

Defining Menopause in Midlife: Measurement Challenges in Population-Based Studies

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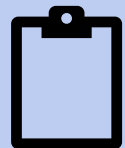
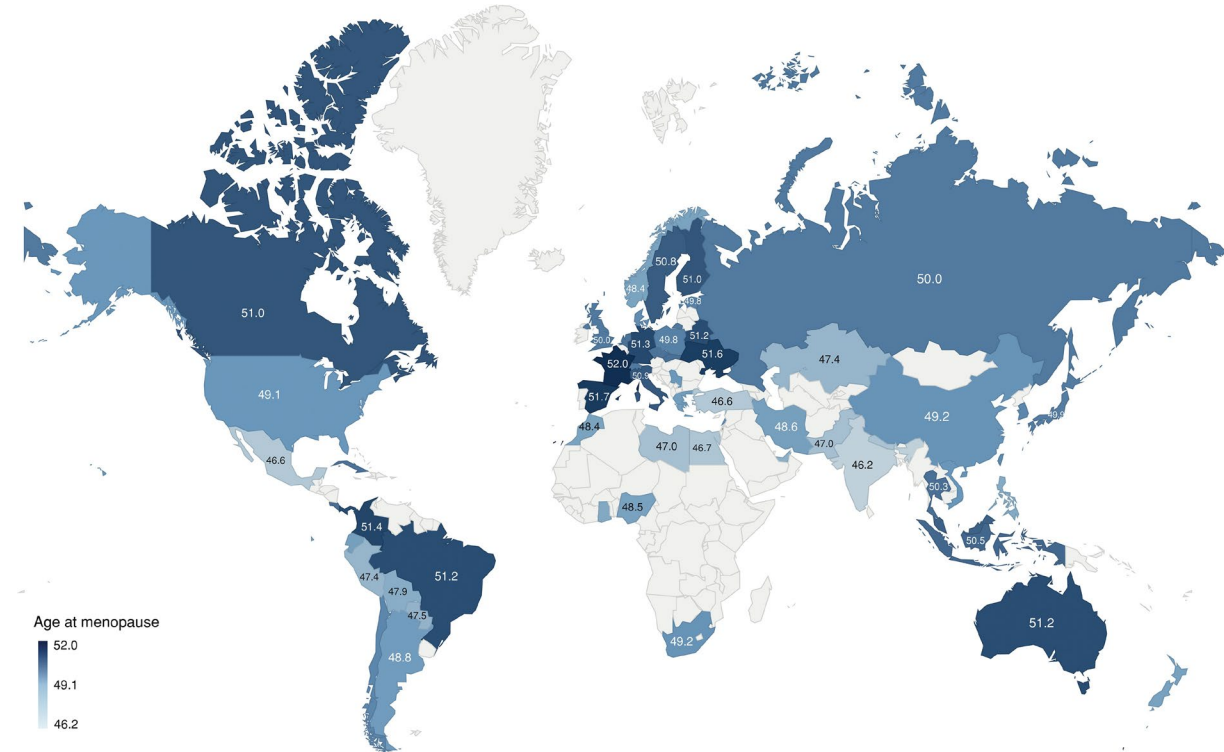
Biomarker Network Meeting

May 6th, 2026

Introduction

- **Menopause is a key marker of women's reproductive aging**, strongly linked to chronic disease, functional decline, and mortality^{1,2}.
- Despite its importance, menopause is **often treated as a discrete, well-defined event** in population studies.
- However, the menopausal transition is **heterogeneous, time-varying, and not always clearly observed**^{3,4}.

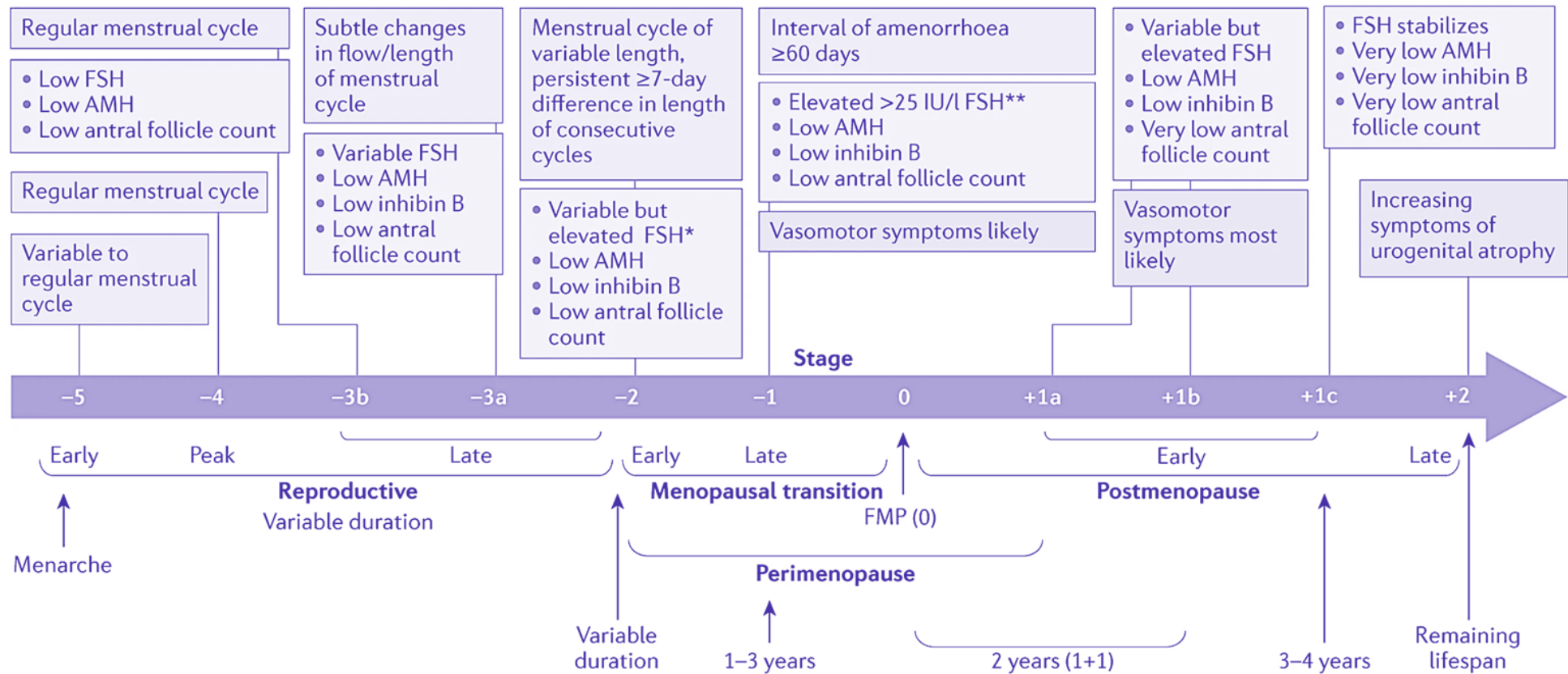
Age at Menopause and Disease Risk in Geographic regions



