English Longitudinal Study of Ageing

Sex and education differences in trajectories of physiological ageing: longitudinal analysis of a prospective English cohort study

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Hallmarks of ageing

López-Otín et al. *Cell* 2013.

Biological ageing vs. chronological ageing

Chronological age: How old are you in years?

vs.

Biological age: Where are you in the molecular/cellular/physiological ageing process?

Chronological age ≠ biological age

Differences in biological age might explain variation in health outcomes in individuals of the same chronological age

Hallmarks of ageing

López-Otín et al. *Cell* 2013.

Biological clocks used to measure the **molecular/cellular** ageing process

Hallmarks of ageing

López-Otín et al. *Cell* 2013.

Altered biomarkers → **Phenotypic or physiological age** used to measure the **physiological** ageing process

Background

Physiological age > chronological age = accelerated ageing
Individuals are older physiologically than expected based on chronological age

Physiological age < chronological age = decelerated ageing
Individuals are younger physiologically than expected based on chronological age

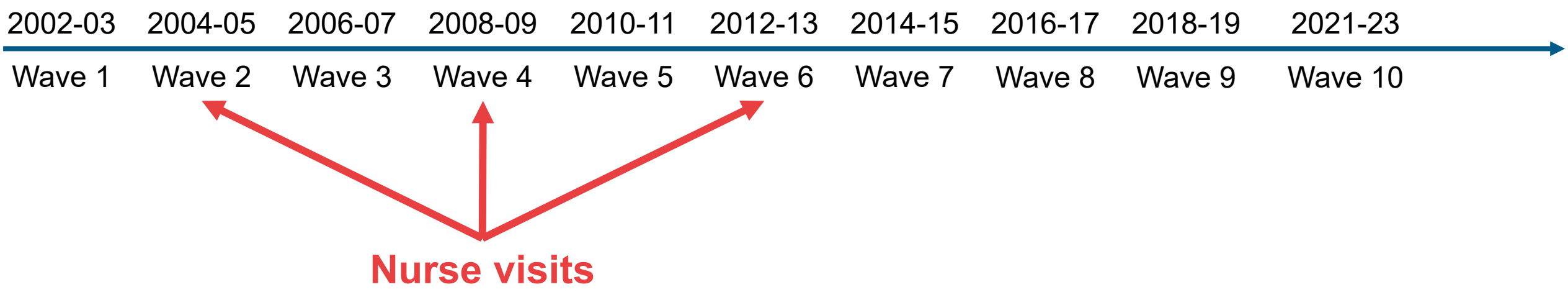
Examining characteristics of individuals with **accelerated** and **decelerated** ageing can reveal sociodemographic/socioeconomic disparities in ageing → physiological age can be considered a healthy ageing index

Gender and education combine to influence ageing but gender and educational disparities in physiological ageing not explored in longitudinal studies → in general women "live longer in worse health" than men

Methods

English Longitudinal Study of Ageing

Nationally representative cohort study of adults aged 50+ residing in England



Methods

Biomarkers collected at nurse visits in ELSA waves 2, 4 and 6 include those pertaining to:

- Cardiovascular system (e.g., pulse, blood pressure)
- Respiratory system (lung function)
- Haematologic system (e.g., haemoglobin concentration)
- Metabolism (e.g., total cholesterol)
- Muscle (grip strength)

Principal component analysis of healthy subset of analytic sample N=822

→ **Physiological age** derived for entire analytic sample N=8,891

Methods

STEP ONE: Validate derived physiological age by examining associations of ageing acceleration with incidence of ageing-related health outcomes occurring between waves 2 (2004/05) and 10 (2021/23) of ELSA using Cox proportional hazards models (adj. for sex and chronological age)

Accelerated ageing was associated with increased incidence of limitations in daily activities, memory impairment, diabetes, lung disease, cardiovascular disease, high cholesterol, high blood pressure, arthritis, osteoporosis, and dementia ($p<0.0001$ for all)

Methods

STEP TWO: Use joint models to examine sex and educational disparities in physiological ageing

Joint models simultaneously estimate longitudinal (mixed model) and survival (Weibull model) sub-models to account for differential attrition

- **Model 1**: Chronological age (CA) + birth cohort + birth cohort x CA + sex + sex x CA
- **Model 2**: Model 1 + education + education x CA
- **Model 3**: Model 2 + sex x education + sex x education x CA

Used to plot trajectories of physiological age from ages 50-80 in men and women (Model 1), by education level (Model 2), and in men and women by education level (Model 3)

