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Dependency change with aging and associated factors in Uruguay: a cohort study.

Alejandra Marroig¹, Maximiliano Machado¹, Graciela Muniz-Terrera ²

¹ Instituto de Estadística, Universidad de La República, Uruguay.

² Centre for Dementia Prevention, University of Edinburgh, Scotland.

Abstract

Objectives: To assess the heterogeneity of transitions toward dependency in older adults and to explore the robustness of results to different operationalizations of dependency. Method: Using data from people aged 60 years and older from a national representative study in Uruguay (*Encuesta Longitudinal de Protección Social*, N= 5071), we fitted multinomial regressions adjusted by sociodemographic and health characteristics to model transitions into dependency and death. We used a harder operationalization with basic activities of daily living (Katz-dependency) and Comprehensive-dependency with basic, instrumental, and advanced activities. Results: Increasing age (RRR = 1.08, CI = [1.05; 1.12], p< .001) and having comorbidities (RRR = 2.16, CI = [1.31; 3.57], p= .003) increased the risk of transition from nondependent to dependent using Katz-dependency. Women with at least two chronic conditions have increased

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risk of Comprehensive-dependency (RRR = 1.79, CI = [1.15; 2.80], p=.010). Discussion:

Inconsistencies in findings emerged when evaluating transitions into dependency with the different measures, which may have social care implications.

Keywords: dependency, activities of daily living, older adults, Uruguay

Introduction

Older populations exhibit higher prevalence of chronic diseases, disability and dependency, and as a consequence of these higher prevalences, national social security and health care systems are usually placed under stress (At et al., 2015; Prina et al., 2020; Sousa et al., 2010). With increasing age the risk of dependency tends to increase, as functional or mental impairments result from declines in health. Yet, the need for daily help or care of older adults living in the community has been shown to be heterogeneous and depend on socio-demographic characteristics such as age, sex, or education (At et al., 2015; Sousa et al., 2009, 2010).

Demographic changes experienced in the past decades in low- and middle-income countries have increased the older segments of the population, stressing the social security, healthcare system and also could be leading to a deterioration in the quality of life of the older population. For instance, in Latin American countries, the share of older people has been increasing since 1990 and is expected to double between 2019 and 2050 (United Nations, 2020). Uruguay, a country with a population of 3.4 million, exhibits the oldest population in Latin America, with 19 per cent of this population aged 60 years or older in 2015 (Rofman et al., 2016). Furthermore, it has been reported that Uruguay began its demographic transition earlier than other Latin American countries (Rofman et al., 2016). Yet, despite being the country with the oldest population in Latin America, the need for help, care or support of older Uruguayan adults, and its changes over time, have not been studied widely.

Developed countries have already gone through these demographic changes and have therefore planned, implemented and reformed their policies to deal with problems associated with dependency of the older population (Matus-López, 2015). However, only some Latin American

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countries have implemented measures to address these problems, in particular, the ones associated with increased dependency to care or support (Galiani et al., 2017; Matus-López, 2015; Matus-López & Rodríguez-Modroño, 2014). Uruguay stands out among Latin American countries due to the implementation of a new Long-Term Care (LTC) program within the framework of the National Care System (NCS) initiated in 2015. Among its objectives, the NCS aims to promote the development of autonomy of dependent older adults, providing them care through services and assistance (Matus-Lopez & Cid Pedraza, 2016).

The World Health Organization (WHO) defined disability as an umbrella term for impairments, activity limitations, and participation restrictions which denotes the negative aspects of the interaction between an individual with a health condition and that individual's environmental and personal factors (WHO, 2001). Dependency, a multidimensional construct that could refer to functional, psychosocial and supportive dimensions and that could also include an economic dimension (Edjolo et al., 2016; Rely et al., 2020), is defined as the need for human help or care beyond that habitually required by a healthy adult (Harwood et al., 2004).

Although the definitions of disability and dependency are clear, there is no consensus on how to operationalize dependency. For instance, in large national representative studies with a multidisciplinary scope such as *The Cognitive Function and Ageing Study* (CFAS) from England and *The Survey of Health, Ageing and Retirement in Europe* (SHARE), different operationalizations were used. Additionally, these differences in the operationalization were evidenced in previous analysis for Latin American countries (Monteverde et al., 2016). Specifically, while in the British study dependency was operationalized using the interval measure, which is based on the lapsed time between periods when participants might require help (Kingston et al., 2017), in SHARE and for Latin American countries it was operationalized counting the

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limitations in daily activities (Monteverde et al., 2016; Rodríguez-Sampayo et al., 2011). Moreover, it has been suggested that to adequately operationalize dependency, in addition to the actual limitations that individuals may experience, it is also necessary to consider information about the daily need for help (Albarrán Lozano et al., 2009; Edjolo et al., 2016; Harwood et al., 2004; Prina et al., 2020). Hence, it could be argued that it is possible to operationalize dependency using information about the need for assistance in performing Activities of Daily Living (ADLs). So, in sum, to assess dependency information about the need for human help will be used, in addition to information on the limitations to perform daily activities.

