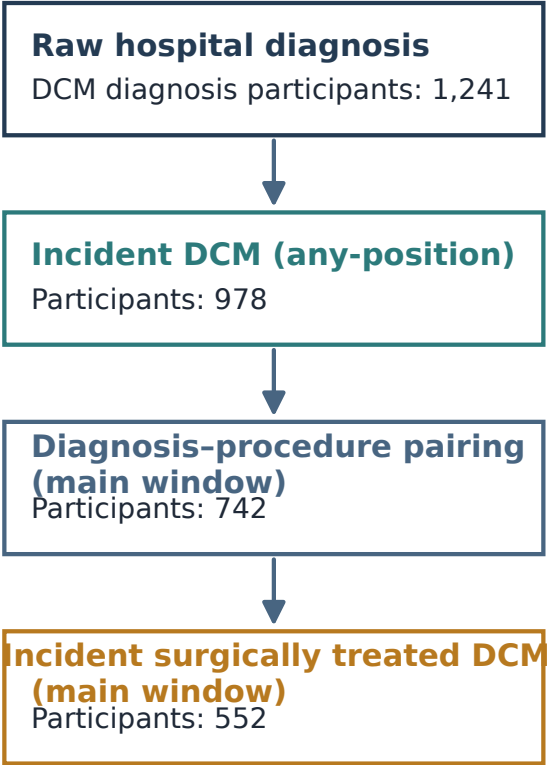
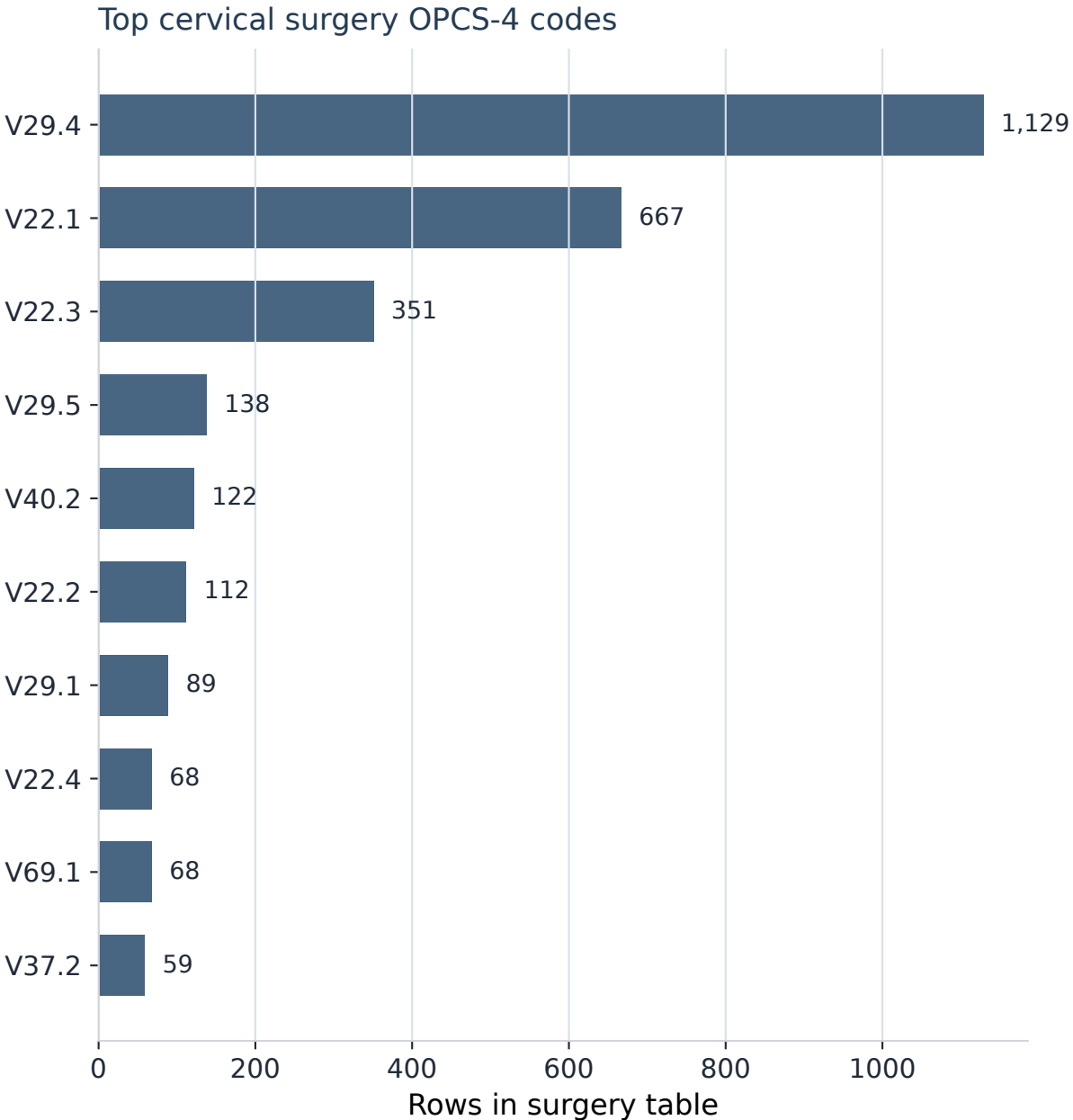