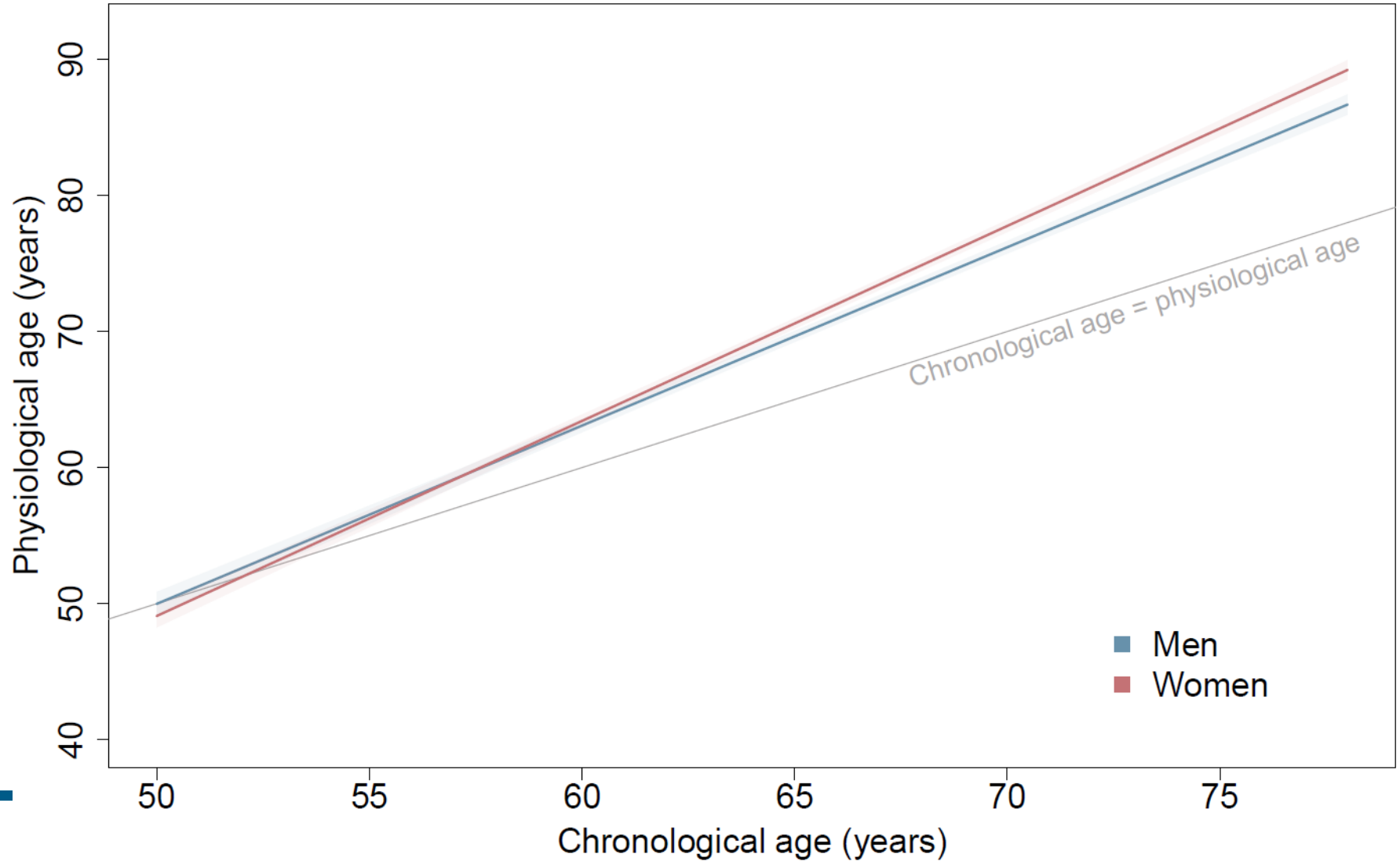
Participant characteristics

Table 2. Characteristics of the analytic sample at first physiological age measurement.