Much of the literature on disability and functional status of older adults have used the Basic Activities of Daily Living (BADLs) that includes activities such as bathing, dressing, toileting, transferring, continence, and feeding (Katz et al., 1963). Later these activities were extended to include Instrumental Activities of Daily Living (IADLs) such as the ability to use the telephone, shopping, housekeeping, among others (Lawton & Brody, 1969). Recently, Advanced Activities of Daily Living (AADLs), that includes social and community participation, communicating and making decisions, are also considered (WHO, 2011).

Including different types of activities and its various combinations can inform about different aspects of dependency experienced by older adults (Millán-Calenti et al., 2010). For instance, a harder operationalization of dependency would consider only BADLs whilst more advanced and comprehensive assessment of the construct could also consider IADLs and AADLs.

Previous analyses have reported that trajectories towards dependency are characterized by a first need for help in IADLs and then an overlapping need for help in BADLs and IADLs (Edjolo et al., 2016).

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The ‘male-female health-survival paradox’ that postulates that women have longer life expectancies but they live in poorer health, is a well-documented phenomenon (Austad, 2006; Bora & Saikia, 2015; Cameron et al., 2010). For instance, a national representative study for England concludes that the proportion of independent older people will increase in the next 20 years but men will be successively more independent than women (Kingston et al., 2017). Using data from several Latin American countries, it has been reported that women spend a longer time with difficulties than men (Prina et al., 2020). The patterns of dependency by sex could also be affected by men and women’s different roles in household activities, and a comparison between different cultures and contexts could provide new insights into patterns of heterogeneity (Millán-Calenti et al., 2010). Sex differences may be relevant to inform the actions to be taken to ensure quality of life of older people despite their difficulties.

In turn, educational level, socioeconomic conditions, physical or functional impairments, and the existence of co-morbidities are risk factors for disability and dependency (Mayston et al., 2014; Prina et al., 2020), although more evidence is needed to understand the dynamics of disability and dependency (Prina et al., 2020).

The different assessment of dependency may provide complementary perspectives of the problem that informs policy design. For instance, to ensure that care or assistance meet needs of dependent older people, it is relevant to analyze differences in the type of activities that individuals will need help with. Previous research has not examined transitions to dependency, and death or the robustness of results to different operationalizations of dependency. A better understanding of dependency, its changes with increasing age including death and its associated factors is critical to inform care policies designed to improve quality of life of older people living in the community and their families.

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In this first study of dependency of the population of older Uruguayans, we aim to generate knowledge about their dependency with increasing age, using data from a nationally representative cohort study and modeling transitions including death. We address the following questions:

- 1) Do transitions towards dependency vary by age, sex and education after controlling for co-morbidities and impairment in the population of older adults in Uruguay?
- 2) Are these transitions sensitive to the measures of dependency considered? Is there heterogeneity by age, sex, education, co-morbidities and impairments?

Methods

Data

We used data from the *Encuesta Longitudinal de Protección Social* (ELPS) for Uruguay. Baseline data were collected between 2012 and 2013, and the follow-up assessments between 2015 and 2016.

This survey is self-reported and representative of the national population of individuals aged 14 years old or older. Participants were asked basic questions about their sociodemographic characteristics and health, in addition to questions about whether they received government benefits, their employment history, social security, heritage and household composition. Specifically, participants were asked their age, sex and the highest level of education completed. They were asked whether they had hearing or sight difficulties, and were asked if they had been diagnosed with any of the following conditions: asthma, emphysema, arthrosis or arthritis,

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tendinitis, rheumatism, hypertension, diabetes, osteoporosis, kidney failure, cardiac problems, spine problems, anemia, cancer and HIV.

For this study, we considered individuals aged 60 years old and older at baseline. Of the 6197 individuals in this age group surveyed at baseline, 1716 (28%) were not included in the follow up wave (11% died, 1% moved to a nursing home and 16% were untraceable). Hence, the analytical sample included 4462 individuals with complete data in both waves and 609 individuals with complete data in the first wave who died before the second wave, totalizing 5071 cases. For further information about the design of the baseline and follow-up data collection waves of the ELPS see BPS (2015).

For the purposes of our analyses, we derived a series of dummy variables to account for differences in education (1= highest educational level completed is primary school or less, 0=otherwise) and sex (1= Female, 0= Male). Dummy variables were also created to indicate the presence of physical health conditions or difficulties. Specifically, a series of independent dummy variables were derived indicating whether an individual had difficulties with their sight (1= have difficulties, 0= otherwise); had hearing difficulties (1= have difficulties, 0= otherwise), had two or more chronic diseases (1= have two or more chronic conditions, 0= have less than two chronic conditions). Age was measured in years.