Figure S1. Endpoint reconstruction and cervical surgery code spectrum

Supplementary view of the diagnosis-procedure pairing framework used to define the primary and surgery-related endpoints.



Pairing windows
Main window: -30 to +180 days
Strict window: 0 to +90 days

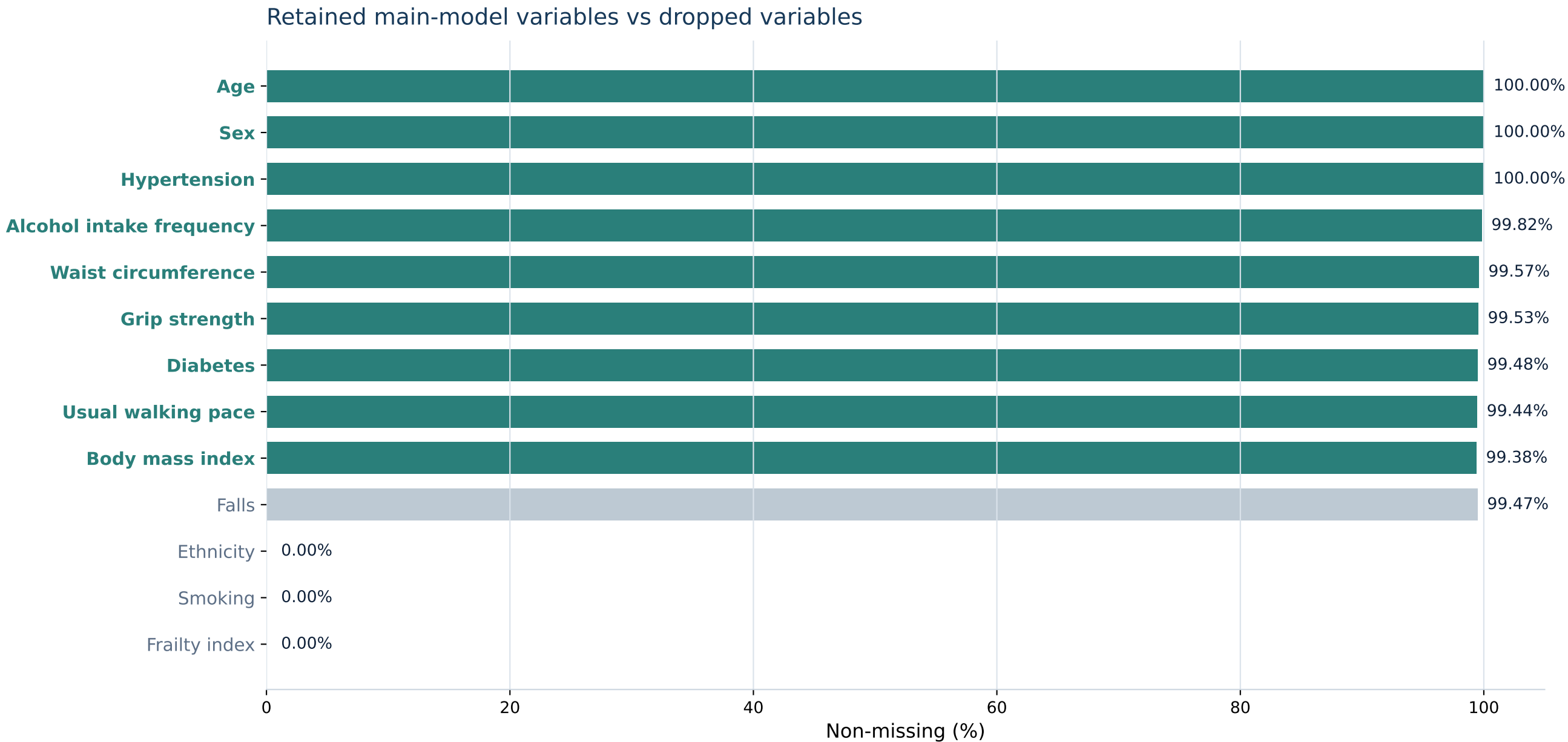


These supplementary data support the endpoint-construction logic but are not themselves treated as primary manuscript results.

