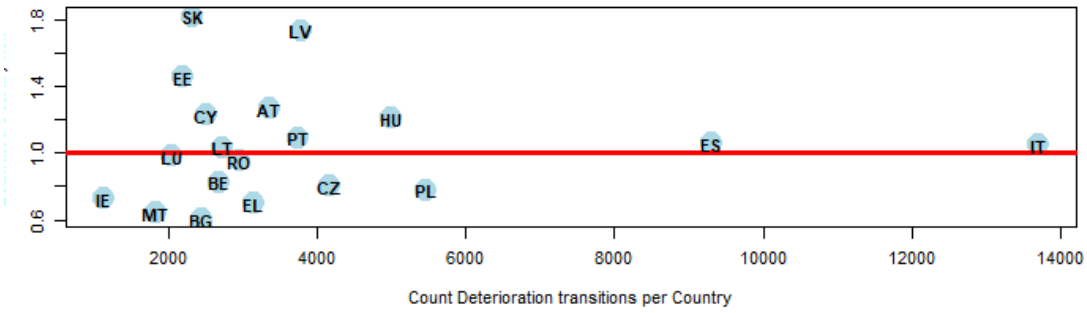


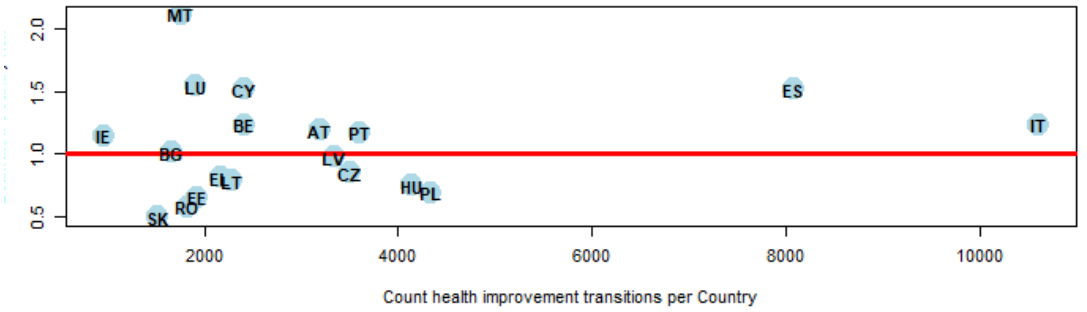
ANNEX 1. 12. TABLE 7.-Population Distribution by country and EU-SILC year´s file. 2007-20014

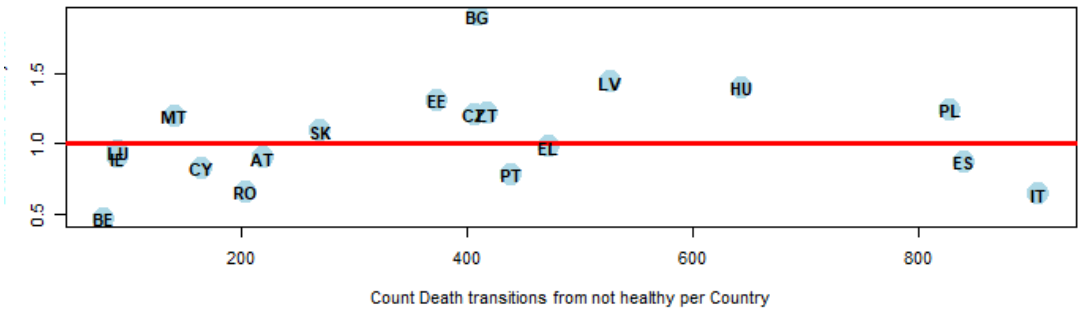
Country	2004 - **2007**	2005- **2008**	2006- **2009**	2007- **2010**	2008- **2011**	2009- **2012**	2010- **2013**	2011- **2014**	Total
AT	4.986	4.192	4.326	4.321	3.690	4.048	3.964	3.559	33.086
BE	2.796	4.492	4.186	4.255	3.265	3.850	4.145	3.852	30.841
BG	-	-	2.814	2.877	4.072	4.850	3.846	3.673	22.132
CY	-	2.515	2.462	2.442	2.197	2.132	4.163	2.864	18.775
CZ	-	9.167	7.563	5.642	4.425	5.294	5.519	4.928	42.538
DK	3.235	3.196	3.092	2.173	2.014	1.983	1.820	-	17.513
EE	-	1.520	4.193	3.825	3.584	2.941	3.586	3.607	23.256
EL	3.834	3.599	4.178	3.775	5.696	5.121	4.158	3.385	33.746
ES	9.623	9.458	9.266	9.777	9.705	9.661	9.290	8.976	75.756
FI	4.381	4.267	4.175	4.124	4.134	3.859	7.581	7.742	40.263
HR	-	-	-	-	-	-	4.469	-	4.469
HU	-	4.789	5.867	6.972	5.768	7.495	6.129	10.646	47.666
IE	3.137	2.935	2.799	-	-	-	2.835	2.766	14.472
IS	1.897	1.853	1.612	1.707	1.811	1.854	1.948	-	12.682
IT	14.176	14.171	13.694	13.679	13.632	13.022	11.823	14.560	108.757
LT	-	2.560	3.831	3.731	2.966	3.121	3.616	2.929	22.754
LU	-	-	-	9.191	8.030	2.548	3.139	2.760	25.668
LV	-	3.313	3.244	3.527	4.375	4.247	4.337	4.287	27.330
MT	-	-	2.882	2.878	2.569	3.082	2.989	3.170	17.570
NL	-	-	4.628	7.343	6.958	6.141	6.702	7.498	39.270
NO	-	-	-	-	-	-	-	7.688	7.688
PL	-	10.562	10.738	9.986	9.567	8.682	9.037	9.027	67.599
PT	3.170	2.961	2.771	3.198	3.170	3.900	3.516	3.970	26.656
RO	-	-	-	4.430	4.121	4.194	4.382	4.172	21.299
SE	4.015	3.937	3.585	4.703	3.871	3.974	3.751	4.629	32.465
SI	-	-	8.598	8.767	9.817	9.182	8.456	8.555	53.375
SK	-	3.408	3.496	3.814	4.042	3.852	3.704	-	22.316
UK	-	6.874	6.499	6.523	6.025	5.703	5.839	6.081	43.544
Total	55.250	99.769	120.499	133.660	129.504	124.736	134.744	135.324	933.486

Source: EU-SILC

ANNEX 1. 13. FIGURE 6.-Random Intercept by country compared with health transitions counts





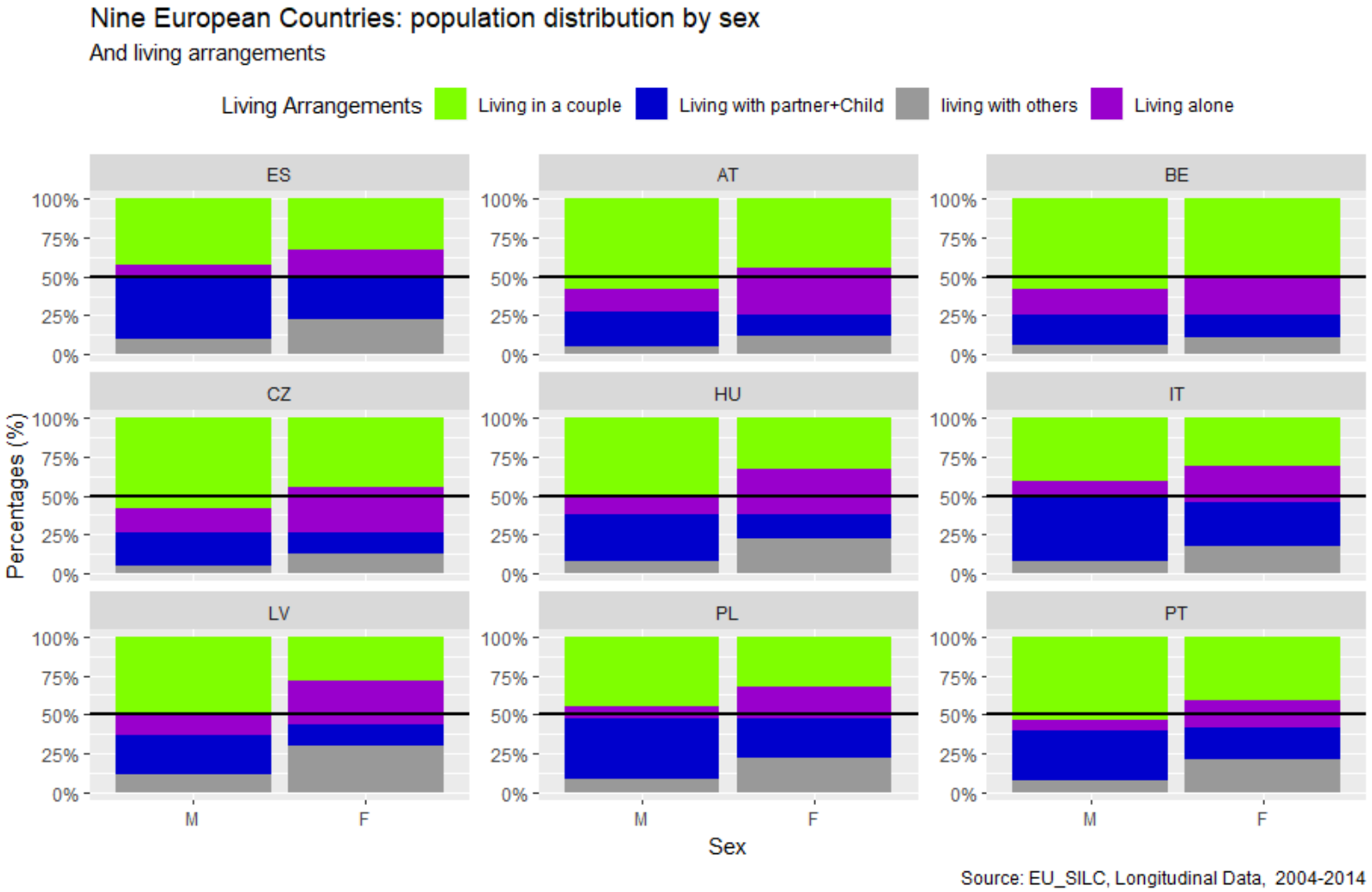


Note: Random coefficients by countries were estimated with "survival" and "coxME" R packages

ANNEX 3. 1. TABLE 8.- Population description at baseline.