Dependency measures

We measured dependency in two different ways. First, we defined an indicator variable that took the value of 1 if an individual needed help on a regular basis with at least one of the following activities: eating, dressing, personal care activities (toothbrush, to comb or face washing), displacing inside home, or using the restroom (Katz et al., 1963). If an individual needed help with at least one of these activities on a regular basis (i.e. declared the need for help “Sometimes”,

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“Many times” or “Always”), we classified the individual as dependent (Katz-dependency from now on). For the analysis of the Katz-dependency we also considered the number of activities in which the person needs help from these five.

Second, we defined dependency using data on the frequency of need for help in any of the activities available in the ELPS study which includes basic, instrumental and advanced activities (Comprehensive-dependency from now on). This approach adds to the five previous activities included in the definition of the Katz-dependency measure the following activities: avoiding health risk (e.g. taking medications), changing/maintaining position, displacing outside home, performing housework, participating in social life and communicating. We also employ the number of activities in which the person needs help from these eleven for the analysis of Comprehensive-dependency and its associated factors.

The use of these two operationalizations of dependency allows us to assess dependency with a harder operationalization (Katz-dependency) that considers only BADLs, and with a more comprehensive assessment (Comprehensive-dependency) that considers also the IADLs and AADLs available in the survey, and therefore, to perform a sensitivity analysis of results to these two different measures.

Statistical Analysis

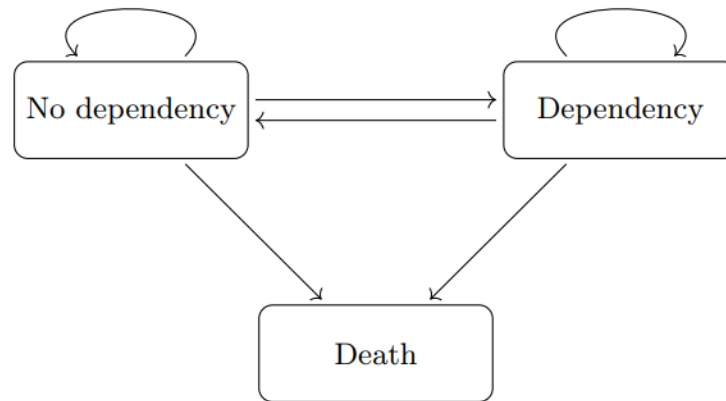
To analyze transitions into dependency we used multinomial logistic regressions to investigate the association between socio-demographic characteristics, co-morbidities and other limitations with transitions into dependency states and death.

In the first wave there are two possible states: no dependency (ND) and dependency (D), while in the second wave, individuals may have died, and therefore, the additional deceased state (Dth) was considered (See Figure 1 for a pictorial representation of the model). In our multinomial model

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staying non-dependent (ND-ND) is the reference category, interpreting the coefficients relative to this transition.

Figure 1 Three state model of transitions into dependency states and death



We were interested in the association of the different factors with the odds of experiencing any transition. Henceforth, we look for the Relative Risk Ratio (RRR) of a given transition, relative to the risk of being non-dependent in both periods (ND-ND). As an example, suppose we were interested in the differences between men and women in the risk of transition ND-D, given a set of control variables X . The RRR representing the risk ratio women have relative to men, of transition ND-D can be written as:

$$RRR = \frac{P(\text{transition} = ND - D | X, \text{woman} = 1) / P(\text{transition} = ND - ND | X, \text{woman} = 1)}{P(\text{transition} = ND - D | X, \text{woman} = 0) / P(\text{transition} = ND - ND | X, \text{woman} = 0)}$$

We further investigated factors associated with both measures of dependency at baseline considering a multivariate perspective. We ran Ordinary Least Squares (OLS) to evaluate the association of factors with the number of activities requiring help at baseline, and logistic regressions to inquire on factors associated with the probability of being dependent.

The multivariate models were adjusted simultaneously by age, sex, education, presence of two or more chronic conditions, visual and hearing difficulties. In addition, we included interactions of

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sex with age and with the presence of two or more chronic conditions in order to reflect the well-known ‘male-female survival paradox’ documented in previous literature.

Individuals who died before the second wave were included in the regressions. Besides, there was no information that allowed us to determine the state at follow up of those untraceable in the second wave (995 cases), hence to analyze if they were different from those with complete data, we checked for differences in the mean of variables between lost individuals and those present in both waves.

All the statistical analyses were done first with the hardest measure of dependency (Katz-dependency) and then considering the more comprehensive measure of dependency (Comprehensive-dependency) and results were compared. Finally, we ran all analyses using STATA 13.

Results

Descriptive Statistics

Table 1 presents descriptive baseline statistics for the sample analyzed. The average age of individuals in the sample was 72 (SD=8.2) years old and 61% of the sample were women. Almost 60% of the individuals reported that primary school was the highest educational level completed. Sight difficulties (7%) were more prevalent than hearing difficulties (2%), and 42% of individuals had at least two chronic diseases.