Figure S2. Covariate completeness and main-model retention

Supplementary figure

Non-missingness of candidate covariates after covariate harmonization. Variables retained in the main analytic model are highlighted.



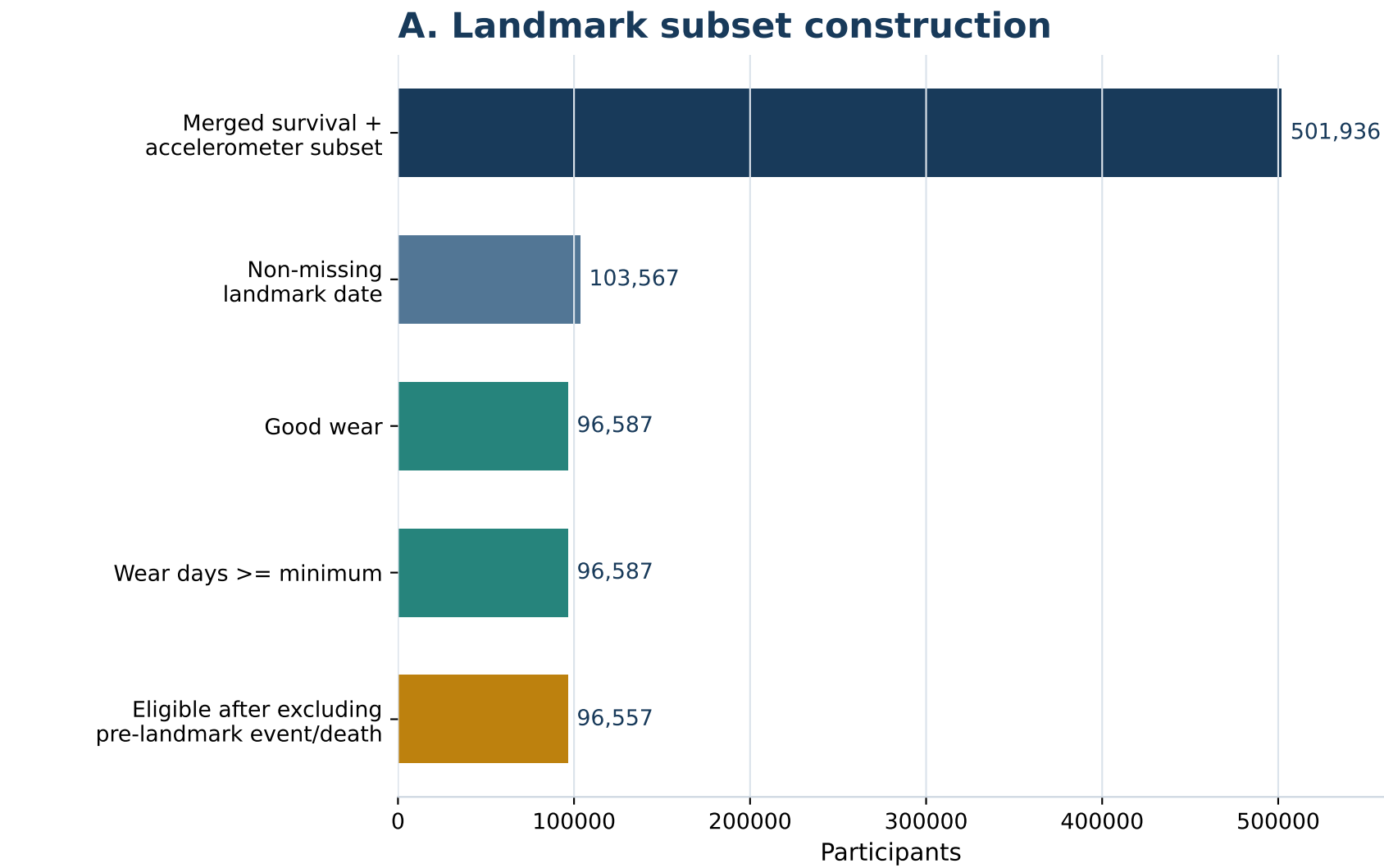
Main analytic variables retained: age, sex, body mass index, waist circumference, alcohol intake, diabetes, hypertension, grip strength, and usual walking pace.