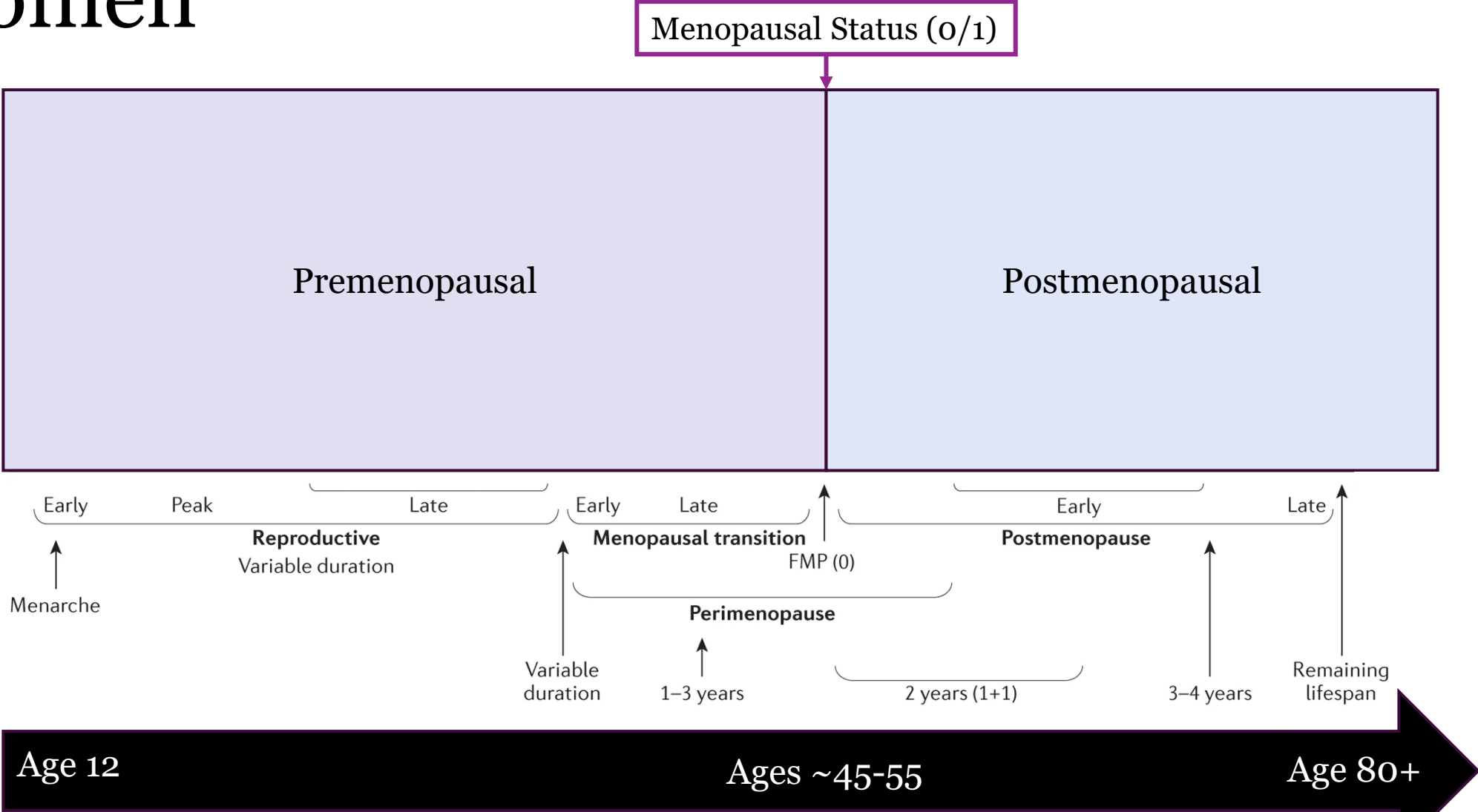
Measurement is often inconsistent, incomplete, and context-dependent.

¹Davis et al., 2015, ²Liu et al., 2026, ³Laisk et al., 2019, ⁴Schoenaker et al., 2014

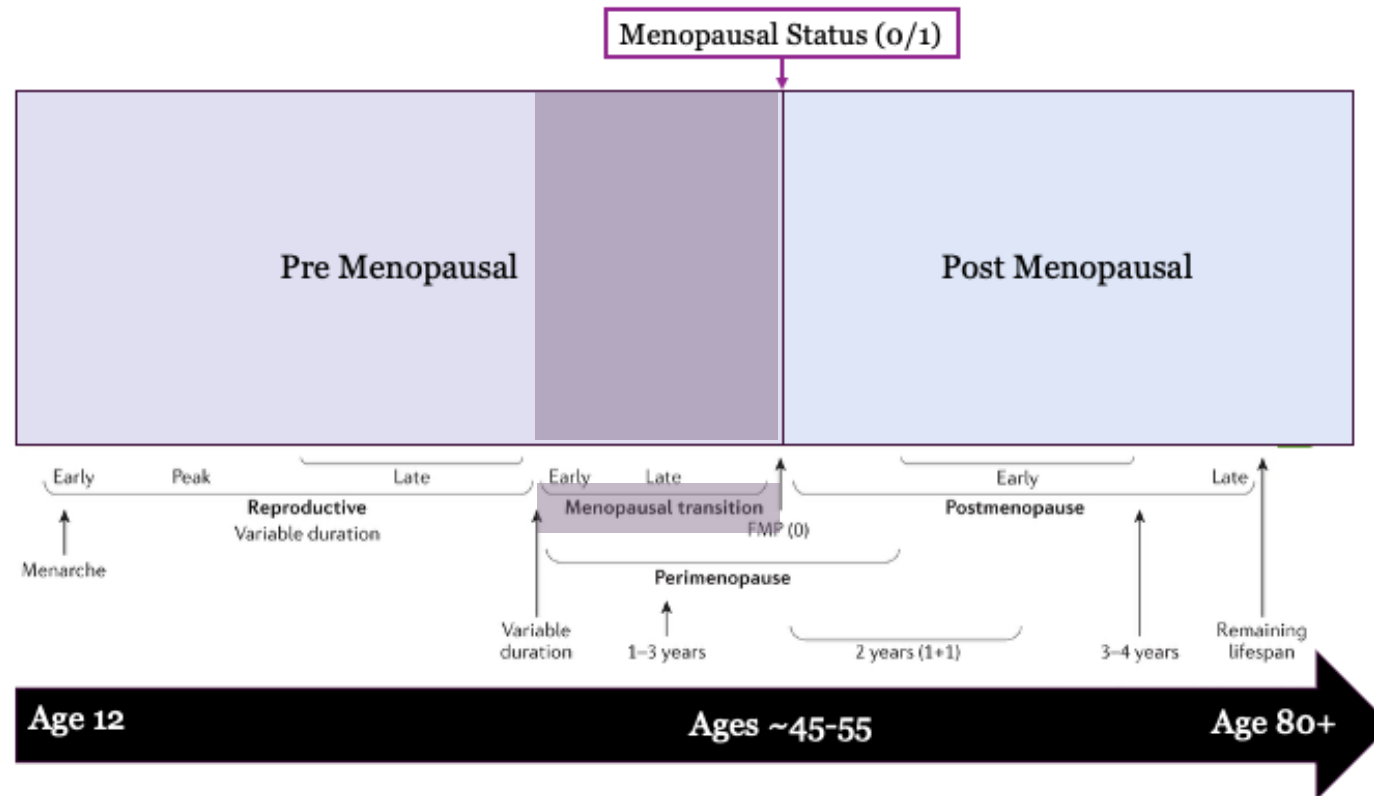
The stages of reproductive aging in women