Table 1 Descriptive statistics of analytical sample at baseline (N=5071)

<i>Age</i>	<i>Mean (SD)</i>	<i>Sex</i>	<i>N (%)</i>
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Age (years)	71.9 (8.2)	Female	3074 (60.6)
Age ranges	N (%)	Male	1997 (39.4)
60-64	1104 (21.8)	<i>Chronic Conditions (CC)</i>	N (%)
65-69	1153 (22.7)	Fewer than two CC	2917 (57.5)
70-74	984 (19.4)	Two or more CC	2154 (42.5)
75-79	797 (15.7)	<i>Sight difficulties</i>	N (%)
80-84	634 (12.5)	Sight difficulties (Yes)	365 (7.2)
85 or more	399 (7.9)	Sight difficulties (No)	4706 (92.8)
<i>Education</i>	N (%)	<i>Hearing difficulties</i>	N (%)
Primary school or less (Yes)	3011 (59.4)	Hearing difficulties (Yes)	105 (2.1)
More than primary school (Yes)	2060 (40.6)	Hearing difficulties (No)	4966 (97.9)

Table 2 presents the descriptive statistics for the dependency measures at baseline, and the distribution of the sample for transitions among dependency states and death. Individuals classified as Katz-dependent at baseline are 4.4%, and this percentage almost doubles when using the Comprehensive-dependency measure (8.1%). On average individuals required assistance in 0.09 (SD=0.5) of the five Katz activities, while this number rises to 0.25 (SD=1.1) when considering the eleven activities of the comprehensive measure.

The analytical sample did not differ from individuals not followed in the second wave in terms of age (t-test, $p=0.18$), sex (t-test, $p=0.68$), education (t-test, $p=0.13$), hearing impairments (t-test, $p=0.30$), number of chronic conditions (t-test, $p=0.47$), Katz-dependency status (t-test, $p=0.89$) or Comprehensive-dependency status (t-test, $p=0.21$). However, there are difference in terms of visual impairments (t-test, $p=0.05$). These results suggest that there is no selection in the missing data.

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Table 2 Descriptive statistics of dependency measures of analytical sample at baseline (N=5071)

<i>Number and percentage of people requiring help in each activities</i>			
<i>Katz activities</i>	N (%)	<i>Other activities</i>	N (%)
Eating	32 (0.6)	Avoiding health risks	52 (1.0)
Dressing	116 (2.3)	Changing/maintaining position	68 (1.3)
Personal care	114 (2.2)	Displacing outside house	269 (5.3)
Displacing inside house	121 (2.3)	Performing housework	231 (4.6)
Using the restroom	92 (1.8)	Participating in social life	108 (2.1)
		Communicating	61 (1.2)
<i>Katz-Dependency</i>	N (%)	<i>Comprehensive-Dependency</i>	N (%)
Katz-Dependent (Yes)	224 (4.4)	Comprehensive-Dependent (Yes)	409 (8.1)
Katz-Dependent (No)	4847 (95.6)	Comprehensive-Dependent (No)	4662 (91.9)
<i>Number of activities requiring help from:</i>	Mean (SD)	<i>Number of activities requiring help from:</i>	Mean (SD)
5 activities of Katz	0.09 (0.5)	11 activities of Comprehensive	0.25 (1.1)
<i>Transitions</i>			
<i>Katz-dependency</i>	N (%)	<i>Comprehensive-dependency</i>	N (%)
ND-ND	4061 (80.1)	ND-ND	3650 (72.0)
ND-D	244 (4.8)	ND-D	527 (10.4)
ND-Dth	542 (10.7)	ND-Dth	485 (9.6)
D-ND	61 (1.2)	D-ND	90 (1.8)
D-D	78 (1.5)	D-D	177 (3.5)
D-Dth	85 (1.7)	D-Dth	142 (2.8)

Notes: ND-D: Non-dependent to Dependent; ND-Dth: Non-dependent to Death; D-ND: Dependent to Non-dependent; D-D; Dependent to Dependent; D-Dth: Dependent to Death.

Risk factors of dependency using the Katz-dependency measure

The results show (See Figure 2) increasing age is associated with a higher number of Katz activities requiring help on average ($\beta=0.004$, $SE=0.001$, $p=0.006$). Also, the presence of at least two chronic conditions ($\beta=0.080$, $SE=0.025$, $p=0.001$) and having sight difficulties ($\beta=0.156$, $SE=0.028$, $p<0.001$) increase this number. Women have a lower mean number of activities that requires help at baseline ($\beta=-0.509$, $SE=0.129$, $p<0.001$) but, since the interaction of age and sex is positive and significant ($\beta=0.007$, $SE=0.002$, $p<0.001$), increasing age increases the mean number of activities requiring help even more for women than for men. Although having hearing difficulties ($\beta=0.090$, $SE=0.050$, $p=0.074$) or low educational level ($\beta=0.027$, $SE=0.015$, $p=0.072$) may have a positive association with the activities requiring help, the coefficients do not reach traditional statistical significance. Finally, results didn't show significant association of the interaction between having two or more chronic conditions and sex ($\beta=-0.028$, $SE=0.031$, $p=0.352$).

