

# Inequalities by gender and education and cognitive ageing. Preliminary findings from the ERC-CRISP project

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## The CRISP Project: Cognitive Ageing – From Educational Opportunities to Individual Risk Profiles



### **Inequalities by gender and socio-economic background, and cognitive functioning later in life**

Do societal conditions determine to which extent individuals are able to build up cognitive reserve? Since there is no medical cure available to delay cognitive ageing, we need to understand how to create the best possible environments to build up cognitive reserve. We investigate the different opportunities of men and women in terms of education, work and pay, and how they relate to cognitive performance in later life. We also investigate how inequalities in educational opportunities – schooling systems that favor children from higher socio-economic backgrounds – play out their influence on cognitive functioning over the life course.



### **Improving long-term dementia risk prediction and lifestyle interventions with new methods**

We have some understanding about the high risk groups to develop dementia, and can build on first evidence on short-term benefits of multidomain lifestyle interventions to delay cognitive decline. However, we have very limited generalized knowledge of what intervention works for whom and when. That is why we need to understand more clearly the potential and limits of lifestyle interventions. How do we do this? We use new causal inference frameworks to analyse observational data in order to identify target groups and promising components of future lifestyle interventions. Additionally, we implement recently developed machine learning methods to improve accuracy of risk prediction.

# Dementia



## Definition

- Range of conditions with severe memory impairment
- Most common form is *Alzheimer's Disease*
- Not a part of the normal ageing process
- Main symptom: Cognitive decline that affects activities of daily living and social functioning

# Dementia



## Numbers of persons living with dementia increase sharply

- in Europe: 10.46 mio. persons in 2015, 13.42 mio in 2030
- in North America: 4.78 mio. in 2015, 7.28 mio. in 2030

## Economic costs

Estimated at 1 trillion USD in 2018

Despite some improvements, still seriously **underfunded** and **underresearched** compared to other diseases<sup>1</sup>

## Dementia



### No cure

No drugs to prevent, slow or halt the progression of the disease

Some evidence for effectiveness of **multimodal behavioral interventions** to slow cognitive decline in high-risk individuals over two years<sup>1</sup>

Reducing modifiable behavioral and social risk factors could prevent up to 40% of all cases of dementia<sup>2</sup>

<sup>1</sup>Ngandu et al., 2015; <sup>2</sup>Livingston et al., 2020; Norton et al., 2014