The stages of reproductive aging in women



The stages of reproductive aging in women



Perimenopause Symptoms



Insomnia, fatigue, & sleep changes



Mood swings, depression, & anxiety

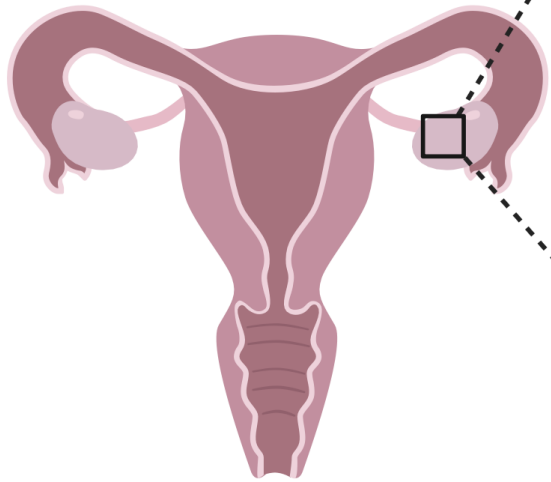


Hormone fluctuations, weight gain, & metabolic changes



Hot flashes, night sweats, & chills

Why measuring menopause is challenging in midlife



Single event

Retrospective measurement

Discordance among indicators

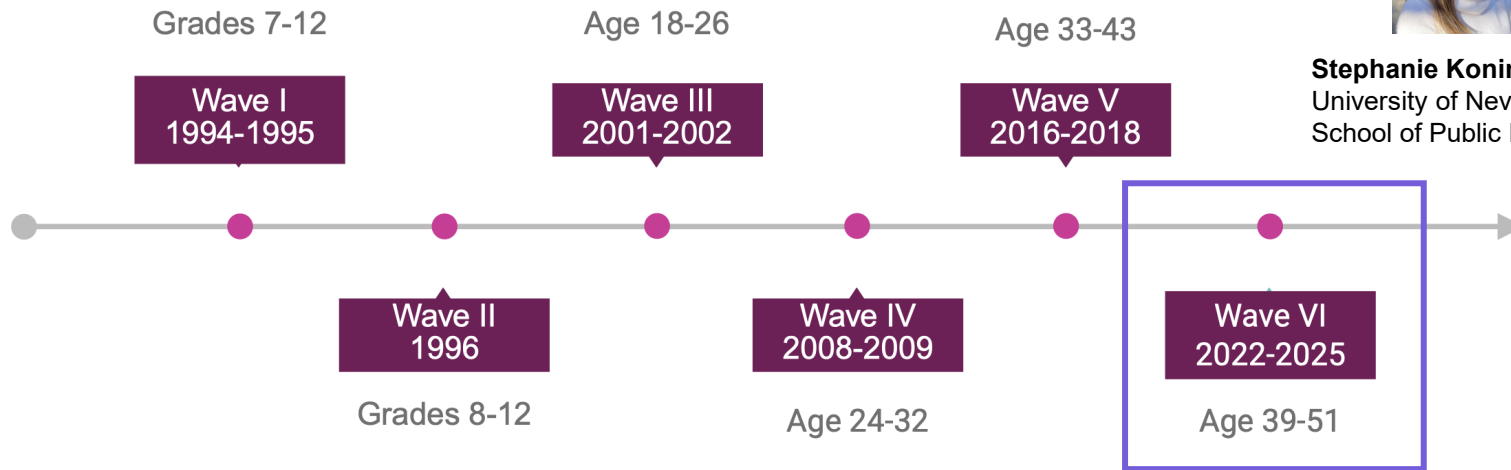
Reporting variation (studies)

Variation in cases (surgery/
hormones)

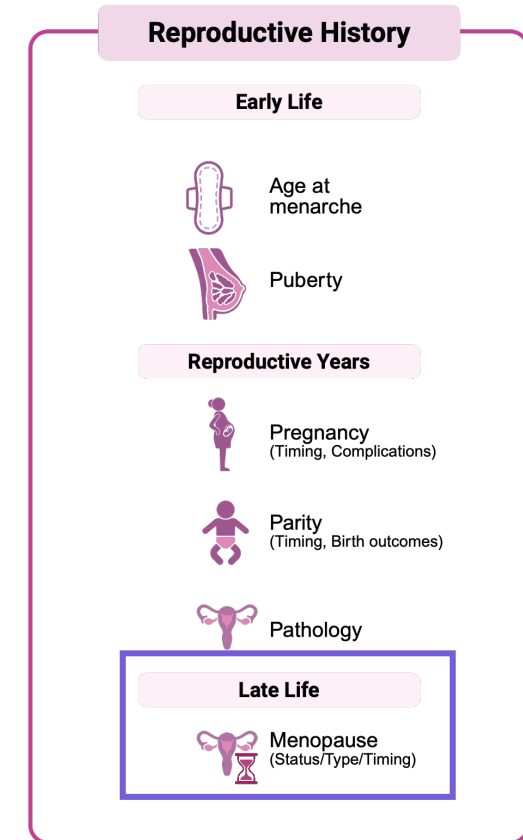
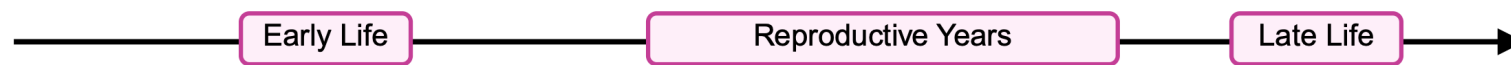
Multi-wave reproductive histories in Add Health



Stephanie Koning, PhD
University of Nevada Reno
School of Public Health

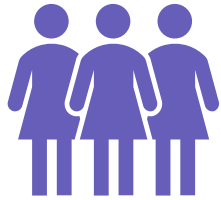


Reproductive Life Course



Offers an unparalleled opportunity to trace women's reproductive experiences **from menarche through menopause.**

