Sick and Sad: A Multi-State Analysis of Chronic Conditions and Depression Onset among Aging Adults in Europe

Introduction

The prevalence of non-communicable diseases increases with population ageing, causing vulnerability and dependency among the older people. Non-communicable diseases may lead to depression because they are often accompanied by pain, loss of energy, heavy treatments and activity restrictions (Alexopoulos, 2005; Alexopoulos et al., 2002, 2008; Assari, 2014; Blazer, 2003; Bramajo, 2022; Feng et al., 2023; Katon, 2011; Read et al., 2017). Additionally, some particular chronic diseases, like cancer, myocardial infarction, cerebrovascular disease and stroke precipitate depressive symptoms through stress-related atrophy of brain cells (Alexopoulos, 1997; Carney & Freedland, 2003; Krishnan et al., 1997; Robinson, 2003).

A comprehensive meta-analysis of 40 studies summarized that individuals with multiple chronic conditions had twice the risk of developing depressive disorders compared to those with only one chronic condition, and almost three times the risk compared to those with no chronic physical conditions (Read et al., 2017). There is an increasing interest among researcher in different fields about how chronic conditions influence patterns of depression in later life and to quantify the duration of the time individuals spend dealing with depressive symptoms is one important aspect of it.

In this interest, the heterogeneity observed in depression trajectories among older adults suggests that individual characteristics, behavioral factors, and contexts may significantly modify these associations. Several studies have found differences depending on national contexts, welfare regimes and health systems, indicating higher risk for depression among older adults in Southern and Eastern Europe (Bramajo, 2022; Zhang & Ma, 2025). And there is evidence on social stratification of depression among mid- and older adults: previous research on different contexts suggest that those with less income, lower education and socioeconomically disadvantaged have higher risk of depression than the ones with higher income, more education and socioeconomically advantaged (Abrams & Mehta, 2019; Blazer et al., 1991; Cuadros et al., 2019; Ge et al., 2024; Mattheys et al., 2016; Wang et al., 2024). But there is also evidence of factors that can prevent depression. The protective effect for depression of social support in older adults has been widely studied (Alexopoulos et al., 2002; Blazer, 2003, 2005; Blazer et al., 1991; Mattheys et al., 2016; Oxman & Hull, 2001; Santini et al., 2020; Wang et al., 2024), which makes it a very important factor when addressing depression in mid- and older adults. Another protective behavioral factor is physical activity, which is related to less onset of depression among older adults (Cheval et al., 2023; Santini et al., 2020; Veronese et al., 2024).

This study aims to examine the transitions to depression among adults aged 50 onwards in Europe, comparing those with chronic conditions and those without, and to evaluate confounders, mediators and potential protective factors in this relationship. Are people with chronic conditions more likely to develop depression than those without chronic conditions? How long do people with chronic conditions experience depression compared to those without? What factors mediate this relationship?

We expect that chronic conditions increases the risk of the onset of depression, particularly among socioeconomically disadvantaged groups with limited access to protective resources such as opportunities for physical and social engagement.

Data and Methods

We use data from the Survey of Health, Ageing and Retirement in Europe (SHARE), a longitudinal cross-national research project that targets individuals aged 50 and older across 27 European countries and Israel. Our analysis uses waves 4 (2011/2012) through 9 (2021/2022), providing approximately 10 years of follow-up. SHARE consists of nationally representative probability samples and collects detailed information on physical and mental health, socioeconomic status, and social networks through face-to-face and telephone interviews conducted approximately every two years. Refreshment samples are regularly drawn to maintain representativeness and compensate for attrition. Mortality follow-up is conducted through end-of-life interviews with proxy respondents from the deceased participant's social network, available for approximately 75% of deceased panel members. In countries with linked administrative mortality records, vital status information is more complete. Our analytic sample excludes individuals with baseline depression, those with only one wave of observation, those with missing information on key variables (age, gender, EURO-D scale, chronic conditions, covariates), and participants whose first wave was the SHARELIFE retrospective interview (wave 7), resulting in a final sample suitable for multi-state modeling. This sample has 56,507 individuals (28,294 men and 28,211 women) with a mean age of 64 years at their entrance in the study, where 39,134 of them enter the survey with at least one of the chronic conditions listed below, and 17,371 have none of them.

Depression

Depression is measured using the EURO-D scale, a 12-item instrument designed for cross-national comparisons of depressive symptoms in older populations (Prince et al., 1999). Each item captures the presence (1) or absence (0) of a depressive component: feelings of guilt, sadness, tearfulness, sleep disturbances, loss of interest, irritability, appetite changes, fatigue, concentration difficulties, enjoyment, pessimism, and suicidality. Depression is then a dichotomous variable, with value 1 for a score of >= 4 and value 0 for < 4 (Castro-Costa et al., 2007; Prince et al., 1999). This threshold has been validated across European populations and shows good concordance with clinical depression diagnoses.

Chronic Conditions

Chronic conditions are assessed through a standard question asking whether a doctor has ever told the respondent that they have any of 12 specific conditions: heart disease, hypertension, stroke, diabetes, chronic lung disease, asthma, arthritis, osteoporosis, cancer, stomach/digestive problems, Parkinson's disease, or cataracts. We create a baseline chronic condition variable indicating the presence (1) or absence (0) of at least one chronic condition at the first observation for each individual. This baseline measure allows us to examine how pre-existing chronic disease status affects subsequent depression trajectories.