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## Inequalities in dementia

Risk of Dementia

Dementia Care

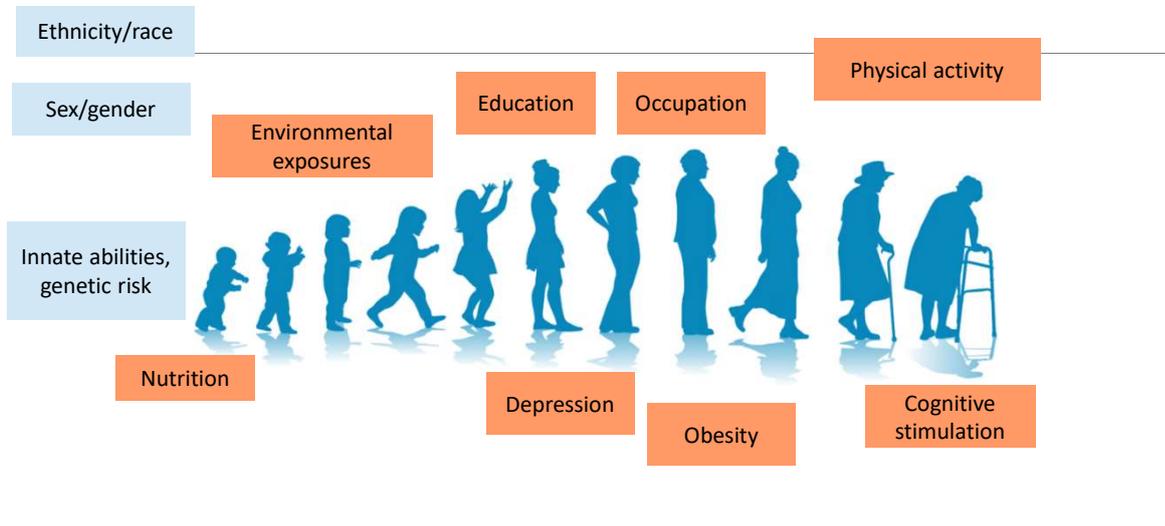
Dementia Research

Dementia Treatment



Leist, 2017 6

# Life course influences on cognitive functioning



Leist, Novella, Olivera, 2018; Leist & Mackenbach, 2014; Leist et al., 2013

## Health and Retirement Studies Across the World

**HRS**

HEALTH AND RETIREMENT STUDY

Mexican Health & Aging Study

CRELES  
Coste Rican Longevity and Healthy Aging Study

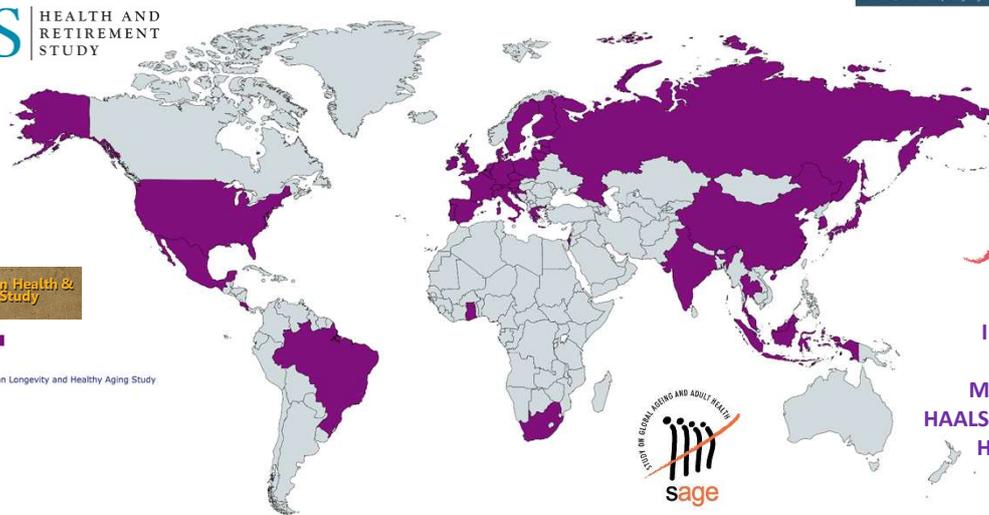
ELSI  
BRASIL  
Estudo Longitudinal de Saúde e Retiro em São Paulo

HAGIS  
Healthy Aging in Germany

SHARE  
Survey of Health, Ageing and Retirement in Europe  
20+ in Europe

NICOLA  
Nurturing Older Adults  
ELSA  
English Longitudinal Study of Ageing

tilda  
The Irish Longitudinal Study on Ageing



CHARLS  
中国健康与养老追踪调查

Japanese Study of Aging and Retirement

- LASI, India
- IFLS, Indonesia
- KLoSA, Korea
- MARS, Malaysia
- HAALSI, South Africa
- HART, Thailand

STUDY OF AGEING AND ADULT HEALTH  
sage

Created with mapchart.net

... merged with data from OECD, national surveys, World Bank etc.

## CRISP Research objective 1

# Inequality of educational opportunity predicts later-life cognitive functioning

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## Background

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- Understand the drivers of older-age cognitive functioning and ageing
- Main cognitive development takes place during schooling (Kremen et al., 2019; Lövdén et al., 2020), and older-age cognitive outcomes are heavily influenced by schooling (Zahodne et al., 2011).
- Schooling systems, i.e., inequality of educational opportunity (IEO), can partly explain student cognitive outcomes (Burger, 2016; Gamoran & Mare, 1989).
- IEO describes to which extent schooling opportunities depend on parental background rather than student cognitive skills, measured as correlation between years of education of parents and their offspring (Rotman et al., 2016)

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## Evidence on macro-level determinants

- Length of compulsory schooling (Glymour et al., 2008; Schneeweis et al., 2014); exposure to economic recessions (Leist et al., 2014)
- Gender-role attitudes and female disadvantage in cognition (Bonsang et al., 2017)
- Distribution in educational attainment is linked to heterogeneity of cognitive functioning at older ages (Olivera et al., 2018)



Higher-IEO contexts may provide better educational resources to children from more advantaged backgrounds, whereas lower-IEO contexts may be more equitable. We hypothesise there is an optimal match between children's cognitive skills and the length and complexity of schooling, which may be more likely realized in lower-IEO contexts.

