

Equity analysis of current dementia risk prediction models: a systematic review using the PROGRESS-Plus framework

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Key Takeaways

1 Equity-relevant attributes were often reported, but inconsistently carried into model development.

2 Subgroup performance analysis was limited and concentrated in selected attributes.

3 Evidence for equitable translation remained limited by incomplete subgroup and cross-setting evaluation.

Background

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- Dementia risk prediction models have expanded across research and planning contexts, including prevention research, risk communication, trial enrichment, and service planning. However, equitable translation requires evidence beyond overall discrimination.
- Prediction studies need to show who is represented in the data, which equity-relevant attributes are considered during model development, and whether model performance is evaluated across groups and settings.

Gap

- Existing dementia prediction-model reviews often summarise overall performance and validation. Equity-relevant evidence is less often examined systematically.

Aim

- To examine how equity-relevant attributes were reported, incorporated into dementia risk prediction models, used in subgroup performance analyses, and represented in external validation evidence using the PROGRESS-Plus framework.

Evidence Base

64

Included studies

10 predictors

Median number of predictors
Range: 4-324

0.50-0.93

Reported discrimination range
AUC / C-statistic

Note: Study-level counts are reported unless otherwise stated.

Methods + PROGRESS-Plus framework

- We conducted a secondary equity-focused analysis of 64 dementia risk prediction model studies from a parent systematic review.
- Equity-relevant attributes were coded using a PROGRESS-Plus informed framework. The original PROGRESS domains and Plus factors were used as a reference framework, while extraction categories were operationalised for dementia prediction model studies.

Assessment methodology

- Variable pathway:** baseline reporting → candidate predictor consideration → final model inclusion.
- Subgroup performance:** reporting of subgroup discrimination and calibration by equity attributes.
- Cross-setting context:** geographic distribution of contributing datasets, and geography and population setting of external validation evidence.

PROGRESS-Plus framework

Place of residence	Race/ethnicity/culture/language	Occupation	Gender/sex
Religion	Education	Socioeconomic status	Social capital