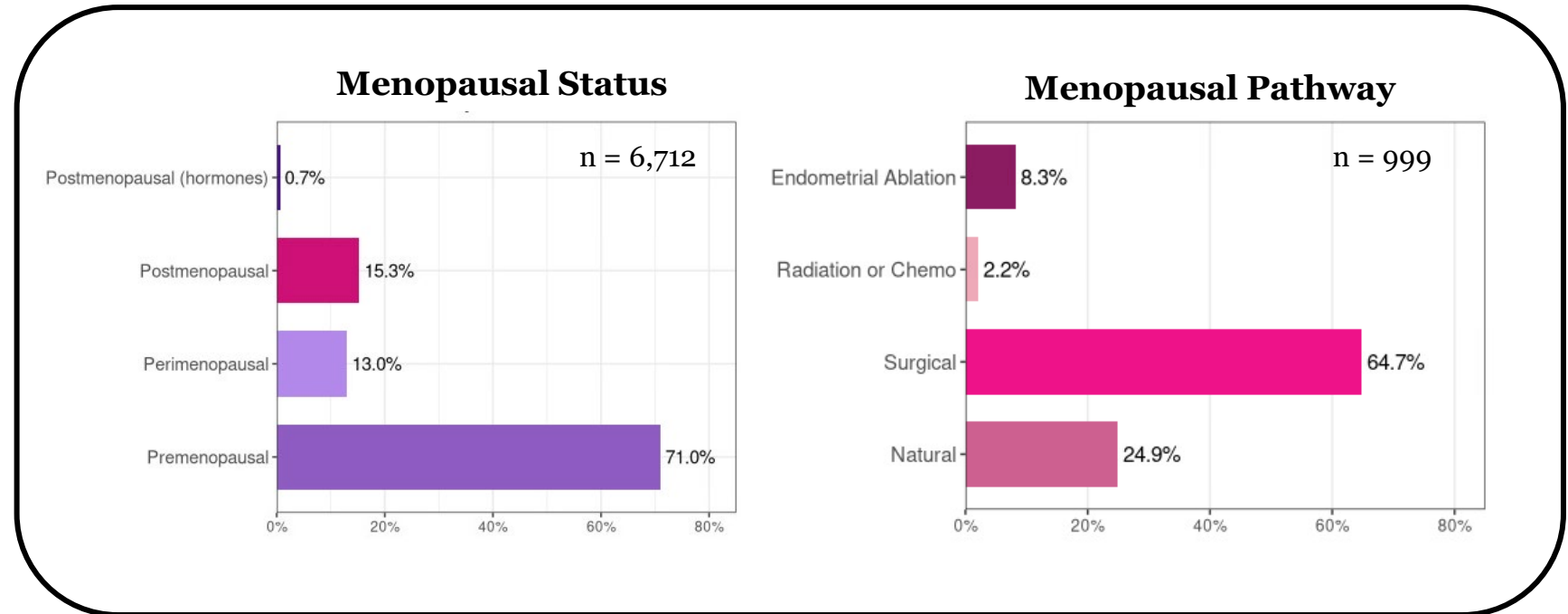
Substantial variation in menopausal status and pathways at midlife



Wave VI

n = 6,712

Mean age = 44.1 years



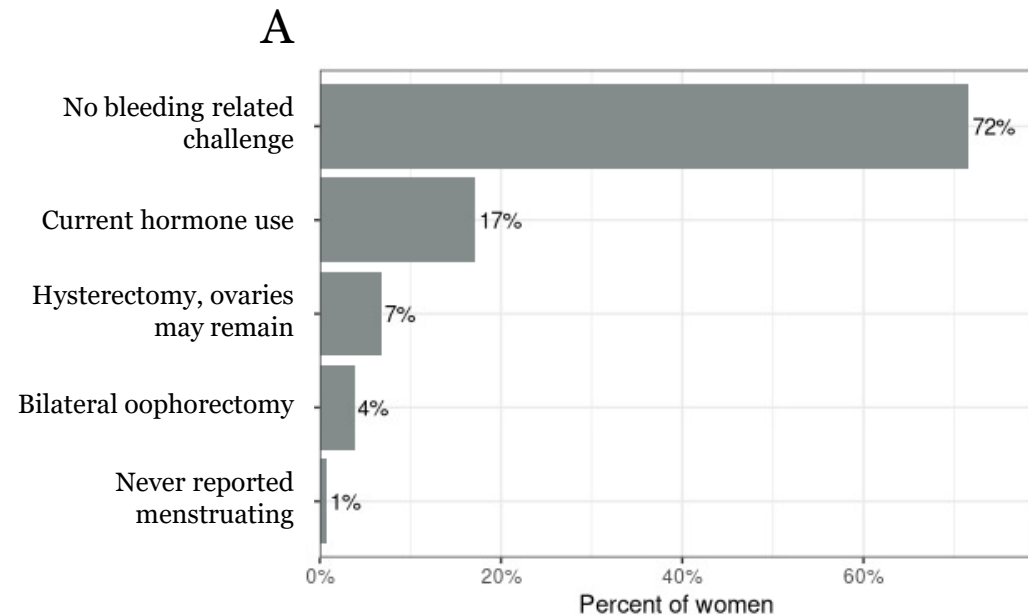
Q: Have your natural menstrual periods ceased permanently?

Q: For what reason did your periods cease?

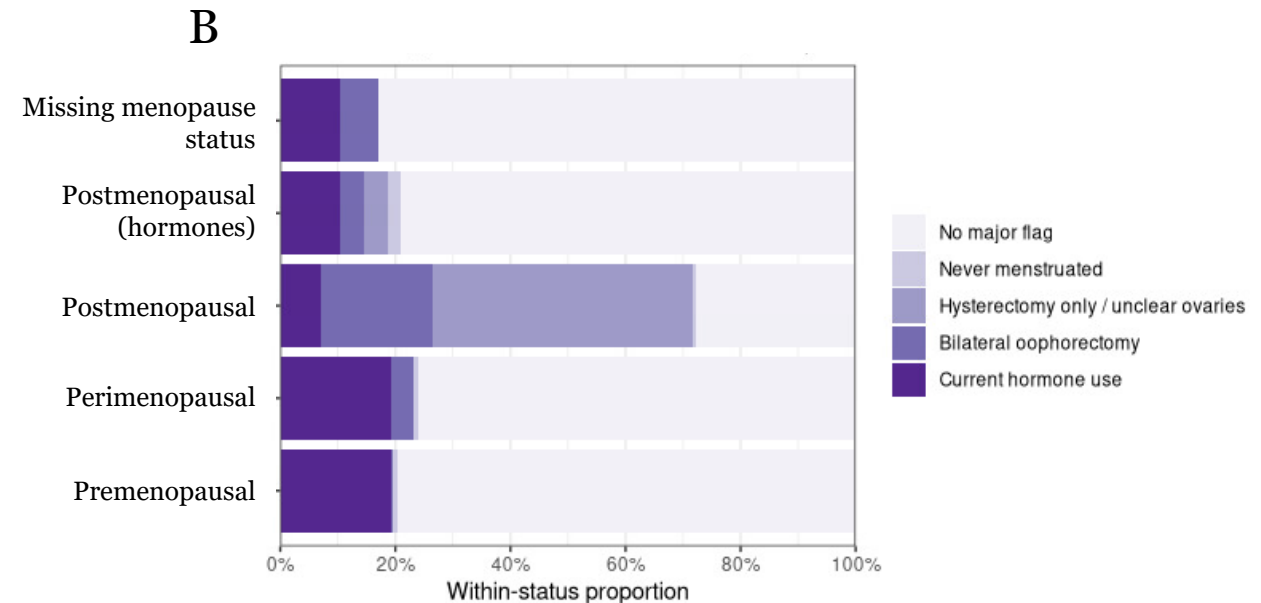
Midlife menopause is heterogeneous, reflecting diverse reproductive trajectories.