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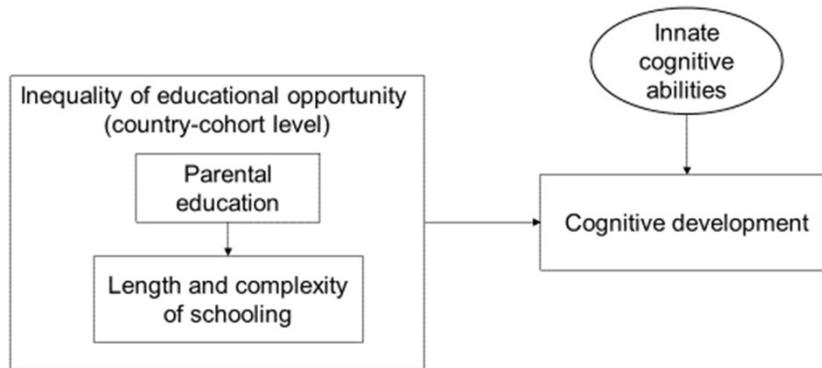
## Research objectives



- Quantify the associations of IEO at time of schooling and older-age cognitive functioning and rate of cognitive decline with age
- Test if these associations differ between men and women in general, and between men and women with different educational attainment.

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## Assumed pathways



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## Data



W1 2004	W2 2006	W3 SHARELIFE	W4 2011	W5 2013	W6 2015	W7 2017 <i>or</i> SHARELIFE
<i>Cognitive assessment + economic, social, and health situation</i>	<i>Cognitive assessment + economic, social, and health situation</i>	<i>Life histories: School performance, parental SES, childhood health</i>	<i>Cognitive assessment + economic, social, and health situation</i>	<i>Cognitive assessment + economic, social, and health situation</i>	<i>Cognitive assessment + economic, social, and health situation</i>	<i>Life histories or Cognitive assessment etc. if particip. in w3</i>

*2-13 years of follow-up to investigate cognitive aging* →

Within the restrictions of this study (country represented in World Bank data,  $\geq 2$  observations per individual), we have data of three cohorts born 1940-49, 1950-59, and 1960-63 from 16 European countries and Israel.

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## Individual-level variables

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### Outcomes

- *Immediate recall*: Remembering words from 10-word list read-out loud immediately afterwards
- *Delayed recall*: Remembering 10-word list after standardized delay
- *Verbal fluency*: Naming as many animals as possible in 1 min

**Education**: ISCED-97 recategorized in *up to lower secondary*, ISCED 0-2, *upper secondary*, ISCED 3, and *post-secondary and tertiary*, ISCED 4-6.

**Covariates**: Cohabitation status, current job situation, self-rated health, number of chronic conditions, number of depressive symptoms, (occupational level w/ISCO).

**Childhood covariates**: Parental SES (number of books), school performance relative to peers in language, and in mathematics, health at age 10.

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## Contextual-level variables

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**Inequality of Educational Opportunity (IEO)**: World Bank Global Database on Intergenerational Mobility

- Country-cohort Pearson's correlation coefficient between parent and & child years of education of cohorts 1940-49, 1950-59, 1960-63

**GDP per capita PPP**: World Bank

**Healthy life expectancy at age 60**: WHO Global Health Observatory, 2005

**Human Development Index (HDI)**: UN Human Development Reports, 2005

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## Multilevel (mixed-effects) models

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Level 3	49 country-cohorts	Random intercept
Level 2	25,544 women; 20,904 men	Random intercept (Random age slope)
Level 1	77,284 - 89,748 observations (women); 61,807 - 71,525 observations (men)	

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## Strategy of data analysis

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- Exposure of interest: **IEO at time of schooling** on mid-age immediate, delayed recall, and verbal fluency, and rate of cognitive decline (IEO\*age) over 2-13 years of follow-up
- Interactions of IEO, sex, and education on 3 cognitive measures
- Adjusted for indicator for first testing (practice effects), age squared
- Suppl analyses: +1 contextual determinant: HDI, GDP, HLE60; childhood information (subsample), ISCO information (subsample)

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## Descriptive statistics

**Cognitive measures:**  $M=5.56$  ( $SD=1.66$ ) immediate recall;  $M=4.22$  ( $SD=2.06$ ) delayed recall;  $M=21.36$  ( $SD=7.55$ ) fluency

**Age:** 50-76 years;  $M=59.3$  ( $SD=6.00$ ) (women) and  $M=59.6$  ( $SD=5.97$ ) (men)

**Length of follow-up:** 2-13.5 years;  $M=7.22$  years,  $SD=3.50$

**Number of assessments:** 2-6;  $M=2.42$  ( $SD=1.27$ ) assessments

**Education:** ISCED 0-2: 38.2% women; 33.3% men; ISCED 3: 34.5% women, 36.6% men; ISCED 4-6: ISCED 4-6: 27.3% women, 30.1% men

**Attrition:** 3.4% died over the course of the study (older, more likely male, less likely higher educated)

**IEO:** between  $r=0.298$  and  $r=0.312$  in the 1960-63 cohorts of the Netherlands and Denmark, and  $r=0.641$  and  $r=0.652$  in the 1940-49 cohorts of Portugal and Italy.