Turning to the risk of being Katz-dependent at baseline, results show increasing age ($OR=1.07$, $CI=[1.04;1.11]$, $p<0.001$), having two or more chronic conditions ($OR=3.06$, $CI=[1.79;5.24]$, $p<0.001$), having sight difficulties ($OR=3.06$, $CI=[1.79;5.24]$, $p<0.001$) and a lower educational level ($OR=1.61$, $CI=[1.16;2.24]$, $p=0.005$) are associated with a higher risk of being Katz-dependent. However, females do not exhibit differences in the risk of being Katz-dependent with males ($OR=0.55$, $CI=[0.03;10.15]$, $p=0.690$) either the interaction of age with sex ($OR=1.02$, $CI=[0.98;1.05]$, $p=0.431$) nor having two or more chronic conditions with sex ($OR=0.66$,

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CI=[0.35;1.26], $p=0.209$) present statistically differences. These results are shown in Figure 2 and in the Supplementary material, Table S. 1.

Table 2 panel (a) shows the results of the multinomial logistic regression using the Katz-dependency measure to define a dependent state of the individual. As individuals age, the results show that the relative risk of each transition is greater than that of the transition of being non-dependent in both waves with the exception of remaining in a dependent state, where the estimate was not significant. Thus, we could expect that per additional year of older age individuals are more likely to move from a non-dependent towards dependent state, relative to remain non-dependent (RRR=1.08, CI=[1.05;1.12], $p<0.001$). Having at least two chronic conditions increases the relative risk of moving from non-dependent state towards dependent (RRR=2.16, CI=[1.31;3.57], $p=0.003$) and from dependent to death (RRR=5.35, CI=[2.30;12.44], $p<0.001$). Women also have a lower relative risk of transition to death from non-dependent state (RRR=0.05, CI=[0.01;0.31], $p=0.001$). Having a lower educational level increases the risk of transition to death from a non-dependent state (RRR=1.43, CI=[1.16;1.76], $p=0.001$) and from dependent state (RRR=2.00, CI=[1.11;3.58], $p=0.020$), relative to the risk of remaining non-dependent in both waves. Finally, having sight difficulties increases the risk of transition from dependent to death (RRR=3.76, CI=[2.22;6.34], $p<0.001$), recover from a state of dependency (RRR=4.24, CI=[2.34;7.69], $p<0.001$), and remain dependent (RRR=2.55, CI=[1.39;4.65], $p=0.002$), relative to stay non-dependent in both waves.

In sum, increasing age and having two or more chronic conditions were found to be the factors associated with a higher risk of transition from a non-dependent to a dependent state, relative to remain non-dependent with the Katz-dependency measure.

Risk factors of dependency using the Comprehensive-dependency measure

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The frequency of each transition was sensitive to the dependency measure (see Table 1). While 4.8 % of the sample transitioned from a non-dependent to a dependent state when dependency was operationalized using Katz measure, this percentage has a two fold increase (10.4%) when considering the Comprehensive-dependency measure. However, for both measures the permanence in a non-dependent state is the most frequent.

In terms of dependency at baseline, the results for the Comprehensive-dependency measure are similar to the results obtained for Katz-dependency measure. The differences are that for the total of activities, the effects sizes are greater than for Katz's activities and that hearing difficulties increased the risk of being Comprehensive-dependent, while it was not associated with being Katz-dependent (See Figure 2 and Table S. 1 in Supplementary material).