Plus examples

Age	Disability/comorbidity	Sexual orientation	Other context-specific factors
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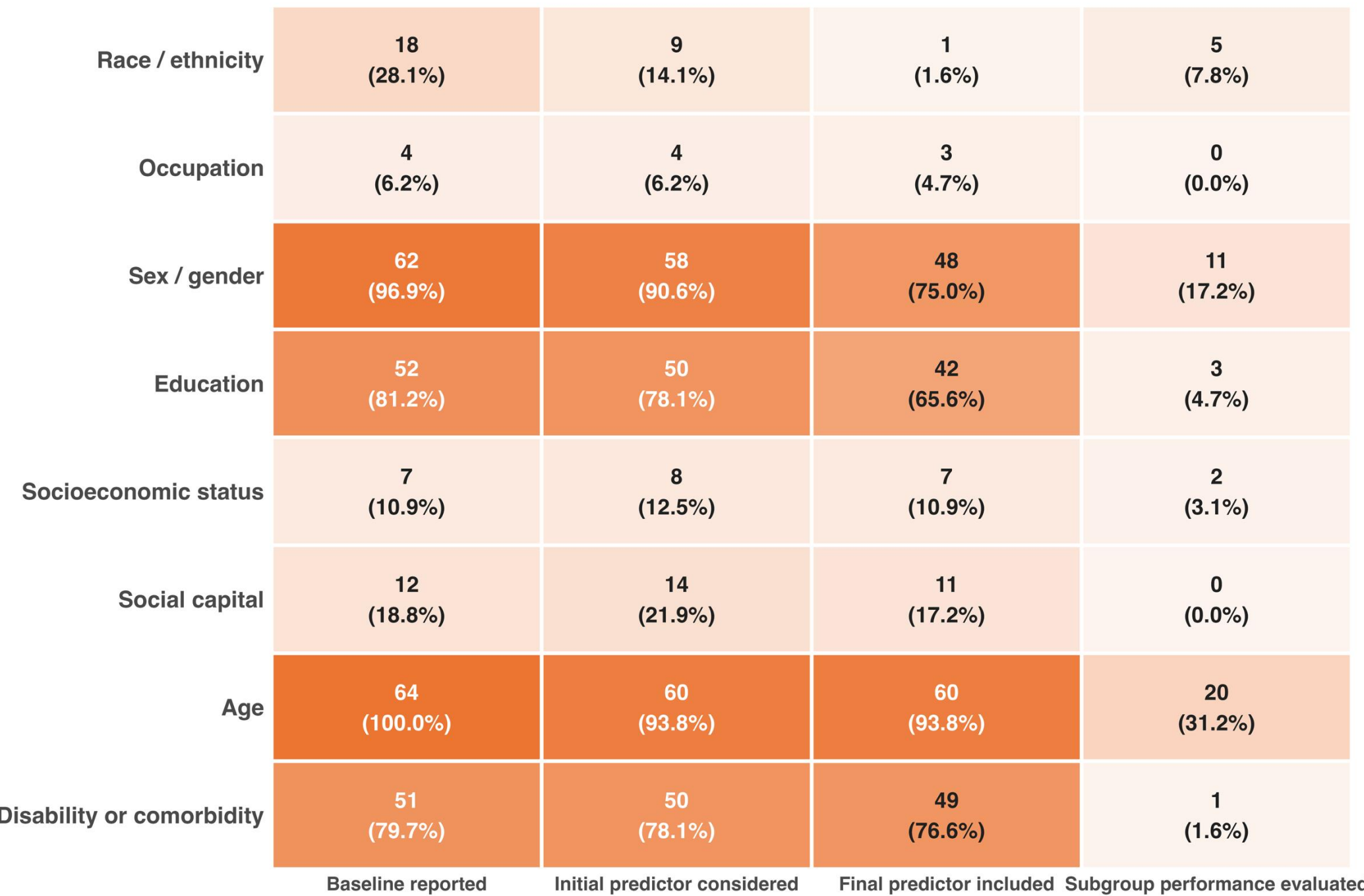
Operationalised extraction categories

Race/ethnicity/culture/language/religion	Occupation	Sex/gender	Education
Socioeconomic status	Social capital	Age	Disability/comorbidity

Note: **Race/ethnicity/culture/language and religion** are separate in the original PROGRESS-Plus framework but were combined operationally in this review.
Place/geography was assessed through study setting and external-validation context rather than as a model-development attribute.

Results -- Equity-variable pathway

Figure 1. Equity-variable pathway in dementia risk prediction model development



The PROGRESS-Plus framework informed heatmap showing whether equity-relevant attributes were reported at baseline, considered as candidate predictors, and retained in final prediction models across 64 studies.

Age + sex/gender

- Age was reported at baseline in **all** studies and retained in final models in **60/64** studies.
- Sex/gender was reported in **62/64** studies and retained in final models in **48/64** studies