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## Main mixed (random-effects) models

Impact of IEO: Higher IEO associated with:

- In men, lower immediate recall, verbal fluency (immediate recall: Coeff. -0.94, CI -1.50, -0.38; verbal fluency: Coeff. -1.79, CI -2.74, -0.84), but delayed recall *n.s.*
- In women, lower immediate recall, delayed recall, verbal fluency (immediate recall: Coeff. -1.23, CI -1.97, -0.48; delayed recall: Coeff. -0.97, CI -1.78, -0.16; verbal fluency: Coeff. -0.39, CI -0.53, -0.24)

Impact of IEO on decline (IEO\*age):

- In men, slower decline in immediate recall (Coeff. 0.48, CI 0.32, 0.65), delayed recall and verbal fluency *n.s.*
- In women, steeper decline in delayed recall and verbal fluency (delayed recall: Coeff. -0.17, CI -0.32, -0.02; verbal fluency: Coeff. -0.39, CI -0.53, -0.24), rate of decline in immediate recall *n.s.*

*Note.* Coefficients and confidence intervals of the model adjusted for age, age squared, practice, education, cohabitation status, current job situation, self-rated health, number of chronic conditions, number of depressive symptoms.

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## Interaction analysis of IEO x sex/gender x education

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- Main effect of IEO: negative for verbal fluency (Coeff. -1.73, CI -2.76, -0.71), immediate and delayed recall *n.s.*
- Women had lower cognitive scores in all three measures if schooled in higher-IEO contexts
- Women of higher educational levels schooled in higher-IEO contexts performed higher on the three cognitive tests compared to women of lower educational level on all three outcomes (e.g., immediate recall: IEO\*female\*ISCED 3: Coeff. 0.80, CI 0.46, 1.14; IEO\*female\*ISCED 4-6: Coeff. 0.83, CI 0.47, 1.19).

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## Discussion

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### Main findings

- Higher IEO at time of schooling could have profound consequences, particularly for lower-educated women of the cohorts under investigation
- Most associations hold in subsample with childhood information and after controlling for competing contextual determinants, but particularly women from lower socioeconomic background seem to have been particularly hurt by higher IEO contexts

### Limitations:

- Availability of historical macro-level indicators, which ones are relevant confounders?
- Longer follow-up needed of this mid-aged cohort to detect (clinically relevant) cognitive decline

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## Discussion

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### The sex/gender perspective

- Associations between inequality of educational opportunity and gender egalitarianism are not systematically known
- Gender roles have changed dramatically over the last decades (Goldin, 2006)
- Socioeconomic disadvantage may particularly hurt women's cognitive development (Wolfova et al., 2021)
- Resource-substitution theory suggests that women may benefit more from education than men (Ross & Mirowsky, 2006)

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## The CRISP team

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#dementia #cognitiveageing #inequalities #prevention #education #gender

Anja Leist, ERC StG grant agreement no. 803239 (2019-23)  
<https://cognitiveageing.uni.lu>

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## CRISP publications until May 2021

Ford, K. J., & Leist, A. K. (2021). Returns to Educational and Occupational Attainment in Cognitive Performance for Middle-Aged South Korean Men and Women. *Gerontology and Geriatric Medicine*, 7, 23337214211004366.

Bertogg, A., & Leist, A. (2021). Partnership and cognitive aging in Europe: Mediating factors and social stratification. *Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*.

Ribeiro, F., Duarte, Y. A. D. O., Santos, J. L. F., & Leist, A. (2020). Prevalence of memory impairment 2000-2015 in Sao Paulo, Brazil: Epidemiology/Prevalence, incidence, and outcomes of MCI and dementia. *Alzheimer's & Dementia*, 16, e045895. *Full paper under review*.

Ribeiro, F., Teixeira-Santos, C., & Leist, A. (2020). Prevalence of Mild Cognitive Impairment in Latin America and the Caribbean: A Systematic Review. *Innovation in Aging*, 4(S1), 897-898. *Full paper under review*.

Settels, J., & Leist, A. K. (2021). Changes in neighborhood-level socioeconomic disadvantage and older Americans' cognitive functioning. *Health & Place*, 68, 102510.

Leist, A., Terrera, G. M., & Solomon, A. (2020). Using cohort data to emulate lifestyle interventions: Long-term beneficial effects of initiating physical activity on cognitive decline and dementia: Prevention (nonpharmacological)/Lifestyle factors (eg, smoking, etc.). *Alzheimer's & Dementia*, 16, e044493.

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## Thank you!

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