EU-SILC Survey sample (9 Countries)				Western countries																Baltic countries	
				AT		BE		ES		IT		PT		CZ		HU		PL		LV	
		% pop.	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)	Total	(Health Trans)
Total Population	377.053		108.476	25.246	8.129	23.932	6.144	62.114	19.919	90.524	26.785	24.105	7.980	32.991	8.203	40.086	10.716	55.633	12.347	22.422	8.253
Aged 50+	172.459		70.720	10.671	4.650	10.211	3.598	27.042	12.401	42.474	18.151	12.038	5.426	17.007	5.882	18.079	7.166	24.141	8.184	10.796	5.262
50+ (%)	45,7%			42,3%	43,6%	42,7%	35,2%	43,5%	45,9%	46,9%	42,7%	49,9%	45,1%	51,6%	34,6%	45,1%	39,6%	43,4%	33,9%	48,1%	48,7%
Sex																					
Female	96.181	55,8%	39.607	54,5%	43%	52,2%	36%	54,0%	46%	53,9%	43%	55,4%	45%	57,5%	35%	59,1%	39%	56,6%	34%	62,4%	48%
Male	76.278	44,2%	31.113	45,5%	44%	47,8%	34%	46,0%	45%	46,1%	42%	44,6%	45%	42,5%	34%	40,9%	40%	43,4%	34%	37,6%	50%
Age Groups																					
[50,60)	64.185	37,2%	21.791	38%	40%	40%	29%	35%	36%	34%	35%	33%	41%	37%	27%	44%	34%	44%	28%	33%	45%
[60,70)	52.047	30,2%	22.443	33%	46%	31%	36%	29%	48%	30%	46%	31%	46%	34%	36%	29%	43%	27%	36%	30%	53%
[70,85)	56.227	32,6%	26.486	29%	46%	29%	42%	36%	54%	36%	48%	36%	48%	29%	43%	27%	45%	29%	42%	37%	49%
Cohort																					
[1.924,1.933)	37.825	21,9%	17.744	21%	46%	19%	44%	26%	54%	25%	46%	22%	46%	20%	42%	17%	45%	18%	43%	23%	48%
[1.934,1.943)	46.213	26,8%	21.264	29%	47%	26%	40%	26%	51%	28%	48%	31%	49%	27%	41%	24%	44%	24%	39%	30%	52%
[1.944,1.903)	59.613	34,6%	22.599	35%	43%	38%	32%	33%	41%	32%	39%	33%	44%	39%	30%	36%	39%	38%	31%	30%	50%
[1.954,1.963)	28.808	16,7%	9.113	16%	37%	17%	27%	15%	32%	15%	34%	14%	39%	14%	23%	22%	31%	20%	25%	17%	43%
Educational Attaiment																					
Primary	88.107	51,1%	39.471	33%	47%	46%	39%	69%	49%	71%	46%	69%	46%	21%	38%	38%	43%	37%	38%	34%	48%
Secondary	59.356	34,4%	21.996	53%	42%	29%	34%	10%	37%	21%	37%	5%	38%	70%	34%	48%	39%	53%	32%	48%	50%
Tertiary	19.637	11,4%	6.652	14%	41%	25%	29%	12%	33%	7%	31%	6%	33%	9%	29%	15%	33%	10%	32%	18%	47%
Missing	5.359	3,1%	2.601	0%		1%		9%		1%		21%		0%		0%		0%		0%	
Living Arrangement																					
Living in a couple	70.603	40,9%	29.886	51%	45%	54%	37%	37%	48%	35%	46%	47%	46%	50%	35%	41%	41%	38%	34%	37%	51%
With partner and Children	46.651	27,1%	17.990	18%	42%	17%	28%	34%	42%	34%	40%	26%	43%	17%	29%	21%	37%	31%	32%	18%	50%
With others	24.398	14,1%	10.686	8%	47%	8%	37%	17%	49%	13%	43%	14%	48%	9%	36%	16%	41%	16%	39%	23%	51%
Living Alone	30.807	17,9%	12.158	23%	41%	21%	37%	13%	47%	17%	41%	13%	45%	23%	36%	21%	38%	15%	32%	23%	41%
Household Size																					
Two members	74.403	43,1%	31.684	51%	45%	54%	37%	39%	48%	39%	46%	43%	46%	54%	35%	45%	41%	40%	35%	40%	51%
Three members	34.619	20,1%	14.065	15%	42%	15%	32%	24%	45%	24%	42%	20%	46%	15%	31%	18%	40%	20%	34%	18%	49%
Four members	18.786	10,9%	7.147	6%	40%	7%	27%	15%	41%	14%	39%	10%	43%	5%	28%	10%	37%	11%	32%	9%	51%
Five and more	12.981	7,5%	5.303	5%	47%	4%	28%	9%	45%	6%	40%	7%	44%	3%	35%	6%	40%	14%	35%	10%	55%
One member	30.812	17,9%	12.161	23%	41%	21%	37%	13%	47%	17%	41%	13%	45%	23%	36%	21%	38%	15%	32%	23%	41%
Missing	858	0,5%	360	0%		0%		0%		0%		7%		0%		0%		0%		0%	
Ends meet																					
Easely	56.504	32,8%	21.742	65%	43%	63%	33%	44%	43%	30%	39%	24%	42%	37%	32%	13%	38%	23%	32%	14%	50%
With Difficulty	115.955	67,2%	48.978	35%	44%	37%	39%	56%	48%	70%	44%	76%	46%	63%	36%	87%	40%	77%	35%	86%	49%
Missing			-																		

ANNEX 3. 2. FIGURE 7.- Living arrangements distribution by sex among countries



ANNEX 3. 3. TABLE 9.-Living arrangements distribution by sex by countries.

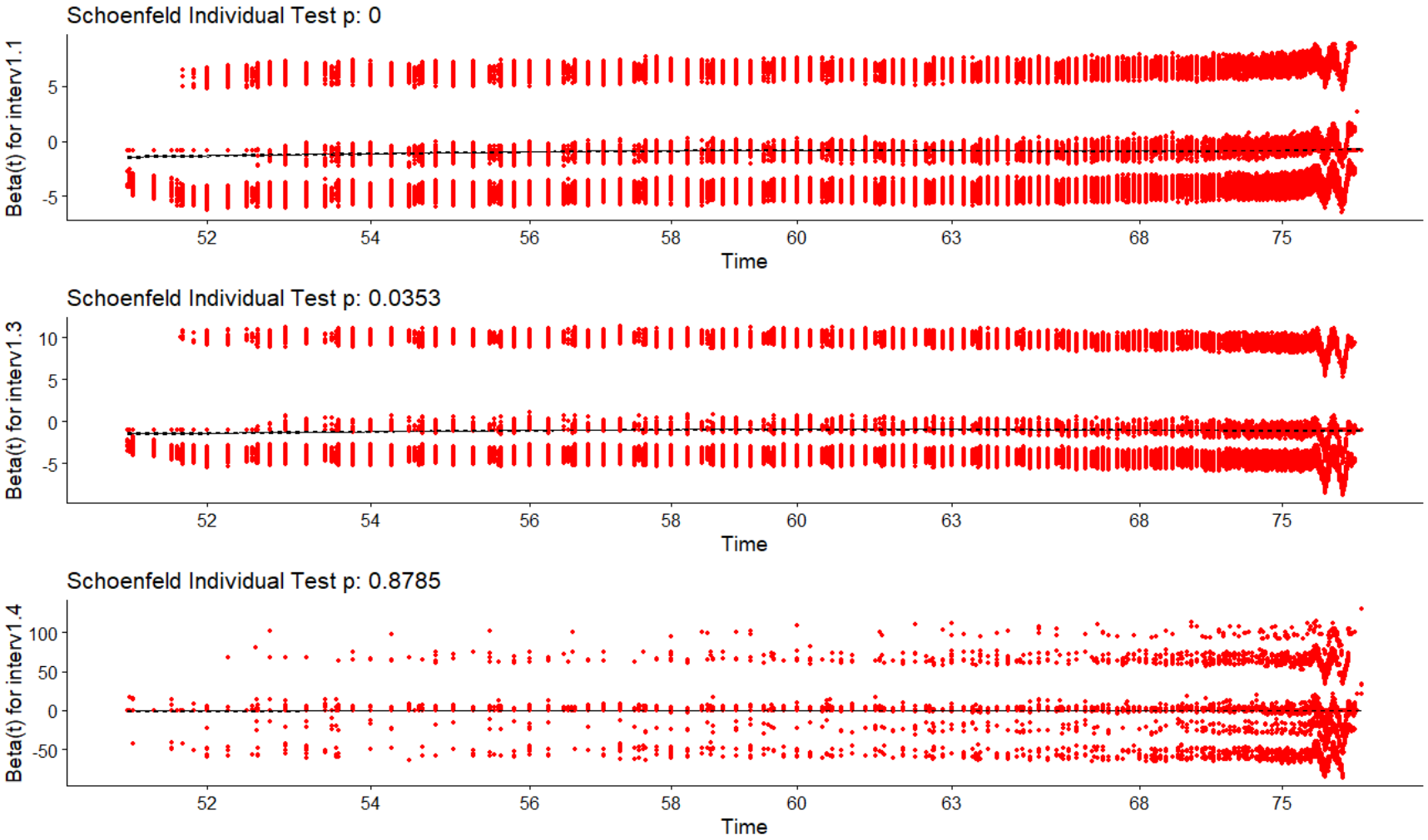
Countries	Sex	Partner	Partner and Child	Others	Alone
Sample	Total	40,9%	27,1%	14,1%	17,9%
Austria	Women	44,26%	14,15%	11,52%	30,07%
	Men	58,41%	22,29%	4,70%	14,60%
Belgium	Women	49,60%	14,76%	10,37%	25,27%
	Men	57,83%	20,04%	5,59%	16,54%
Spain	Women	32,84%	28,31%	22,51%	16,35%
	Men	41,97%	39,97%	9,87%	8,19%
Italy	Women	31,31%	28,42%	17,55%	22,72%
	Men	40,27%	40,69%	7,75%	11,29%
Portugal	Women	40,98%	21,15%	20,58%	17,28%
	Men	54,04%	32,45%	6,87%	6,65%
Czech Republic	Women	44,36%	13,36%	12,32%	29,96%
	Men	58,74%	21,46%	5,06%	14,75%
Hungary	Women	33,39%	15,50%	22,29%	28,83%
	Men	51,66%	29,90%	7,72%	10,72%
Poland	Women	32,36%	25,39%	22,42%	19,83%
	Men	44,51%	39,18%	8,12%	8,19%
Latvia	Women	28,50%	13,65%	29,54%	28,31%
	Men	50,47%	25,42%	11,22%	12,89%