Race/ethnicity-related

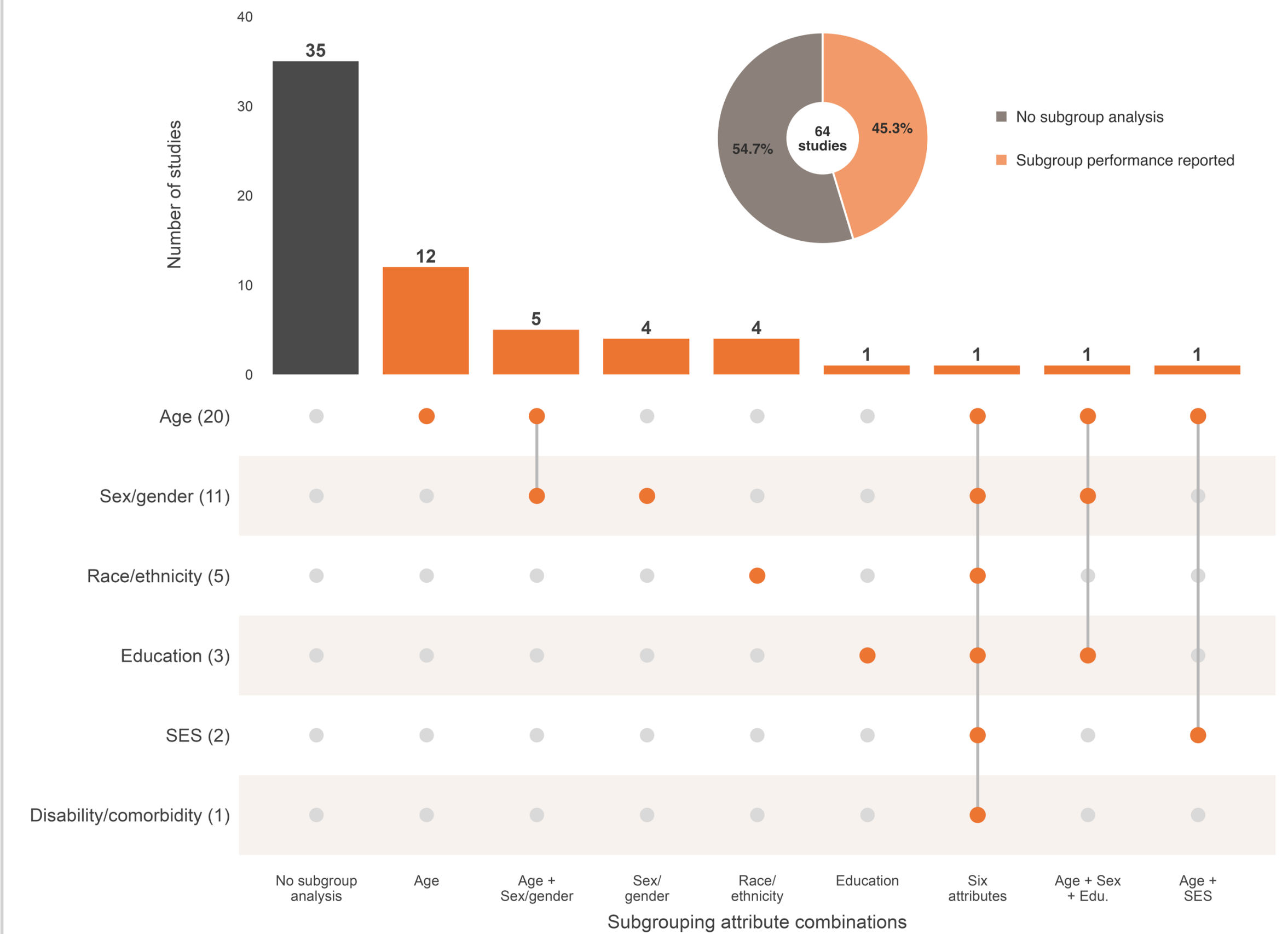
- Race/ethnicity-related information showed marked narrowing from baseline reporting to final inclusion, declining from **18/64** studies to final-model retention in **1/64**.

Other attributes

- Socioeconomic status remained rare.
- Other PROGRESS-Plus attributes were less consistent than age and sex/gender.
- Failure to include equity-related variables means that models may not capture important risk factors that are particularly relevant for marginalized populations. This might reduce overall predictive accuracy and limits the utility of these models in diverse settings.

Results -- Subgroup analyses

Figure 2. Subgroup performance analyses by equity attributes



The donut shows the proportion of studies with and without reported subgroup performance analysis. Bars show the number of studies for each subgrouping-attribute combination, and dots indicate which attributes were used. Row labels show the total number of studies using each attribute. Attribute totals are not mutually exclusive.