Bleeding is an imperfect proxy for menopause

Clinical definition of menopause: 12 consecutive months of amenorrhea in the absence of pregnancy, pathology, or intervention.

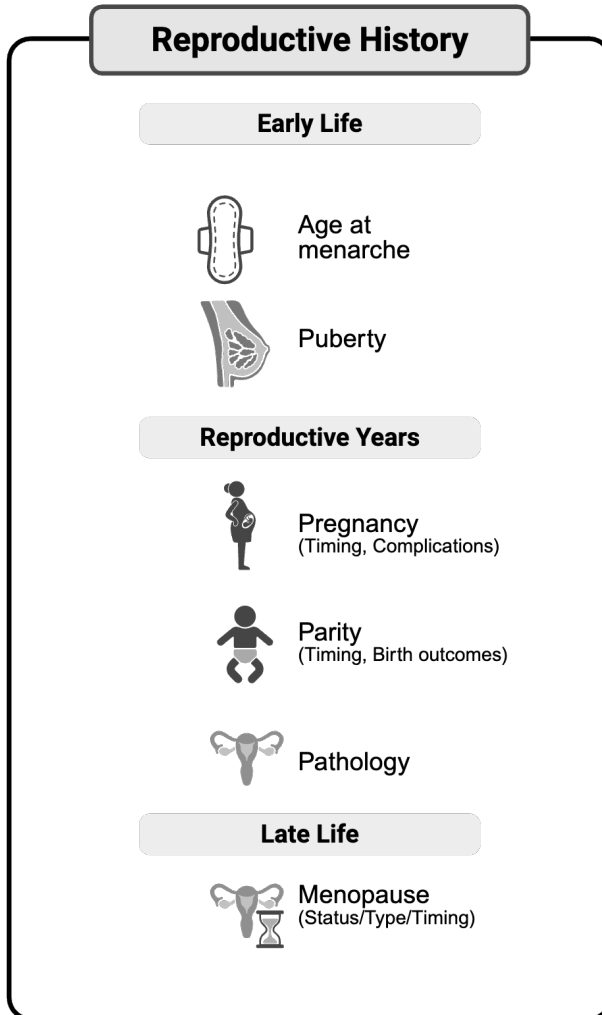


Bleeding does not always reflect ovarian function