Source: EU-SILC. Nine countries. Panel Data 2004-2014

ANNEX 3. 4. TABLE 10.- Health transition probabilities by time interval

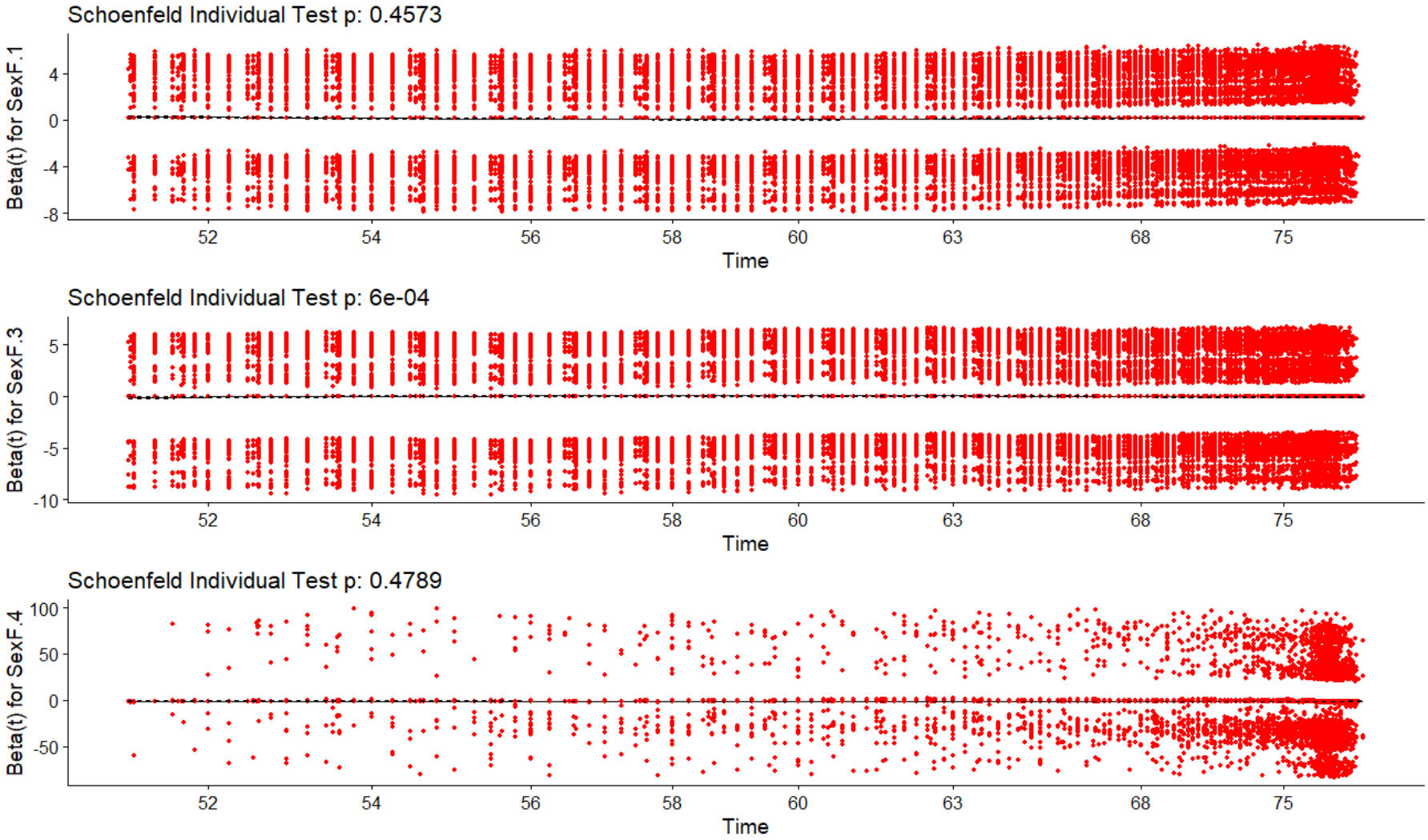
Health Transition type	terms	RR	Coeff	CI		sig.
Deterioration	Two years interval	0,41	-0,89	-0,87	-0,91	***
	Three years interval	0,07	-2,64	-2,61	-2,66	***
Health Improvements	Two years interval	0,35	-1,05	-1,02	-1,07	***
	Three years interval	0,06	-2,75	-2,71	-2,78	***
Death	Two years interval	0,65	-0,42	-0,36	-0,49	***
	Three years interval	0,16	-1,82	-1,75	-1,90	***

ANNEX 3. 5. FIGURE 8.- Schoenfeld test on time interval by transition type



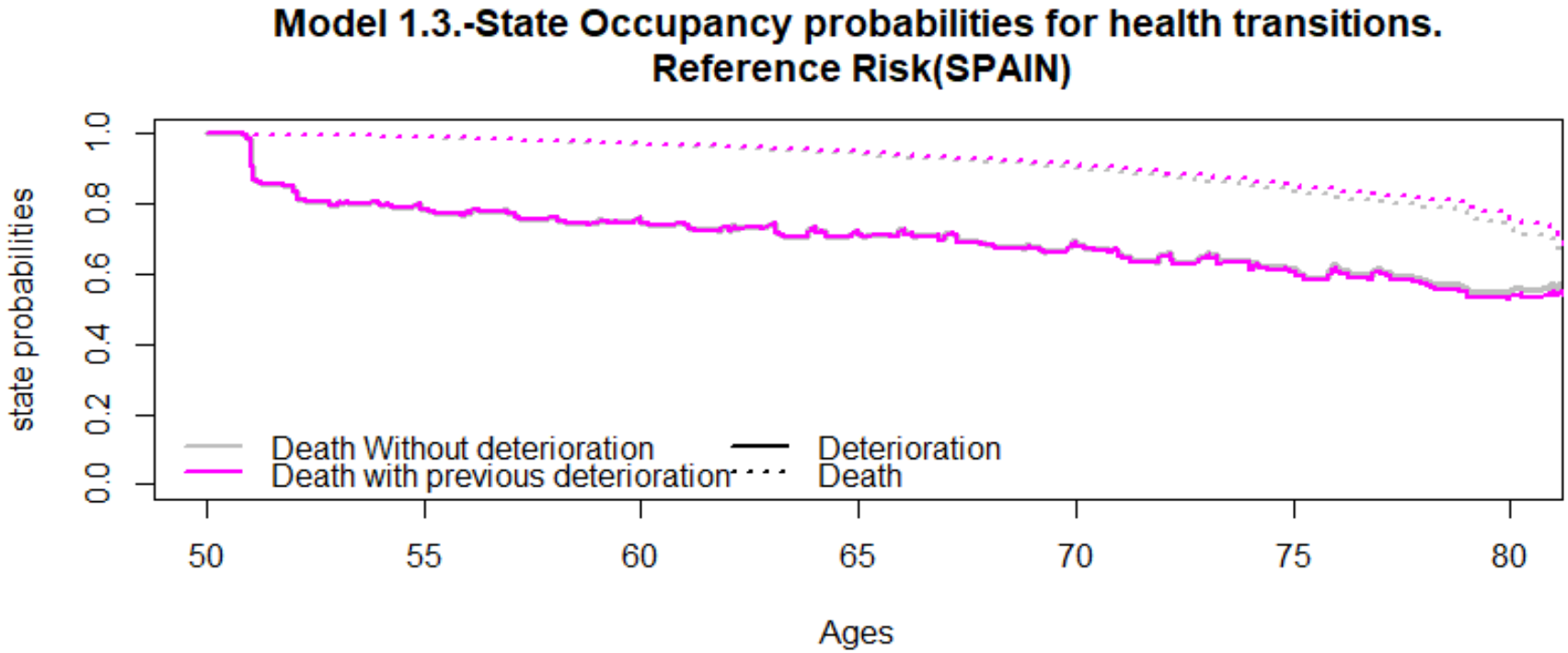
Note: Interv1.1= Deterioration in a two years 'interval, Interv1.3= Health Improvements in a two years 'interval, Interv1.4= Mortality in a two years 'interval

ANNEX 3. 6. FIGURE 9.- Schoenfeld test on sex variable by transition type



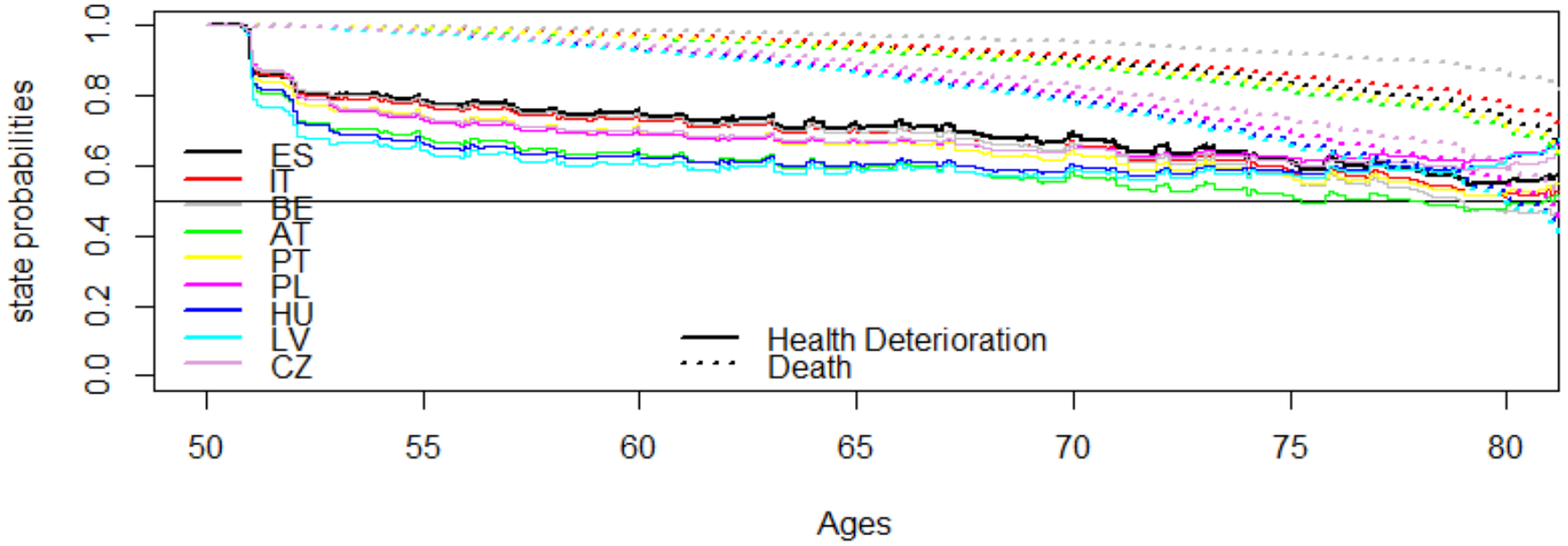
Note: SexF.1= Women in Deterioration, SexF.3= Women in Health Improvements, SexF.4= Women in Mortality.