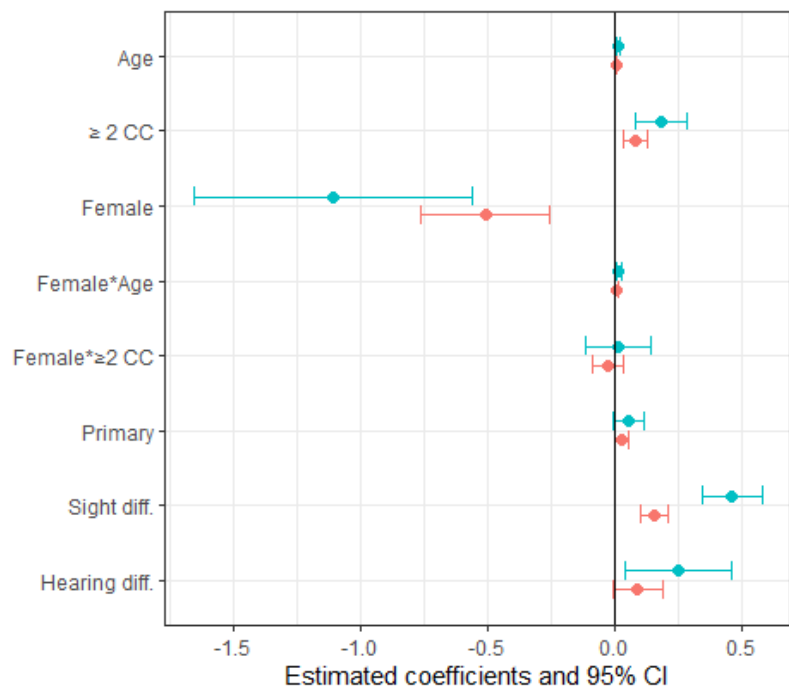
In addition, when we use the Comprehensive-dependency measure rather than the Katz-dependency measure, the results show inconsistencies with respect to the factors associated with risk of transitions into dependent and non-dependent states and death (see Table 2). While the effect of age does not change in direction and magnitude when the different measures are used, having two or more chronic conditions was not found to be significantly associated with the risk of becoming Comprehensive-dependent relative to remain non-dependent, contrary to the previous significant result when the Katz-dependency measure was used. In addition, having a low educational level (RRR=1.33, CI=[1.08;1.63], p=0.010) and sight difficulties (RRR=1.86, CI=[1.34;2.58], p=0.000) were associated with a greater risk of transiting to a Comprehensive-dependent state, relatively to remain non-dependent. More importantly, results show that the interaction between being female and having at least two chronic conditions increases the risk of becoming Comprehensive-dependent (RRR=1.79, CI=[1.15;2.80], p=0.010). For instance, we

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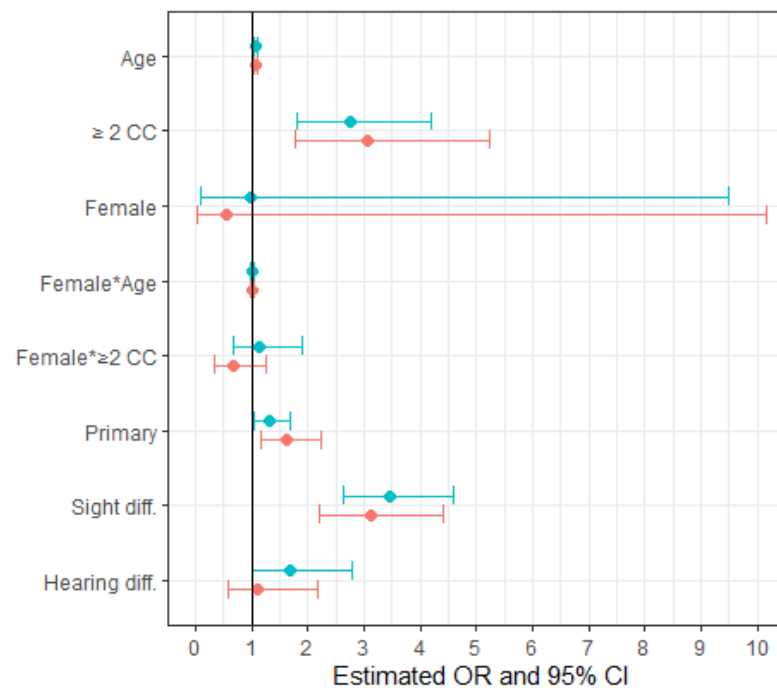
could expect that a woman with two or more chronic conditions has a risk 1.79 times higher of moving from non-dependent to Comprehensive-dependent relative to stay non-dependent.

Figure 2 Associated factors to dependency at baseline

(a) Number of activities



(b) Dependent (Yes/No)



Measures —●— Katz-D —●— Comprehensive-D

Panel (a): OLS for number of activities requiring help. Katz-D counts help in five activities and Comprehensive-D in eleven activities. Panel (b): logistic regression for dependent state at baseline. Katz-D defines dependent if required help in at least one

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activity of Katz-dependency measure and Comprehensive-D defines dependent if required help in at least one activity of the Comprehensive-dependency measure. Abbreviations: CC, Chronic conditions. CI, Confidence Interval. OR, Odds Ratio.

Table 3 Relative risk ratios for transitions to dependency and death. Base transition ND-ND.

	(a) Katz-dependency					(b) Comprehensive-dependency				
	ND-D	ND-Dth	D-ND	D-D	D-Dth	ND-D	ND-Dth	D-ND	D-D	D-Dth
Age	1.08*** (1.05; 1.12)	1.08*** (1.06; 1.10)	1.11** (1.02; 1.20)	1.04 (0.98; 1.10)	1.14*** (1.09; 1.20)	1.09*** (1.07; 1.12)	1.09*** (1.07; 1.11)	1.05* (0.99; 1.11)	1.08*** (1.03; 1.12)	1.15*** (1.10; 1.19)
≥ 2 CC	2.16*** (1.31; 3.57)	1.22 (0.92; 1.61)	3.26* (0.91; 11.72)	2.03 (0.86; 4.75)	5.35*** (2.30; 12.44)	1.30 (0.89; 1.91)	1.16 (0.87; 1.55)	2.21* (0.90; 5.39)	2.43** (1.23; 4.80)	3.90*** (2.05; 7.40)
Female	2.87 (0.18; 45.04)	0.05*** (0.01; 0.31)	211.61 (0.28; 159516)	0.01** (0.00; 0.71)	0.05 (0.00; 7.84)	3.12 (0.41; 23.54)	0.06*** (0.01; 0.43)	4.31 (0.04; 517.30)	0.37 (0.01; 14.07)	0.01** (0.00; 0.62)