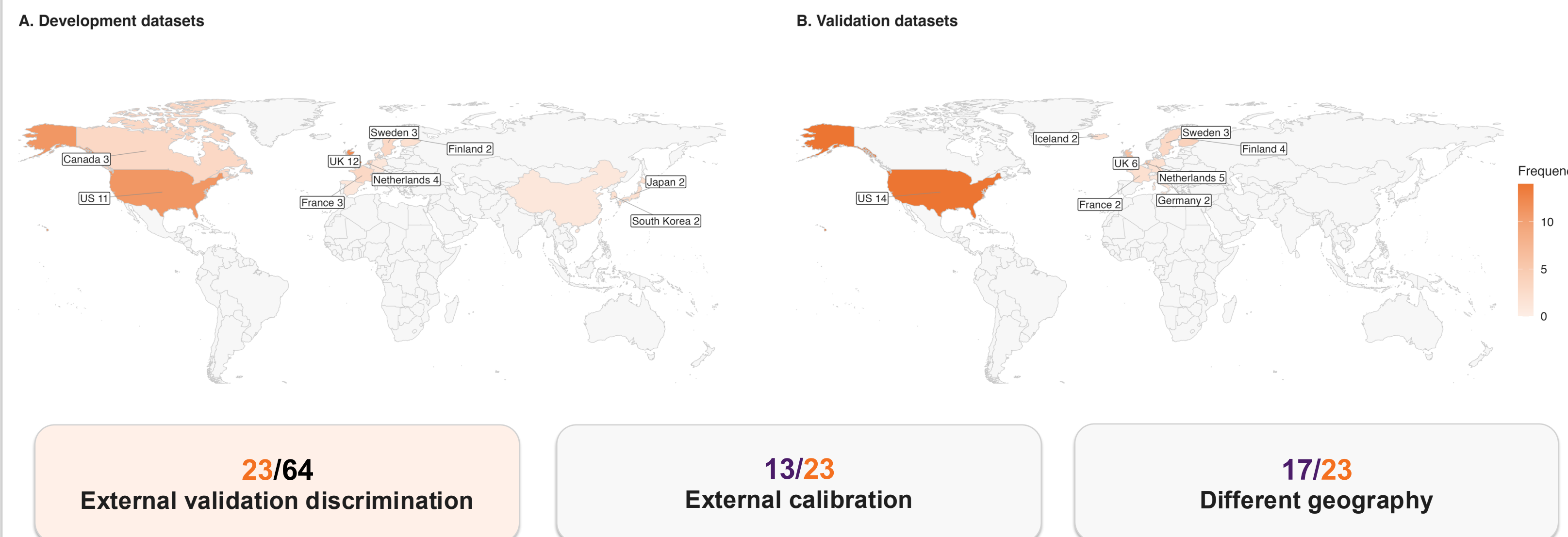
Subgroup performance analysis was only reported in **29/64** studies. Subgroup calibration was reported in 4/64.

Reported subgroup analyses most often used **age** and/or **sex/gender**, while race/ethnicity, education, SES, and disability/comorbidity were less frequently used.

Subgroup calibration was rarely reported, limiting evidence on whether model calibration was consistent across population subgroups.

Results -- Cross-setting evidence was present but incomplete

Figure 3. The geographic distribution of development and external validation datasets



- The geographic distribution of contributing datasets indicated a marked concentration in high-income settings. Of 45 datasets used for model development or validation, 14 were from the United States and 23 from European regions.
- Most models were developed in high-income countries (86%) with predominantly White, well-educated populations.
- Cross-setting evaluation was present but incomplete, especially for calibration.

Discussion & Implications

What this shows

- In dementia risk prediction research, studies more often describe who is represented in the data than demonstrate whether models perform consistently across groups or settings.
- Variables most relevant to equity, particularly race/ethnicity and socioeconomic status, were seldom carried through from reporting to model inclusion and subgroup evaluation.
- Apparently acceptable overall performance cannot be taken as evidence of equitable translation into practice. Evidence needed to judge equity-relevant performance, calibration, and transportability remains incomplete.

What future studies need

- Future work should strengthen the handling of equity-relevant attributes during model development and external validation across diverse settings and populations.
- Stronger subgroup assessments, especially calibration, are needed to enhance equity and transportability evaluation.
- Practical guidance or appraisal tools for equity considerations in prediction models may help improve the public health relevance and responsible application of dementia risk prediction models.