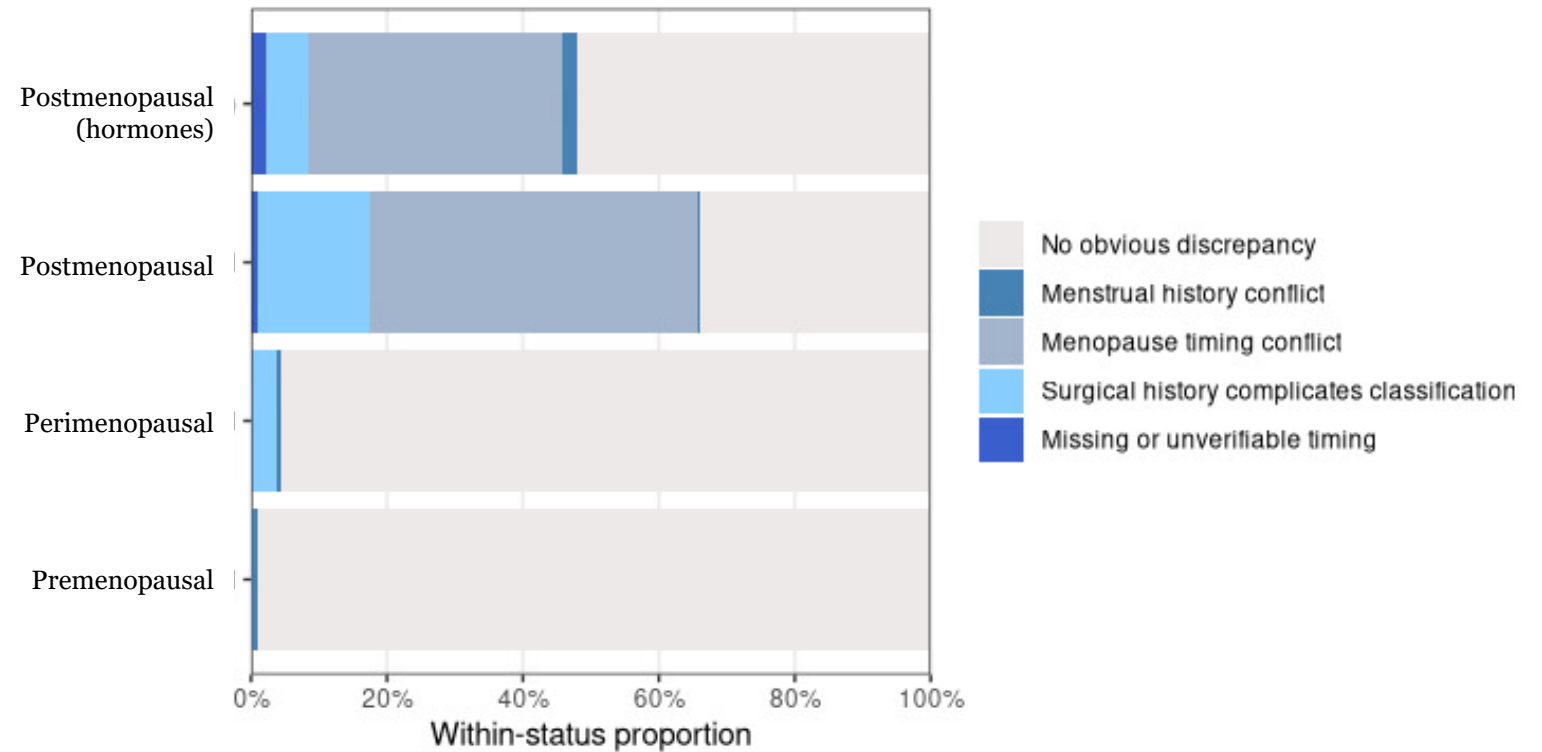


Menopausal status mixes biologically different situations

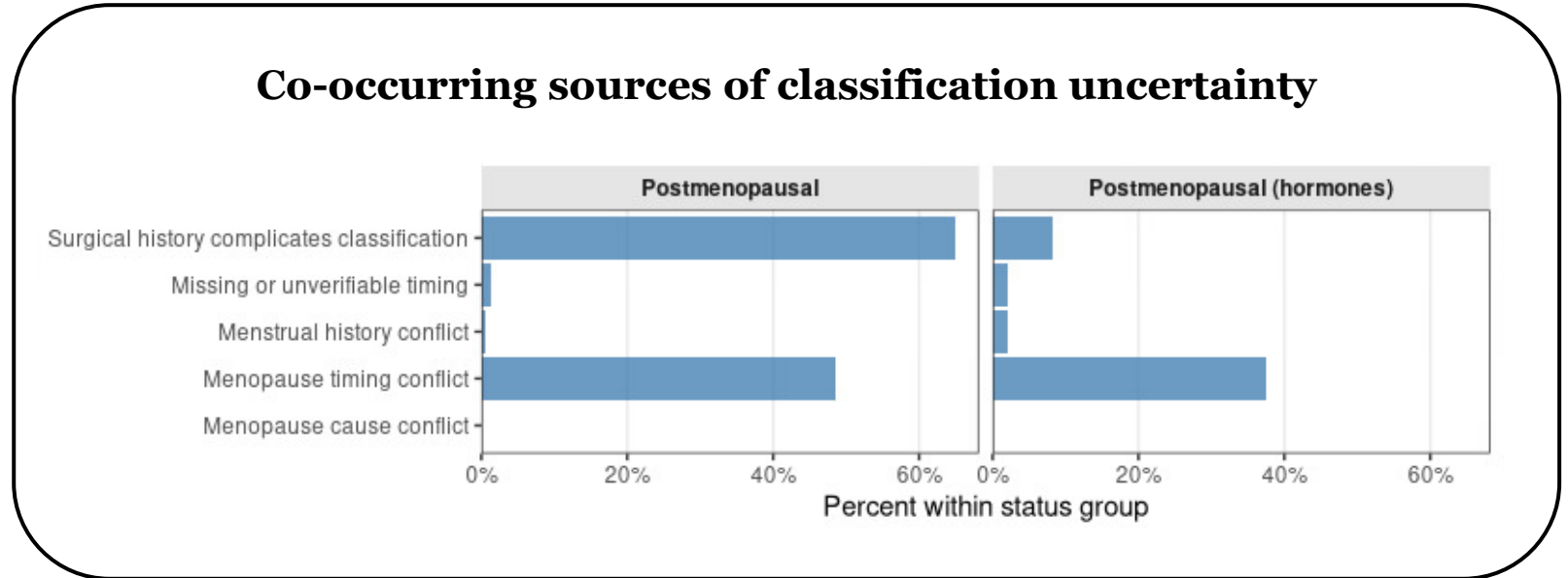
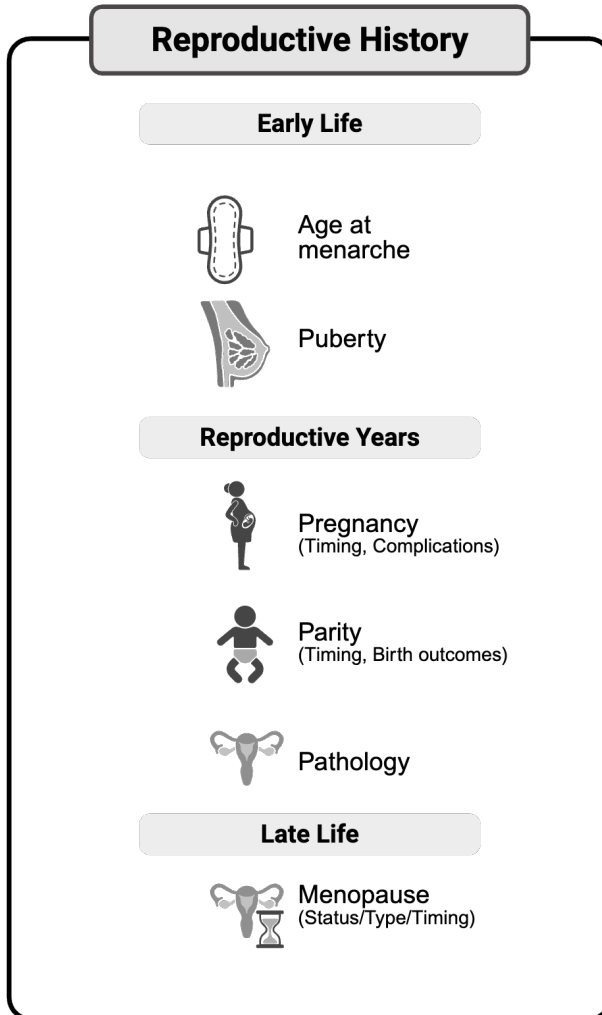
Misclassification of menopausal status