ANNEX 3. 7. FIGURE 10.- Deterioration before death



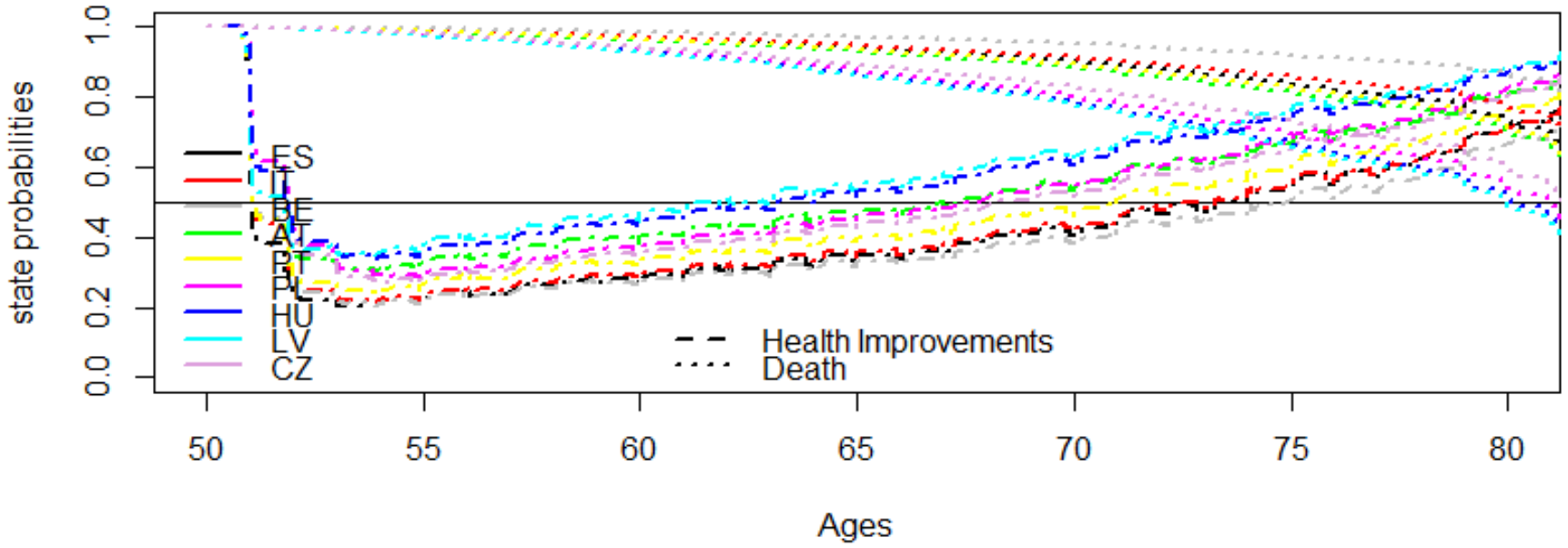
Note: Expected transition probabilities calculated with “mstate” R package, functions “msfit” and” probtrans”.

ANNEX 3. 8. FIGURE 11.- Health transition by countries. State occupancy probabilities. Model 1.3. Health deterioration and mortality by selected countries



Note: Expected transition probabilities calculated with “mstate” R package, functions “msfit” and” probtrans”.

ANNEX 3. 9. FIGURE 12.- Health transition by countries. State occupancy probabilities. Model 1.3. Health improvements and mortality by selected countries



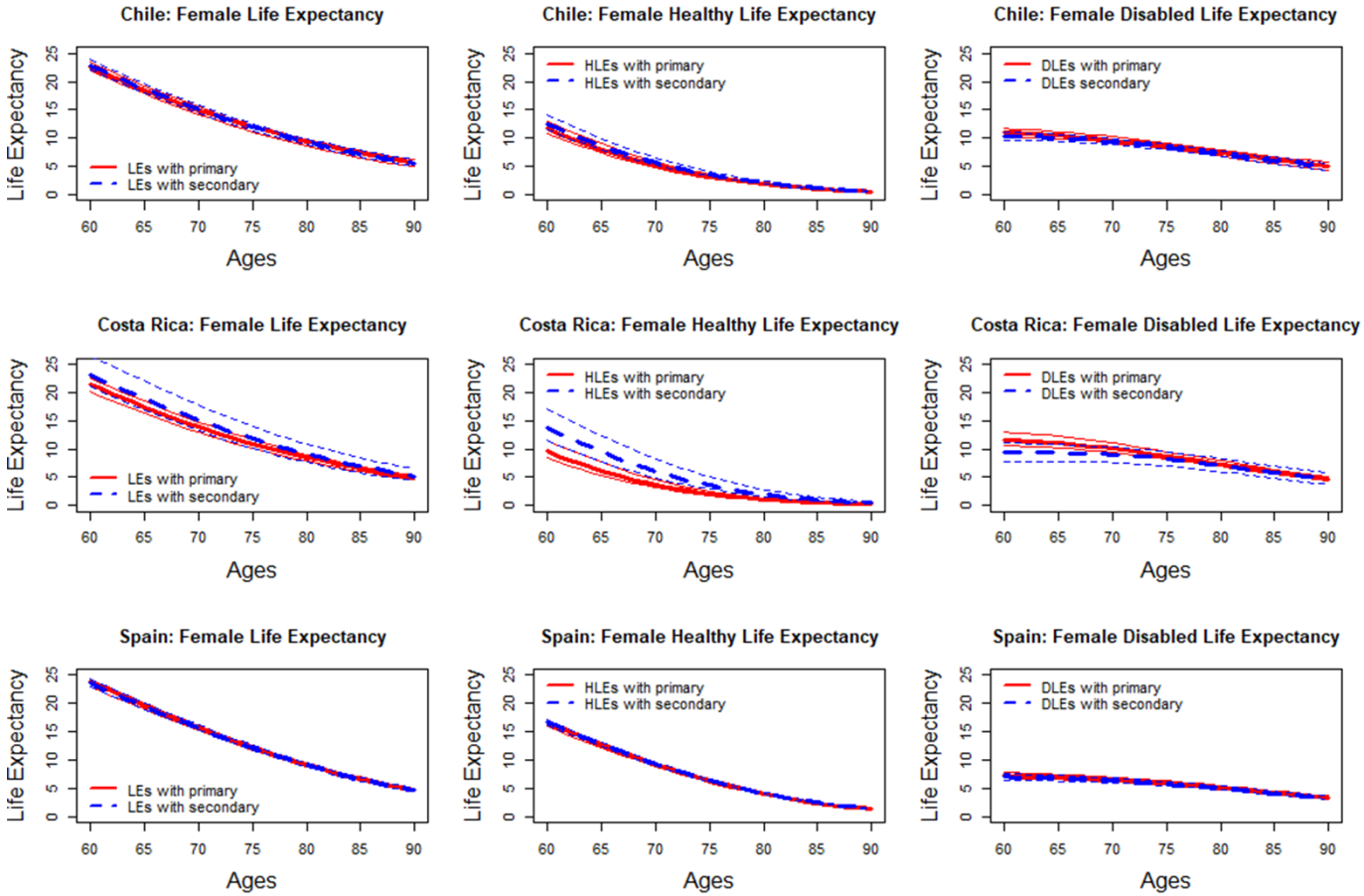
Note: Expected transition probabilities calculated with “mstate” R package, functions “msfit” and” probtrans”.

sx

ANNEX 4. 1. TABLE 11.- Criterios por países de las preguntas de actividades básicas, avanzadas e instrumentale de la vida diaria.