The smoking_status_3 field was unavailable in the original analytic variable set; a separate raw baseline smoking variable was recovered for the available-smoking sensitivity model reported in Table S4.

Figure S3. Accelerometer subset boundary

Supplementary figure

Objective activity was evaluated as an enhancement layer, but no activity bundle yielded a usable common complete-case landmark cohort.



B. Bundle gate summary

Bundle	Definition	n / events	Status
Three metrics	Overall acceleration Acceleration SD Weekend shift	0 / 0	Too small
Two metrics	Overall acceleration Acceleration SD	0 / 0	Too small
Overall only	Overall acceleration only	0 / 0	Too small

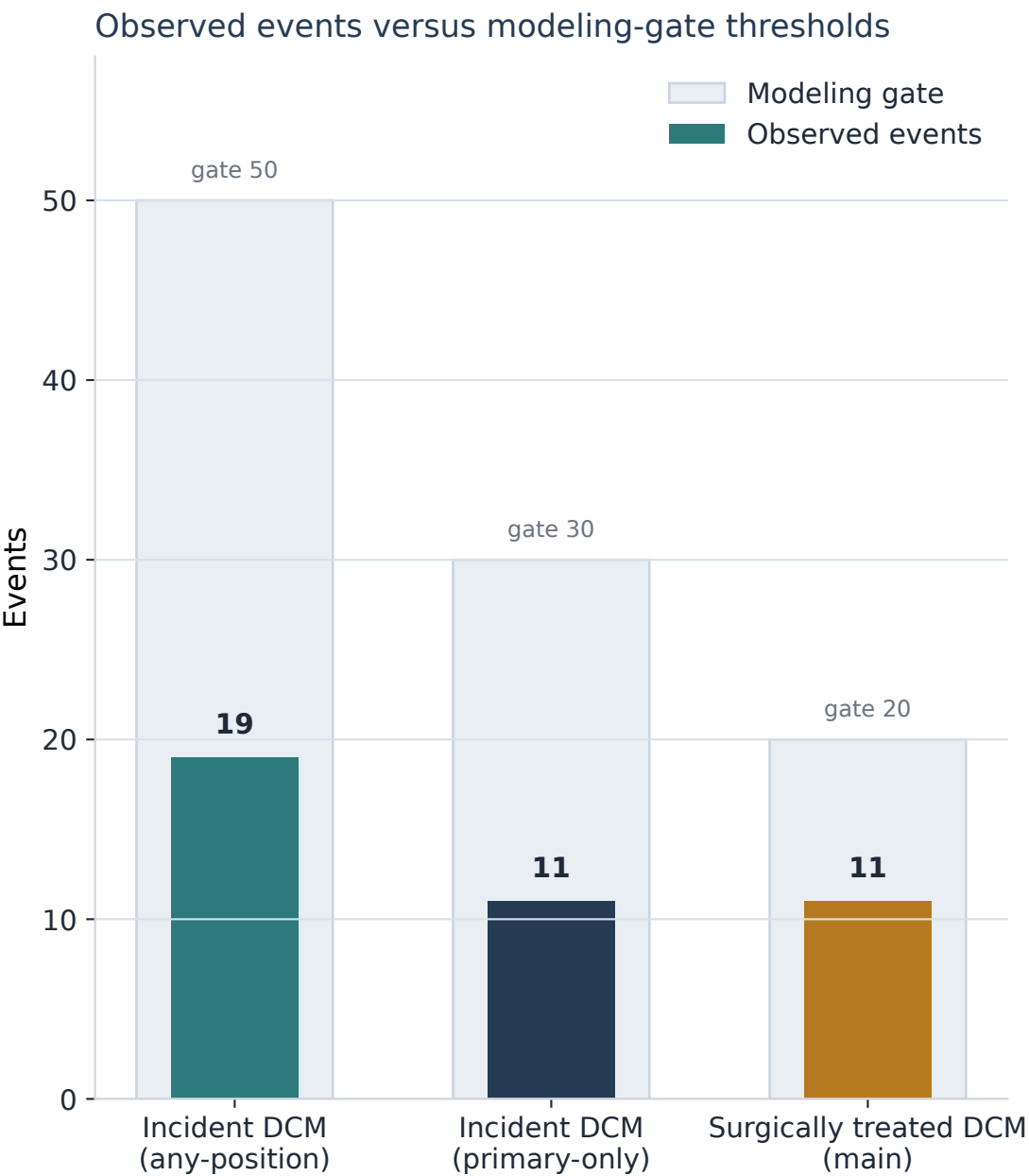