Primary source of menopausal classification inconsistency

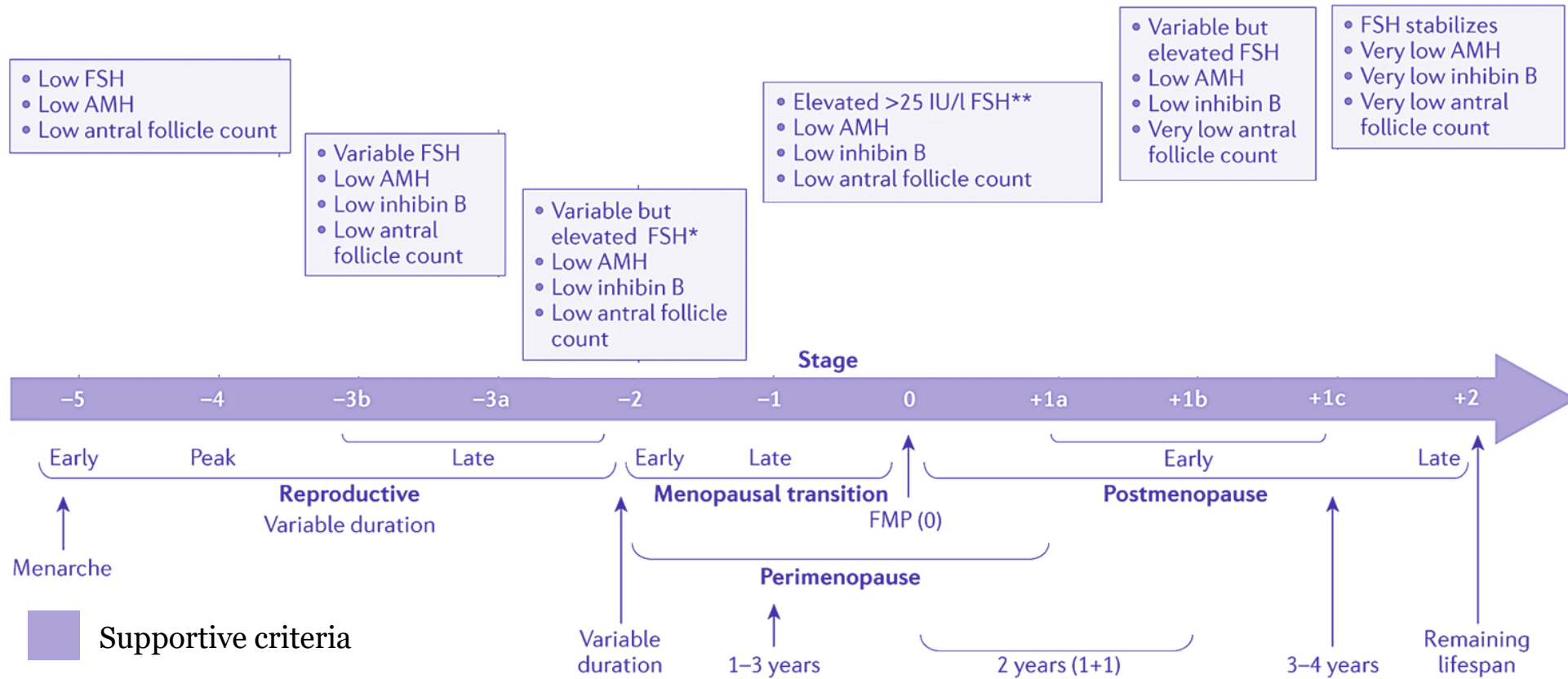


Misclassification of menopausal status

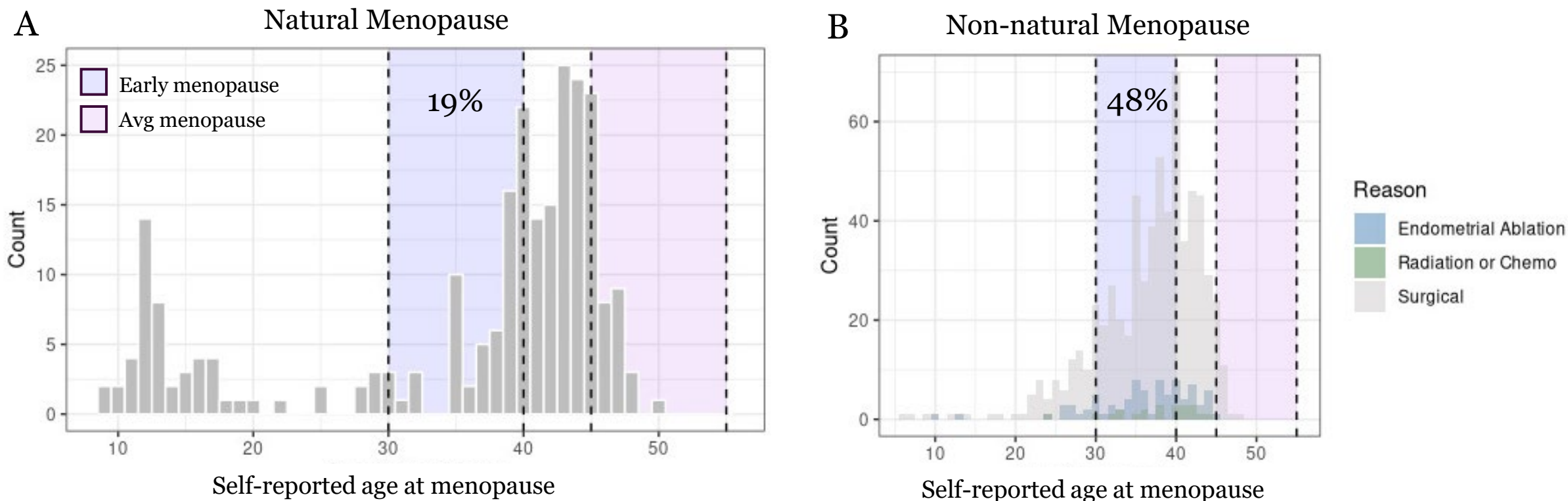


In midlife populations, menopausal status is difficult to measure reliably.