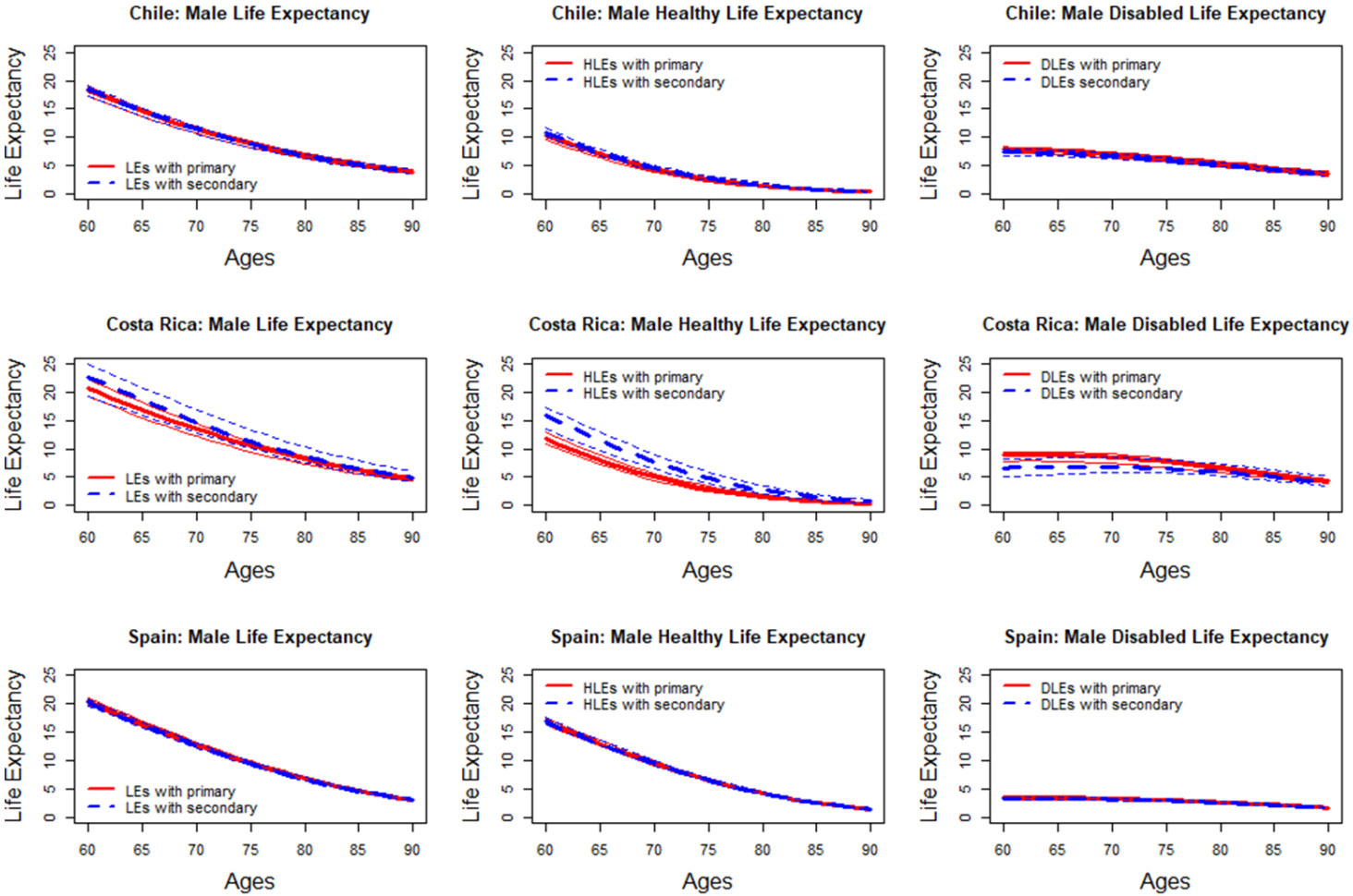
País	Europa		Costa Rica		Chile	
Encuesta	Survey og Health Aging and Retirement (SHARE)		Costa Rican Longevity and Healthy Aging Study, (CRELES)		Encuesta Longitudinal de Protección social, (EPS)	
Rondas	Seis rondas		Tres rondas		Cinco rondas	
Años	2005-2007-2011-2013-2015-2017		2005-2007-2009		2004-2006-2009-2015-2017	
Población	Población 50 +		60 años +, nacidos en 1945 o antes		Población 50+	
Tamaño de la muestra	336.601 registros (no personas) de 30 países europeos. España como país de referencia para la comparación con Europa		2.827 Persona		Alrededor de 16.000 individuos por ronda	
Actividades de Movilidad funcional (mobility functional) o Actividades Avanzadas de la Vida Diaria	**Please tell me whether you have any difficulty doing each of the everyday activities on this card. Exclude any difficulties that you expect to last less than three months.**	**Respuesta:**	**Pregunta lo siguiente:**	**Respuesta:**	**¿Habitualmente usted necesita ayuda de terceros o tiene dificultad para realizar las siguientes actividades?**	**Respuesta:**
	1. Walking 100 metres	selección de la categoria	¿Tiene dificultad para caminar varias cuadras?		f16_02 Caminar largas distancias	Sí
	4. Climbing several flights of stairs without resting		¿Tiene dificultad para subir por las escaleras varios pisos sin descansar	Sí	f16_03 Subir escaleras	No
	7. Reaching or extending your arms above shoulder level		Por favor levante y estire sus brazos por encima de sus hombros.	No		No puede
	8. Pulling or pushing large objects like a living room chair		¿Tiene dificultad para empujar o jalar un objeto grande como un sillón	No puede		
			¿Tiene dificultad para cortarse las uñas de los pies?	No lo hace		
	2. Sitting for about two hours		Puede usted caminar?		f16_01 Ejercicio extenuante o intenso	
	3. Getting up from a chair after sitting for long periods					
	5. Climbing one flight of stairs without resting					
	6. Stooping, kneeling, or crouching					
	9. Lifting or carrying weights over 10 pounds/5 kilos, like a heavy bag of groceries					
	10. Picking up a small coin from a table					
	96. None of these					
Actividades Básicas de la vida Diaria	**Please tell me if you have any difficulty with these activities because of a physical, mental, emotional or memory problem. Again exclude any difficulties you expect to last less than three months.**	**Respuesta:**	**Pregunta la siguiente Actividades Básicas de la Vida Diaria (ADLs):**	**Respuesta:**	**F.16 ¿Habitualmente usted necesita ayuda de terceros o tiene dificultad para realizar las siguientes actividades?**	**Respuesta:**
	2. Walking across a room	selección de la categoria	¿Tiene dificultad para cruzar de un lado a otro de un cuarto caminando	Sí	F.37.g ¿Puede moverse/ desplazarse solo dentro de	Sí
	3. Bathing or showering		¿Tiene dificultad para bañarse, incluyendo entrar y salir de la bañera?	No	f16_04 Bañarse	No
	4. Eating, such as cutting up your food		¿Tiene alguna dificultad para comer, incluyendo cortar la comida, llenar los vasos, etc.?		f16_06 Comer	No responde
	5. Getting in or out of bed		¿Tiene dificultad para acostarse o pararse de la cama?		f16_07 Salir de su cama	
	6. Using the toilet, including getting up or down		¿Tiene dificultad para usar el servicio sanitario, incluyendo sentarse y levantarse del escusado o inodoro?			
	1. Dressing, including putting on shoes and socks				f16_05 Vestirse	
Actividades Instrumentales de la Vida Diaria	8. Preparing a hot meal	**Respuesta:**	¿Tiene dificultad para preparar una comida caliente?	**Respuesta:**	F.37.e ¿Puede hacer compras o ir al médico solo sin ayuda o compañía?	**Respuesta:**
	9. Shopping for groceries	selección de la categoria	¿Tiene dificultad para hacer compras (por ejemplo, alimentos o ropa)?	Sí		sí
	11. Taking medications		¿Tiene dificultad para tomar sus medicinas?	No		no
	13. Managing money, such as paying bills and keeping track of expenses		¿Tiene dificultad para manejar su propio dinero?			no responde
	NO comparables					
	10. Making telephone calls 12. Doing work around the house or garden 14. Leaving the house independently and accessing transportation services 15. Doing personal laundry 96. None of these				F.37.d ¿Puede salir solo a la calle, sin ayuda o compañía?	

ANNEX 4. 2. FIGURE 13.- Estimaciones de Esperanza de vida, años de vida saludable y años de vida en mala salud según nivel educativo para las mujeres de 60-90 años. Chile, Costa Rica y España.



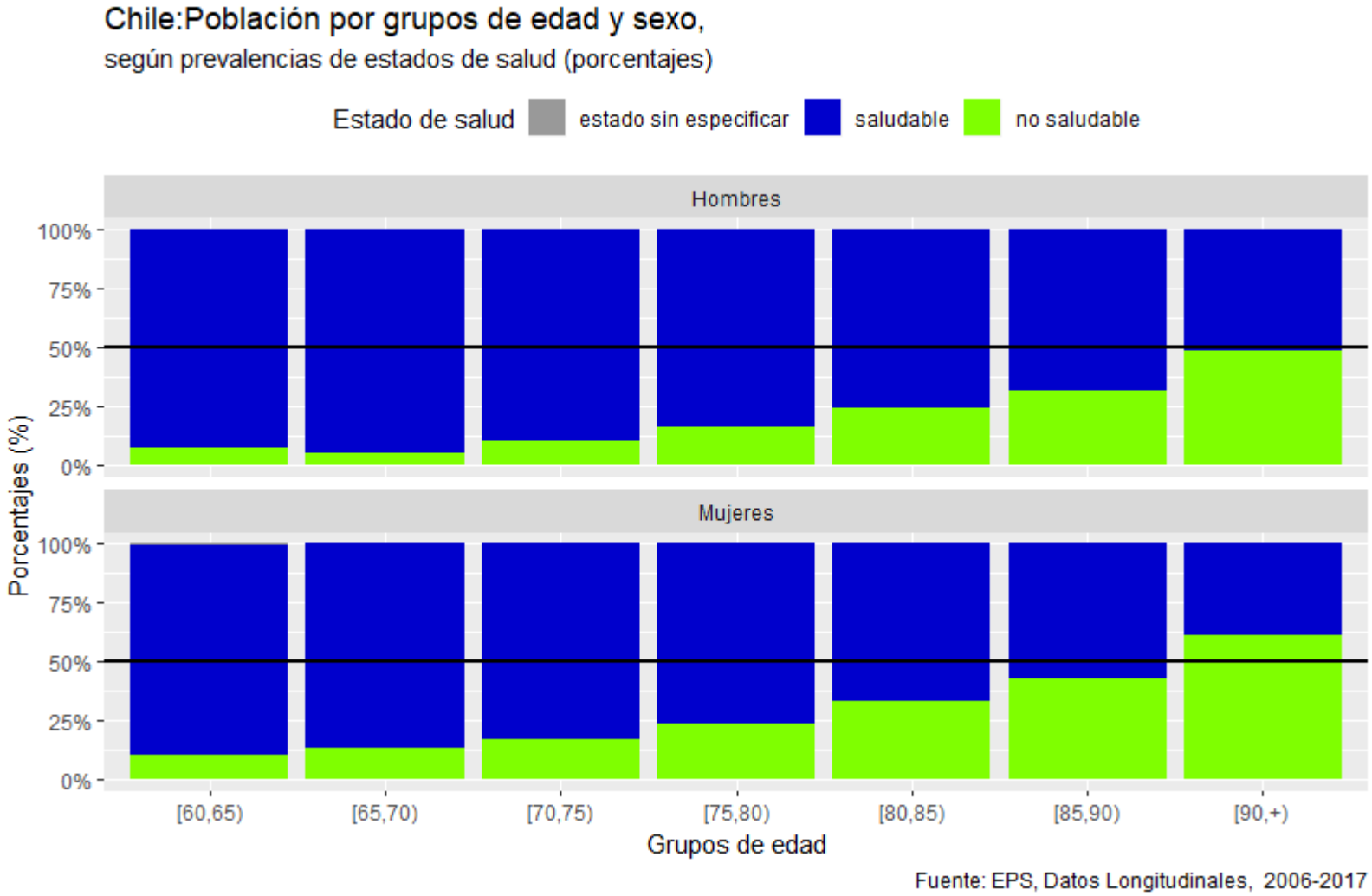
Note: Life expected calculated with "msm" and "elect" R packages, 25 simulaciones.

ANNEX 4. 3. FIGURE 14.- Estimaciones de Esperanza de vida, años de vida saludable y años de vida en mala salud según nivel educativo para los hombres de 60-90 años. Chile, Costa Rica y España.