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Female*Age	0.99	1.03**	0.94	1.07**	1.04	0.99	1.03**	0.98	1.02	1.06**
	(0.95;	(1.01;	(0.87;	(1.01;	(0.98;	(0.96;	(1.00;	(0.92;	(0.97;	(1.01;
	1.02)	1.05)	1.03)	1.14)	1.11)	1.02)	1.05)	1.05)	1.07)	1.12)
Female* ≥ 2 CC	1.31	1.09	0.96	1.10	0.36**	1.79**	1.15	2.24	1.66	0.83
	(0.72;	(0.74;	(0.23;	(0.39;	(0.13;	(1.15;	(0.76;	(0.76;	(0.75;	(0.37;
	2.41)	1.60)	4.05)	3.07)	0.99)	2.80)	1.73)	6.60)	3.66)	1.84)
Primary	1.20	1.43***	1.57	1.61*	2.00**	1.33***	1.43***	1.18	1.32	2.02***
	(0.90;	(1.16;	(0.88;	(0.95;	(1.11;	(1.08;	(1.15;	(0.76;	(0.94;	(1.28;
	1.59)	1.76)	2.70)	2.73)	3.58)	1.63)	1.78)	1.85)	1.85)	3.19)
Sight diff.	1.43	1.35*	4.24***	2.55***	3.76***	1.86***	1.42*	4.80***	3.86***	4.32***
	(0.92;	(0.97;	(2.34;	(1.39;	(2.22;	(1.34;	(0.98;	(0.98;	(2.57;	(2.77;
	2.20)	1.88)	7.69)	4.65)	6.34)	2.58)	2.08)	2.08)	5.82)	6.74)
Hearing diff	0.89	1.57*	0.94	1.41	1.29	1.52	1.63	2.96**	1.42	2.28**
	(0.37;	(0.94;	(0.22;	(0.48;	(0.51;	(0.83;	(0.90;	(0.90;	(0.60;	(1.09;
	2.14)	2.63)	4.10)	4.16)	3.29)	2.78)	2.97)	2.97)	3.36)	4.74)

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N	5,071	5,071	5,071	5,071	5,071	5,071	5,071	5,071	5,071	5,071
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Notes: 95% confidence intervals in parentheses; *** p<0.01, ** p<0.05, * p<0.1

ND-ND: Non-dependent to Non-dependent; ND-D: Non-dependent to Dependent; ND-Dth: Non-dependent to Death;

D-ND: Dependent to Non-dependent; D-D; Dependent to Dependent; D-Dth: Dependent to Death. CC: Chronic conditions.

Sensitivity analyses and additional analyses

We performed two sensitivity analyses to study the robustness of our results. First, we changed the Katz-dependency measure, replacing the activity of “Displacing inside home” with “Changing/maintaining position”. Second, we analyzed the subsample of individuals who responded the survey by themselves, which implies a loss of 3% of the analytical sample (the subsample corresponds to 4468 cases). The results are in the Supplementary material, Tables S2-S5.

We performed additional analyses which are included in the Supplementary material. We have fitted a series of multinomial logistic models adding the covariates one at a time and using interaction terms to capture the ‘male-female survival paradox’. Also, we have added a dummy variable to indicate whether the person lives alone or not (“Lives alone” =1, the person lives alone; “Lives alone” =0, otherwise). For the sake of brevity, we have reported in the Supplementary material, Tables S6-S7, only the relative risk ratios for the transition ND-D, for both dependency operationalizations (Katz- and Comprehensive-dependency). Finally, we have considered the net household income of the last month (in logs) and included it as a covariate in the model. However, as 20% of the data on income is missing, the number of observations for models including income as a covariate, is 4162. Hence, we added an additional estimation of the multinomial logistic regression with this subsample and the results are reported in Table in the Supplementary material, Table S8.

Discussion

Our work reports the first investigation about dependency and its dynamics for older adults in Uruguay using data from a national representative study. The main aims of the current work were to assess the heterogeneity of transitions towards dependency by socio-demographic characteristics in the population of older adults and to explore the sensitivity to different measures of dependency. In our analyses, heterogeneity of transitions towards dependency emerged, and results showed inconsistencies when evaluating these transitions with different measures.