Reproductive hormones as a biomarker for understanding the menopausal transition

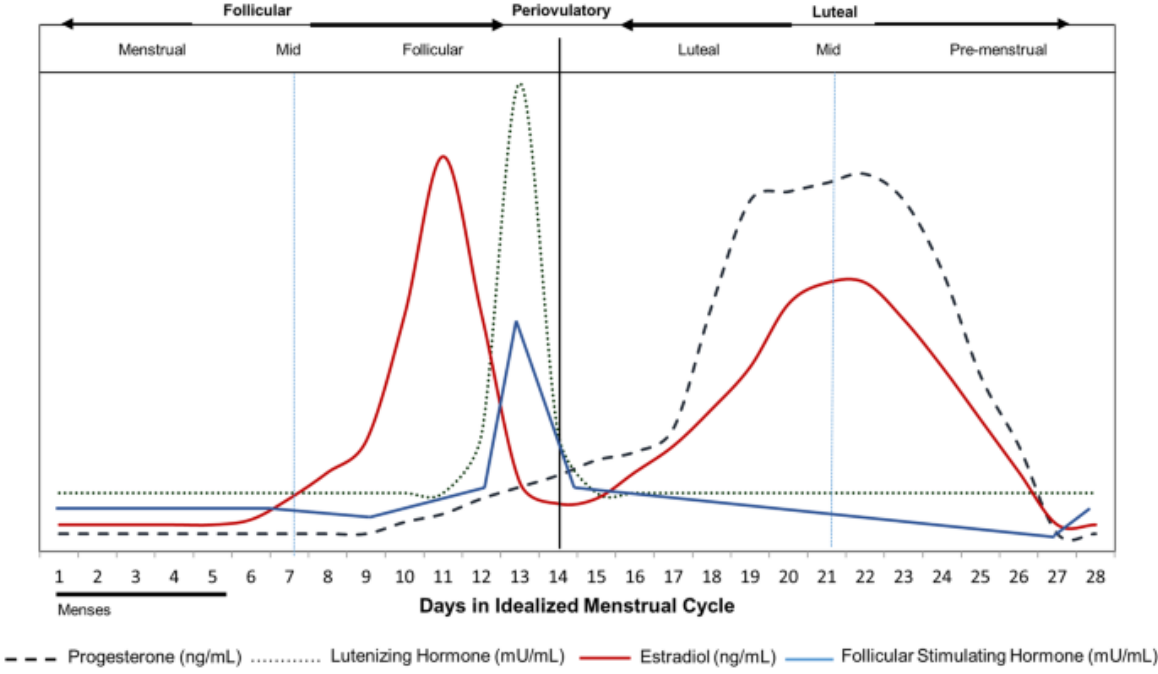


Age at menopause varies depending on the pathway

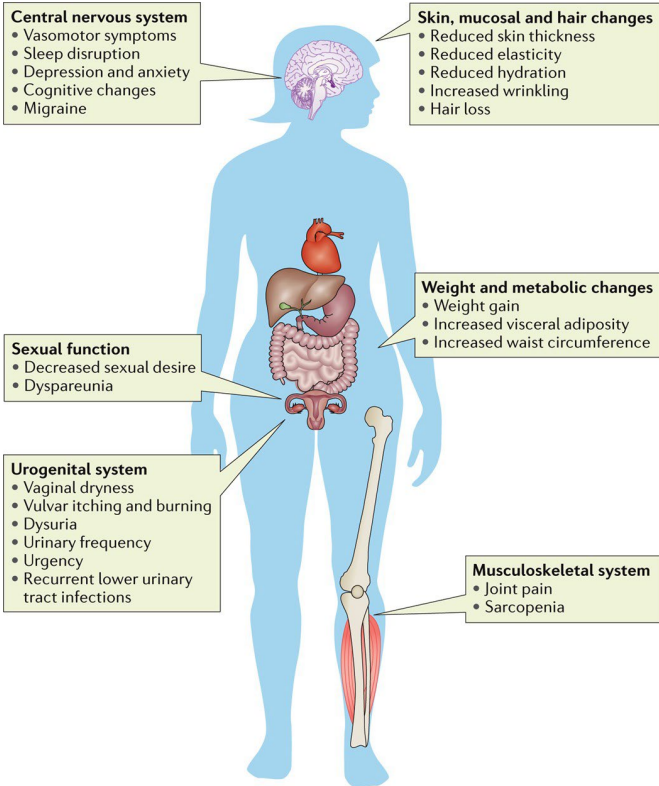


Age at menopause varies by pathway and can be sensitive to how it is measured and reported.

Additional sources of measurement uncertainty



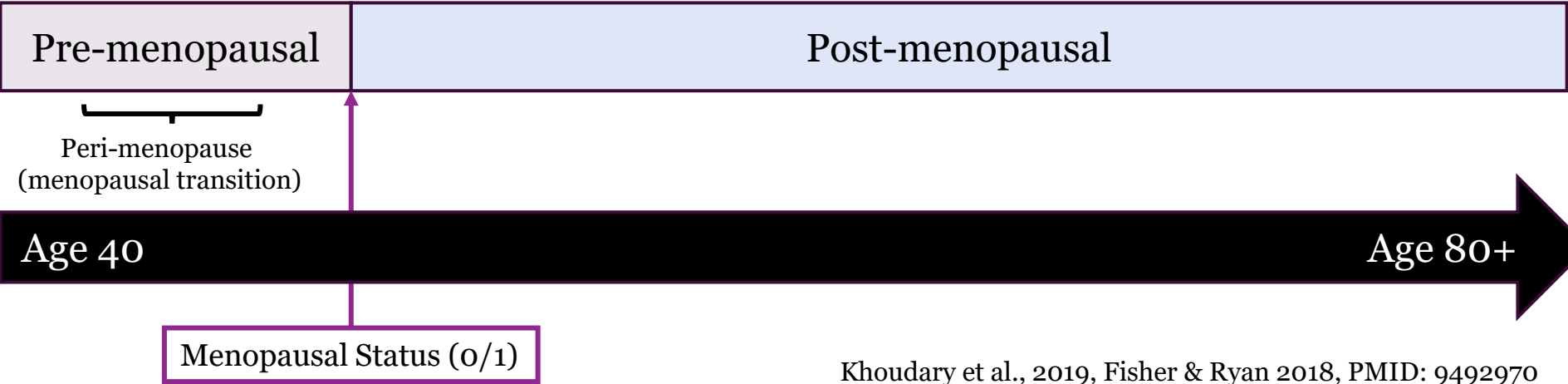
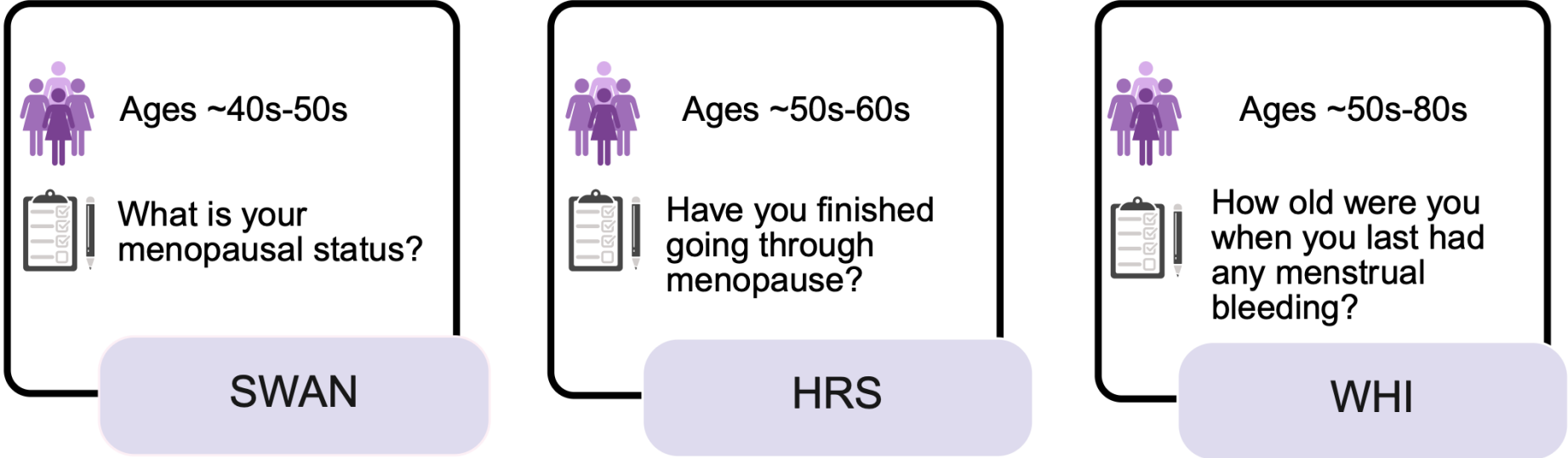
Changes in cycle length and variability



Nature Reviews | Endocrinology

Vasomotor and other secondary symptoms

Approaches to measuring menopause also vary across studies



Beyond bleeding: improving measurement of the menopausal transition

- Bleeding is an imperfect proxy for biological menopause
- Misclassification is common and differs across groups and pathways.
- Early midlife cohorts like Add Health provide a unique opportunity to study this prospectively.



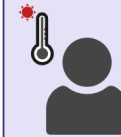
A unified, multi-dimensional measurement approach is needed.

Cycle Regularity & Timing



- Changes in cycle length or regularity
- Missed periods
- Age of onset

Vasomotor Symptoms



- Hot flashes or chills
- Night sweats
- Frequency, severity, duration
- Age of onset

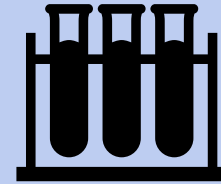
Mood, Sleep, & Somatic Symptoms



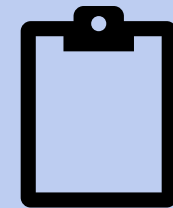
- Mood swings
- Depression or anxiety symptoms
- Sleep disruptions or insomnia
- Weight gain or body composition changes

Future directions

- **Incorporating reproductive hormone measures (AMH, FSH, E2) to better define the menopausal transition.**



- **Development of a new comprehensive reproductive health survey instrument.**



Acknowledgements



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School of Public Health

Interested in collaborating?

Contact: mccoyb@unc.edu



National Institute
on Aging

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