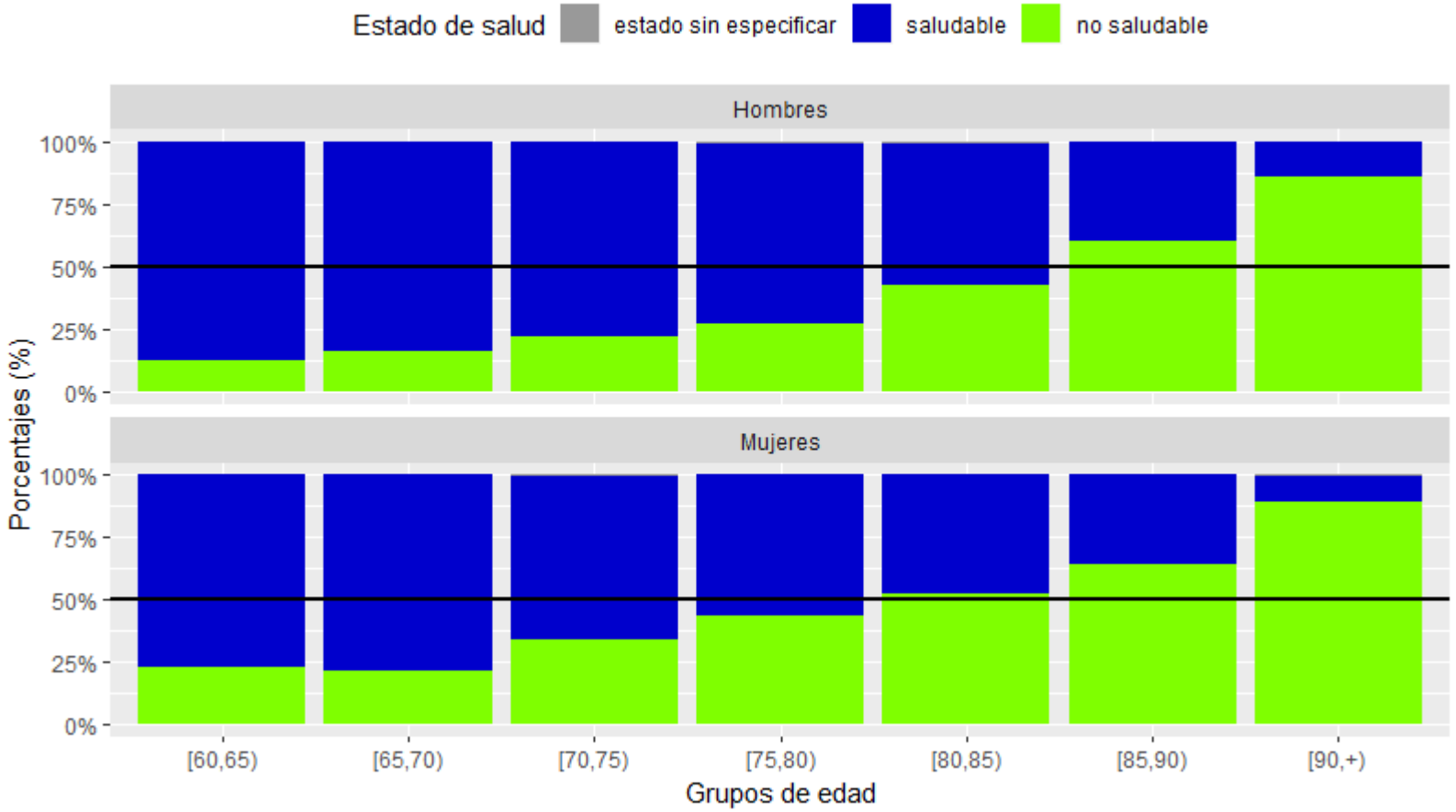
Note: Life expected calculated with "msm" and "elect" R packages, 25 simulaciones.

ANNEX 4. 4. FIGURE 15.- Prevalencias de estados de salud en la línea basal para hombres y mujeres según países.



Costa Rica:Población por grupos de edad y sexo,

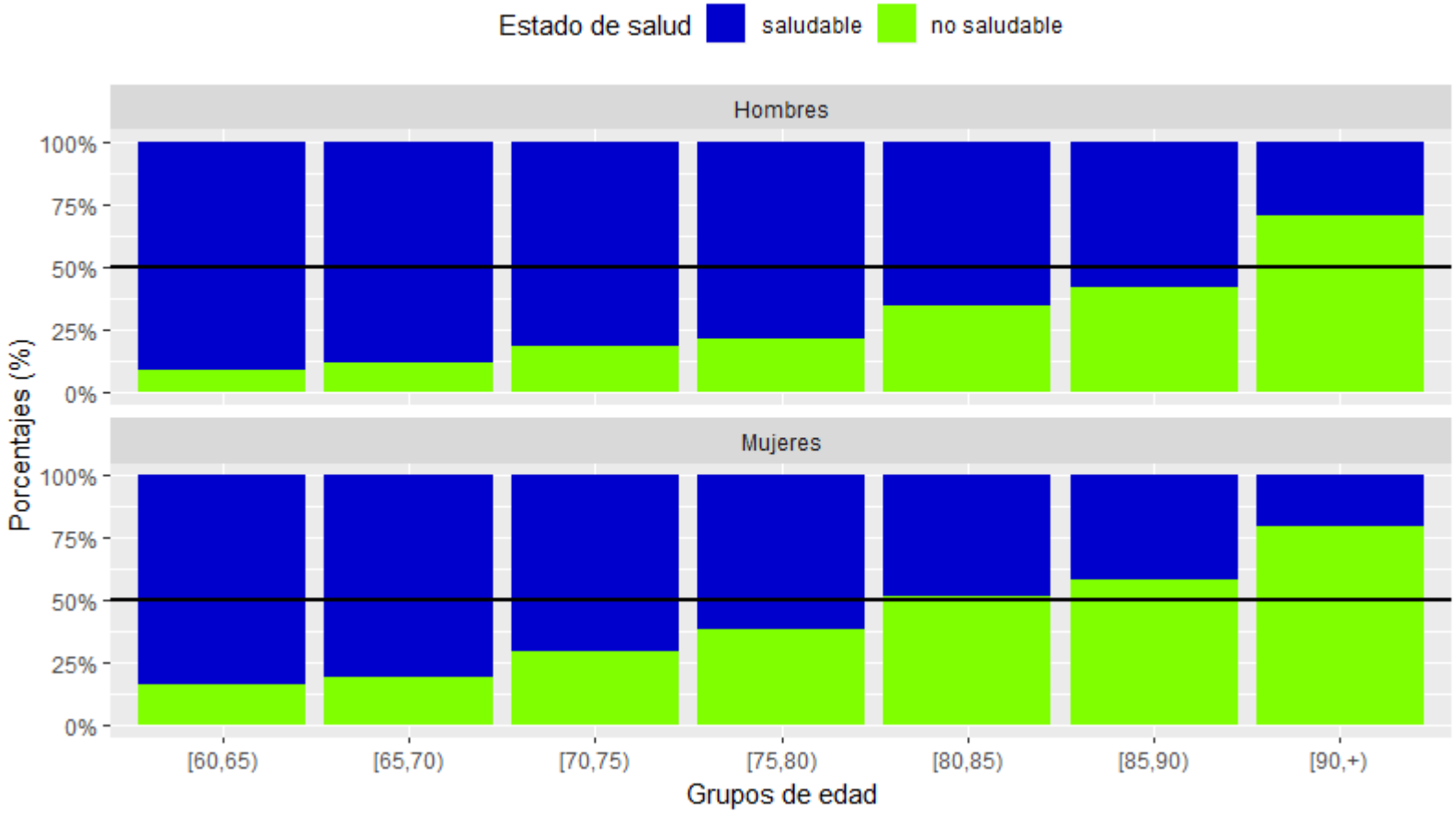
según prevalencias de estados de salud (porcentajes)



Fuente: CRELES, Datos Longitudinales, 2005-2009

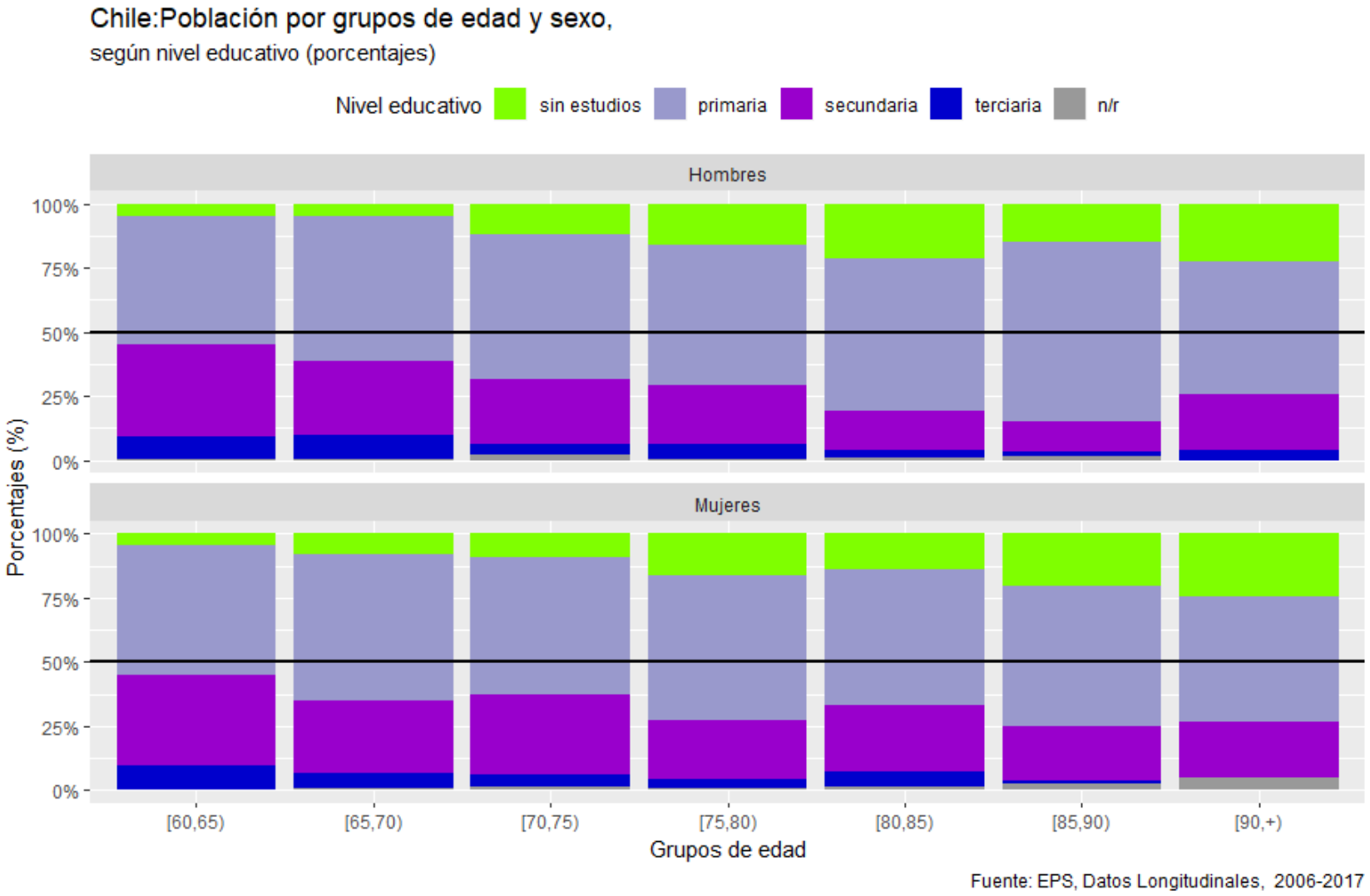
España:Población por grupos de edad y sexo,