Covariates

We control for the effects of age, education, income and partnership status as confounders in the multivariate analysis. Age is treated as a continuous variable. Education level was divided into three groups based on the International Standard Classification of Education-97 (ISCED-97): low education (ISCED 0–2), middle education (ISCED 3–4) and high education (ISCED 5–6) assessed using the ISCED-97. Partnership

status was dichotomized as partnered (either married or non-married) and non-partnered.

We also control for potential mediators and modificators in this relationship that go in different directions: chronic pain and activity limitations, following the hypothesis that these may trigger depression; social participation, physical activity and type of welfare state of the country of residence as variables that may protect the individuals from the onset of depression. For chronic pain, the presence of chronic pain and coded binary (0 = no pain, 1 = presence of pain), independently on the location of the pain. Activity limitations was assessed by the question about whether an impairment or health problem limits usual activities, recoded as binary (0 = no, 1 = yes). Social participation indicates if the respondent has participated in any social activity from a list in the past 12 months. 1 indicates participation in any of the activities. The type of welfare state of the country of residence was constructed based on the pioneer work of Esping-Andersen (Esping-Andersen, 1990, 2008) and some of its reviews (Bambra, 2007; Cambois et al., 2016; Fenger, 2007; Ferrera, 1996) categorizing countries into Liberal, Conservative, Social-Democratic, and Southern/Eastern European. These regimes differ in their provision of social protection, healthcare access, and support for healthy ageing, potentially moderating the chronic condition-depression relationship.

Statistical Analysis

We employ continuous-time multi-state models (MSM) implemented in the *msm* R package. Multi-state models are particularly suited to our research questions because they explicitly model transitions between health states over time, accommodate time-varying covariates and transition-specific effects, and incorporate death as a competing risk (absorbing state). The utilization of these models follows the assumption that the health trajectories of middle-aged and elderly individuals follow a Markov process, meaning that transitions between different health states are determined primarily by the individual's current state of health at one specific age and are independent of the history of previous states (Talifu et al., 2024). By incorporating having baseline chronic conditions as a covariate in the model, we wanted to investigate how this factor impacts the intensity and dynamics of transitioning to depression. We hypothesized that having at least one baseline chronic condition significantly influences the transitions to depression among individuals, whereby we expected to observe specificities in the probabilities and patterns of transitions, reflecting distinct health trajectories, and different times expected to spend in each state. We modeled men and women separately since trajectories are fundamentally different (Talifu et al., 2024). We estimate four nested models separately by gender: Baseline chronic conditions + age (model 1); model 1 + socioeconomic factors (model 2); model 2 + health mediators (model 3); model 3 + behavioral factors (model 4). Model fit is assessed using the Akaike Information Criterion (AIC), and we verify proportional hazards assumptions through graphical checks and time-interaction terms where appropriate.

Results

Our population has a mean age of 62.6 years (62.1 for men, 63.1 for women), and almost half is in the first age group of 50-59 years, and around 8% is aged 80 onwards. 64% of the population has at least one of the considered chronic conditions.

Table 1 Descriptive statistics

Characteristic	Overall N = 46,588,851[1]	Men N = 24,630,490[1]	Women N = 21,958,361[1]
Age	62.6 (10.2)	62.1 (10.0)	63.1 (10.5)
Age group			
50-59	21,919,608 (47%)	12,063,380 (49%)	9,856,228 (45%)
60-69	12,540,972 (27%)	6,538,464 (27%)	6,002,509 (27%)
70-79	8,630,098 (19%)	4,422,320 (18%)	4,207,777 (19%)
80+	3,498,173 (8%)	1,606,327 (7%)	1,891,847 (9%)
Baseline condition(s)			
Neither	16,684,398 (36%)	8,816,199 (36%)	7,868,199 (36%)
At least one chronic condition	29,904,453 (64%)	15,814,291 (64%)	14,090,162 (64%)

[1] N (%); Mean (SD)

Our analyses suggest that having at least one chronic condition significantly increased the risk of depression onset by 24% among men ($HR = 1.24, 95\% CI: 1.12 - 1.38$) and 41% for women ($HR = 1.41, 95\% CI: 1.30 - 1.53$). From age 50, people with chronic conditions at baseline are expected to live a higher proportion of years with depression, compared to those with no chronic conditions at baseline (11.6% vs. 8.4% for men, 20.4% vs. 15.8% for women). At age 70, women without chronic conditions are expected to spend 21% of their remaining years of life with depression, while those with chronic conditions are expected to spend 27%. Men show a similar age pattern but with lower overall burden: men without chronic conditions are expected to spend from 8.4% of their remaining years with depression at age 50, and 13.4% at age 70, and from 11.6% to 18% for those with chronic conditions.

When adding chronic pain and health-related activity limitations (model 3), having baseline chronic condition(s) becomes non-significant for men ($HR = 1.08, IC\,95\%: 0.95 - 1.22, p = 0.089$). Among women, even though having baseline chronic condition(s) is still significant ($HR = 1.18, IC\,95\%: 1.07 - 1.29, p < 0.001$), the risk of depression onset attributable to chronic conditions reduces from model 2 to model 3 by half (37% to 18%).

Chronic pain and health-related activity limitations explain the associations between chronic conditions and transitions to depression among men but not entirely among women. Physical activity and social participation reduce the risk of depression, even among individuals with chronic conditions. Preliminary country-level analyses suggest that the chronic condition-depression relationship is moderated by welfare regime type, with individuals with chronic conditions living in Mediterranean having higher risk of depression than those in the Nordic countries. This risk is higher than it is for those individuals without chronic conditions.

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