Firstly, we showed that it is more likely to transition to dependency when a comprehensive measure of the construct is used. Although, this could be due to the greater number of activities in the measure, it also may be related to the different type of activities included. As previously reported in the literature, IADLs are the first in which people become dependent, and older people tend to have, on average, less difficulty with BADLs than with IADLs (Carmona-Torres et al., 2019; Edjolo et al., 2016; Graciani et al., 2004; Millán-Calenti et al., 2010; Rodríguez-Sampayo et al., 2011). The Katz-dependency measure includes only BADLs, while the Comprehensive-dependency also IADLs and AADLs and this may be increasing transitions towards dependency with the comprehensive measure. Consequently, operationalizing dependency with a comprehensive measure, including BADLs and IADLs, expands the target population of dependency care policies, even more than when the operationalization uses only BADLs. Moreover, in Uruguay's current NCS the official measure that determines whether a person can be a beneficiary of the program or not, is a comprehensive operationalization of dependency (MIDES, 2018b). Although the methodology of the official scale is not publicly available, it is known that all activities asked in ELPS are included in the official scale construction (MIDES, 2018a, 2018b). Therefore, our results suggested that the comprehensive operationalization of dependency used in

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the NCS of Uruguay, by expanding the program's target population, may increase program's costs more than when the operationalization of dependency uses only BADLs. While it is desirable to consider a comprehensive measure of dependency (WHO, 2011), it may be also to consider a more restrictive operationalization to take into account the sustainability of the policy, especially in the long term.

In addition, our results show that increasing age, poorer health and sight impairments are factors associated with a greater number of activities requiring help and higher probability of being dependent at baseline, in keeping with previous studies (Rodríguez-Sampayo et al., 2011; Sousa et al., 2009, 2010). These results are consistent either when we consider the Katz-dependency or the Comprehensive-dependency measures. Besides, hearing difficulties also emerged as a risk factor when we use the Comprehensive-dependency measure, which may be due to the activities included in this measure. In particular, hearing impairments could be affecting Comprehensive-dependency due to “participating in social life” and “communicating” included only in that measure.

Furthermore, in agreement with previous research, the analyses of transitions towards dependency including death show heterogeneity by age, sex, education, health and physical impairments for older people in Uruguay (At et al., 2015; Kingston et al., 2017; Prina et al., 2020; Sousa et al., 2010). Moreover, we showed that results are sensitive to the dependency measure. For instance, moving from non-dependent to dependent state, with the comprehensive measure is associated with sex rather than when the harder operationalization of dependency is used (the Katz-dependency measure). For the latter case, only age and the presence of comorbidity are factors associated with higher risk of transition towards a dependency state.

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Consistently with previous literature, our results suggest that women age with poorer health than men (At et al., 2015; Kingston et al., 2017; Prina et al., 2020; Sousa et al., 2010). Older woman with chronic conditions are more likely to enter into dependency state when considering a comprehensive measure of dependency than men. So, the ‘male-female survival health paradox’ is combined with a higher risk of dependency for older woman indicating that care policies should take this into account to improve their quality of life (Alexandre et al., 2014; Alvarado et al., 2008; Tareque et al., 2017). It is possible that the role of women in the household combined with their poorer health results in women’s higher risk of transition into a Comprehensive-dependent state (Millán-Calenti et al., 2010).

Finally, our findings suggest that how dependency is measured is also relevant to understand dependency dynamics over time. Older people with chronic conditions have unmet care needs (Abdi et al., 2019), so it is important to develop care models based around the needs of older people. The differences identified in the risk factors of transiting to a dependent state when using different measures of the construct, provide new insights about how to design and implement policies that provide care to older dependent population living at home. As mentioned above, in the NCS of Uruguay the official scale operationalizes dependency in a comprehensive manner, and our results suggest that in the comprehensive operationalization, women with worse health condition are at greater risk of transitioning to dependency. Therefore, not considering sex to determine whether or not a person is a beneficiary of the program, could generate gender inequities between the older population, to the detriment of women. In addition, this could be worsened if restrictions are applied to program access due to budgetary issues or long-term sustainability of the policy. This could affect the design of interventions to improve quality of life of dependent older people, as our results suggest the need to design sex specific interventions. Further work

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could deepen knowledge about the type of care required to improve the design of care policies, as our results suggest that the transition to dependency is associated with different characteristics when using a hard operationalization of the construct rather than when a comprehensive operationalization is used.

A limitation of the current work is that the ELPS study only has two waves. Even though attrition is not a major problem, the analysis of transitions into dependency is limited when data has only two observations maximum per individual. Another drawback is that international comparisons may be hampered by the absence of databases with comparable information in nationally representative samples.

Despite full harmonization of databases is challenging, our analysis extends previous reports from other Latin American countries such as those produced by the 10/66 Dementia Group (Prince, 2009), adding evidence about the population of older adults in Uruguay, and thus allowing a better understanding of dependency in the context of the aging process. Future research on dependency in Uruguay should guarantee the harmonization, that may provide new insights regarding international comparisons, the heterogeneity in the evolution of dependency as individuals age, and the associated need for help.

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