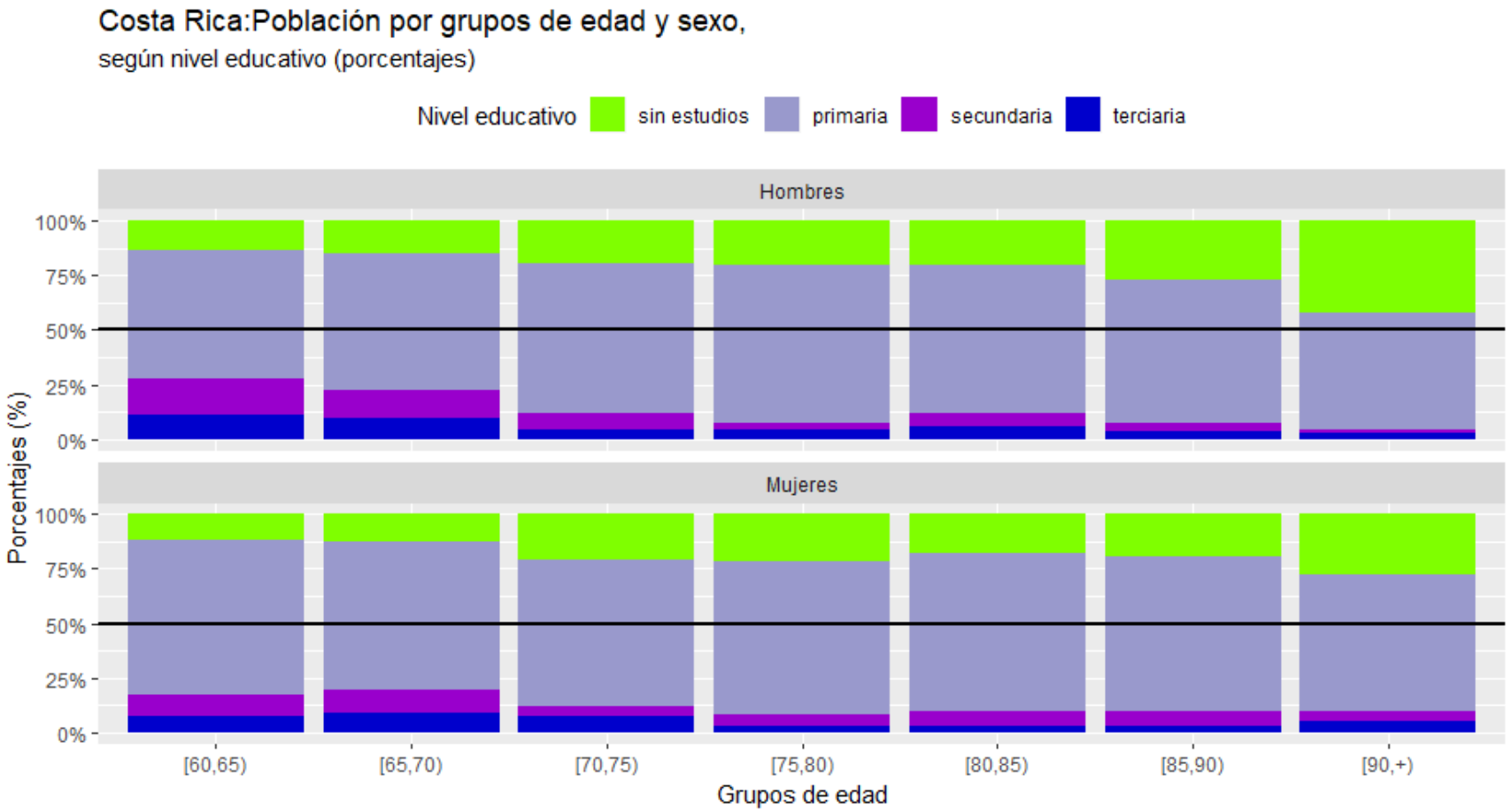
según prevalencias de estados de salud (porcentajes)



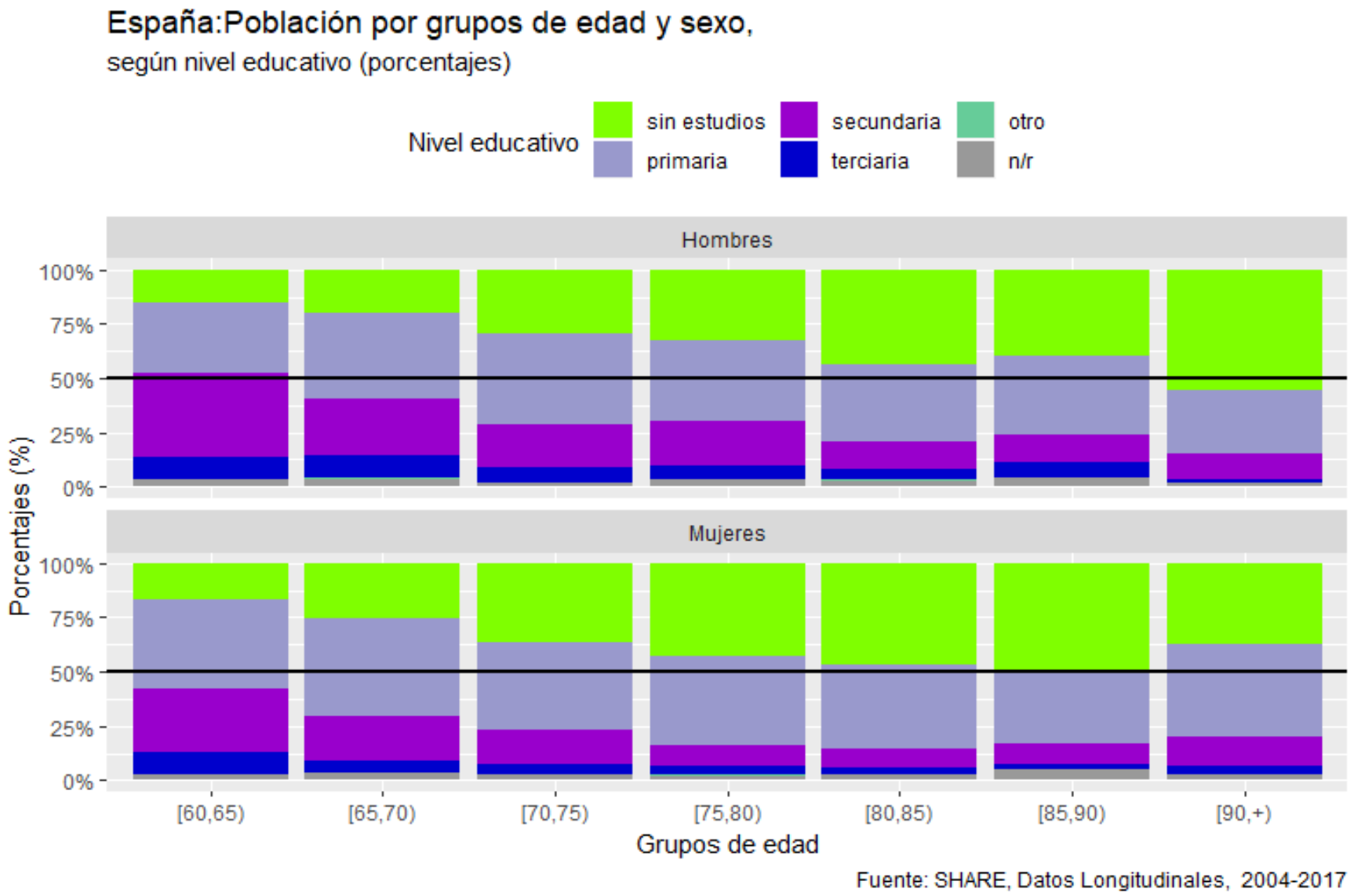
Fuente: SHARE, Datos Longitudinales, 2004-2017

ANNEX 4. 5. FIGURE 16.- Composición de la población mayor por nivel educativo en la línea basal para hombres y mujeres según países.