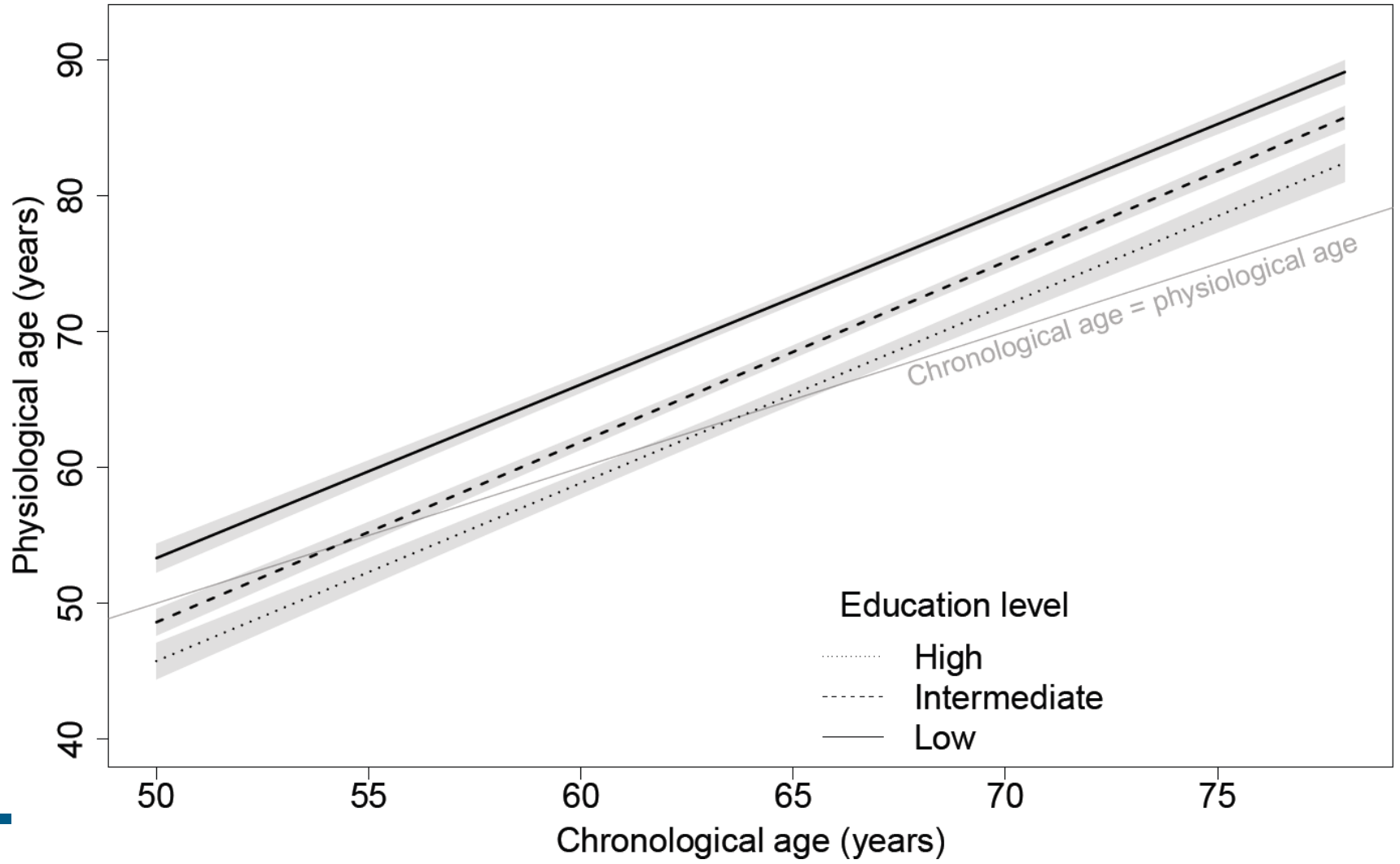
	Men N=4094	**Women** N=4797	P-value
Chronological age, mean (SD)	64·1 (9·1)	64·1 (9·4)	0·94
Biological age, mean (SD)	68·4 (18·7)	69·2 (20·4)	0·045
Ageing acceleration, mean (SD)	4·2 (13·1)	5·1 (14·3)	0·0048
Highest educational qualification			
Less than high school	1586 (38·7)	2198 (45·8)	
High school	1849 (45·2)	2107 (43·9)	<0·0001
Above high school	659 (16·1)	492 (10·3)	

N (%) shown unless otherwise indicated. Abbreviations: SD, standard deviation.

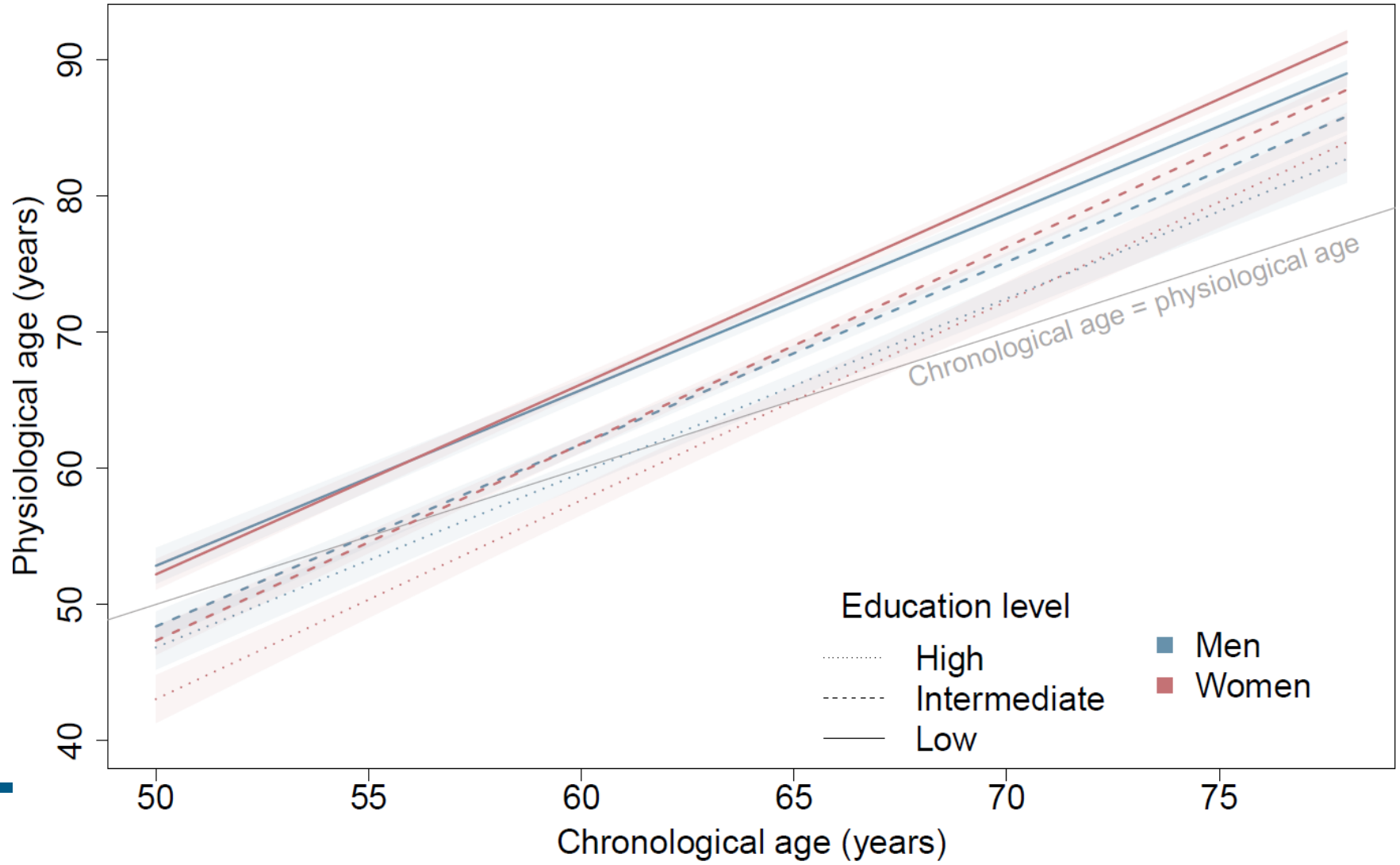
Sex differences in physiological ageing



Educational differences in physiological ageing



Sex and educational differences in physiological ageing



Conclusion

Sex differences in physiological age were minor before chronological age 50 but grew larger as women aged faster than men

More education associated with lower physiological age but no difference in pace of ageing

High education level provided larger midlife benefit for women

- Women educated above high school level were physiologically younger than men until chronological age 70
- Women educated to high school level or below had physiological ages increasingly older than men from age 60 onward

Education above high school level may be particularly important to reduce female disadvantages in physiological ageing

Limitations and directions for future research

Could not externally validate physiological age → associations with chronic conditions in ELSA suggests physiological age internally valid measure of healthy ageing

Limited to biomarkers available in ELSA → other biomarkers (e.g., the Targeting Aging with Metformin assay) may better capture central ageing processes

Development of longitudinal measure of physiological age that could be compared across cohorts to examine disparities in ageing needed

Thank you!

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