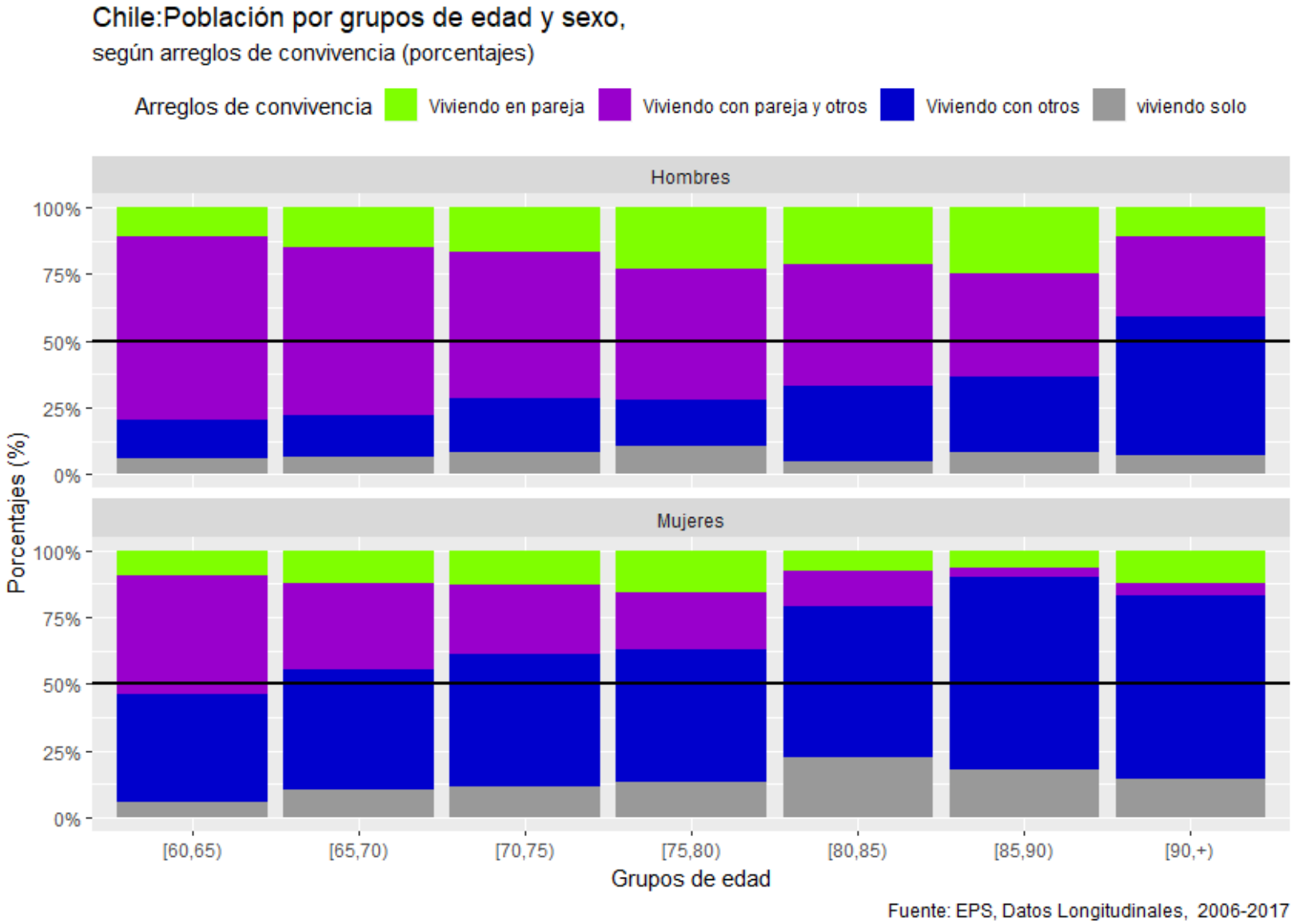


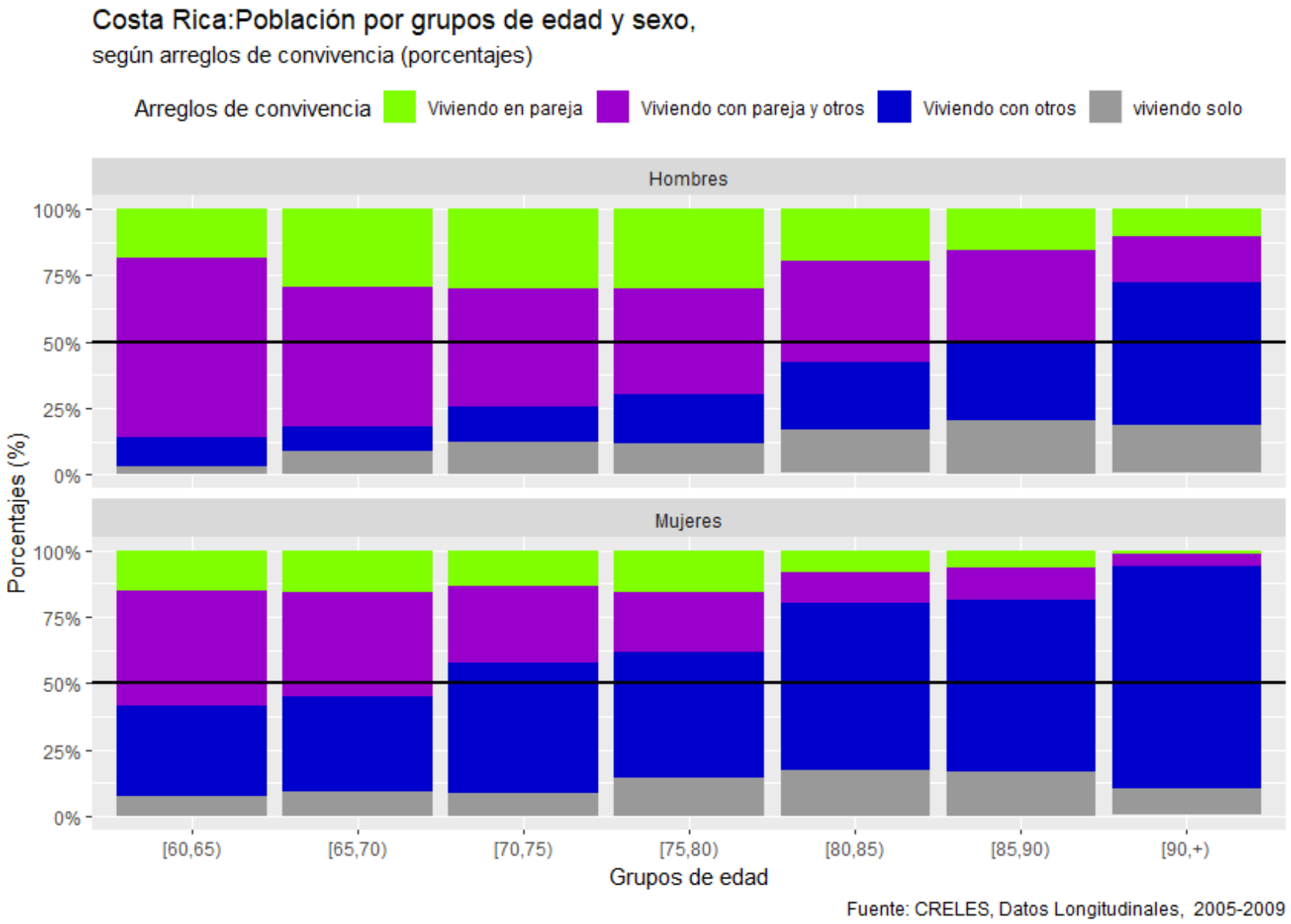


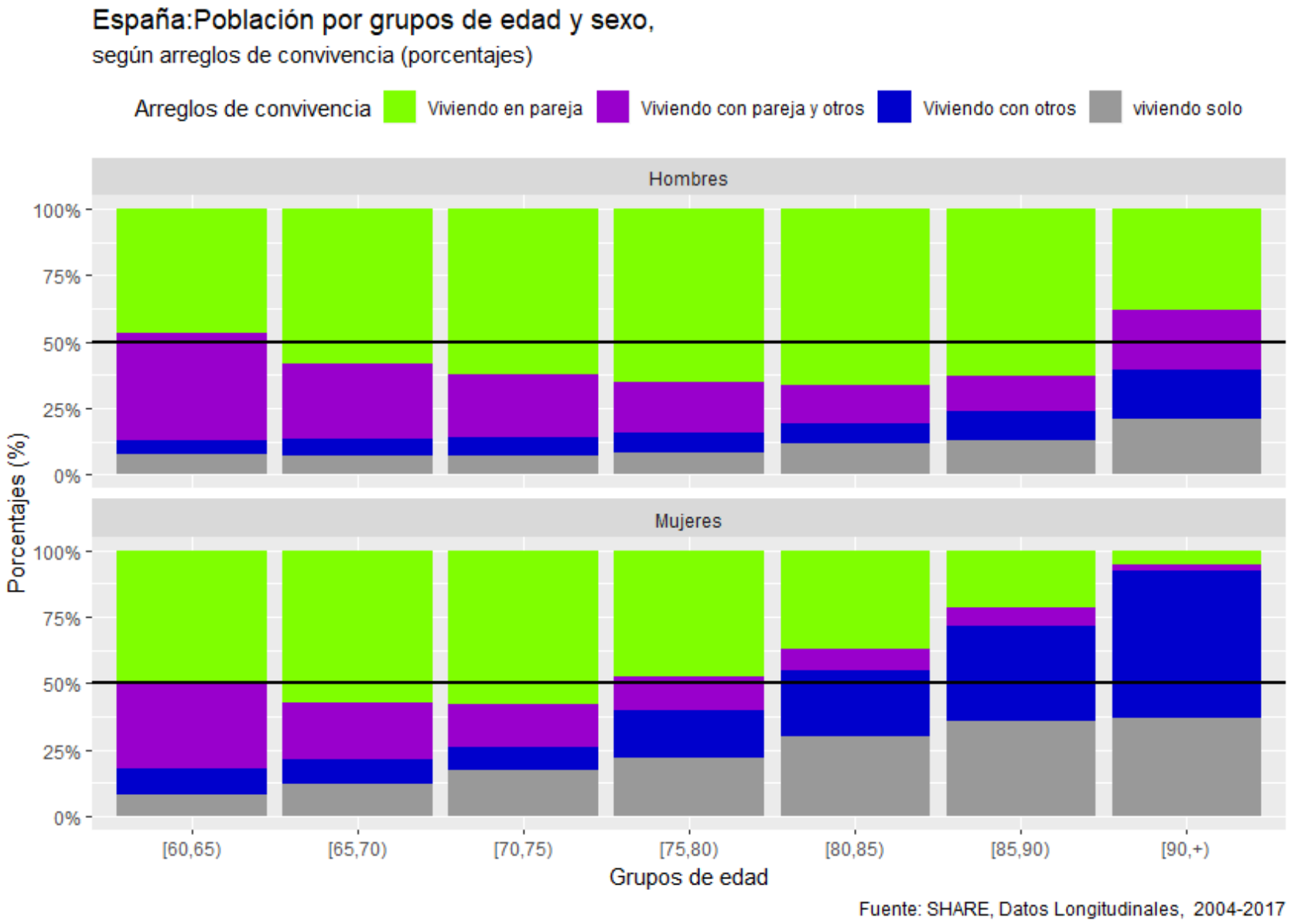
Fuente: CRELES, Datos Longitudinales, 2005-2009


España:Población por grupos de edad y sexo,
según nivel educativo (porcentajes)
Nivel educativo
sin estudios
primaria
secundaria
terciaria
otro
n/r
Hombres
Mujeres
100%
75%
50%
25%
0%
Porcentajes (%)
[60,65)
[65,70)
[70,75)
[75,80)
[80,85)
[85,90)
[90,+)
Grupos de edad
Fuente: SHARE, Datos Longitudinales, 2004-2017

ANNEX 4. 6. FIGURE 17.- Arreglos de convivencia de la población mayor en la línea basal para hombres y mujeres según países.




Costa Rica:Población por grupos de edad y sexo,
según arreglos de convivencia (porcentajes)
Arreglos de convivencia
Viviendo en pareja
Viviendo con pareja y otros
Viviendo con otros
viviendo solo
Hombres
Mujeres
100%
75%
50%
25%
0%
Porcentajes (%)
[60,65)
[65,70)
[70,75)
[75,80)
[80,85)
[85,90)
[90,+)
Grupos de edad
Fuente: CRELES, Datos Longitudinales, 2005-2009


España:Población por grupos de edad y sexo,
según arreglos de convivencia (porcentajes)
Arreglos de convivencia
Viviendo en pareja
Viviendo con pareja y otros
Viviendo con otros
viviendo solo
Hombres
Mujeres
100%
75%
50%
25%
0%
Porcentajes (%)
[60,65)
[65,70)
[70,75)
[75,80)
[80,85)
[85,90)
[90,+)
Grupos de edad
Fuente: SHARE, Datos Longitudinales, 2004-2017

ANNEX 4. 7.TABLE 12 .- Preguntas de participación social según países de estudio

Costa Rica	Chile	España
Las familias y amistades se apoyan unas a otras de diferentes maneras, como parte de esta investigación se requiere saber como lo hacen, por lo que ahora le voy a preguntar por el apoyo que usted recibe o proporciona:	Participa usted en las siguientes organizaciones	The following variables indicate social activities that have been done in the month before the interview.
Iglesia	Talleres productivos, laborales o de microempresa	Done voluntary or charity work
Cuidado de niños	Organización campesina, grupos de adelante rural	Provided help to family, friends or neighbors
Actividades cívicas	ONG, fundación o corporación	Attended an educational or training course
Deportes	Agrupación o Asociación Indígena	Gone to a sport, social or other kind of club
Actividades recreativas (manualidades, artesanías,etc)	Organización de voluntariado	Taken part in a political or community-related organization
	Organizaciones de personas con discapacidad	None of these
	Iglesia o Centro religioso	
	Otra	

Fuente: Costa Rica (CRELES, 2005), Chile (EPS, 2004), España (SHARE, 2004)