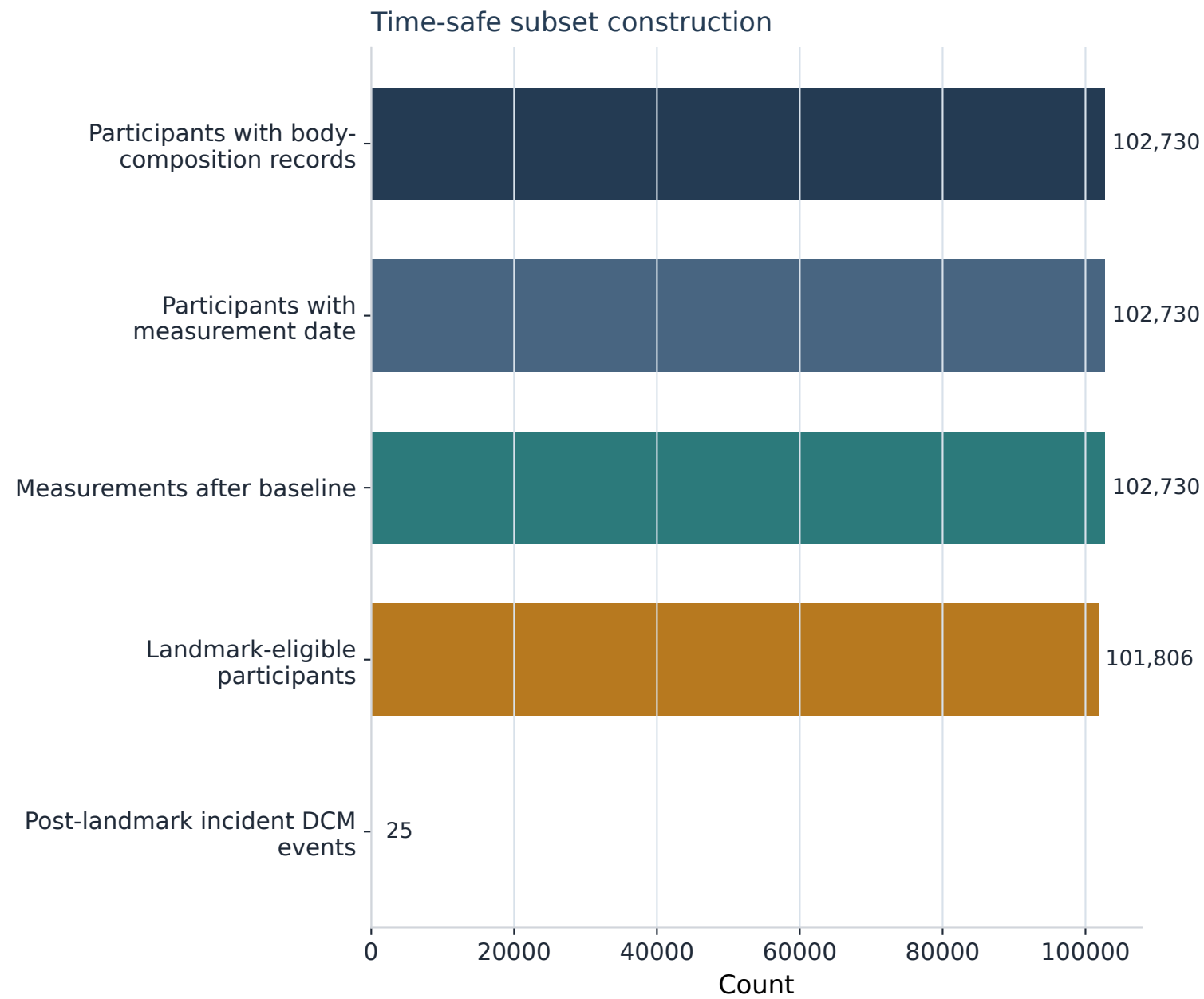
C. Interpretation

- The landmark concept itself was not the failure point.
- Activity variables did not yield a usable common complete-case cohort after alignment with the clinical covariate set.
- The accelerometer layer therefore remained a null / inconclusive enhancement context.

Figure S4. Body-composition subset boundary

Supplementary figure

Body-composition measurements required landmark anchoring and did not yield a bundle that reached the modeling gate after time-safe anchoring.



Median baseline-to-measure lag: 4,598 days. All available body-composition measures occurred after baseline, so landmark anchoring was required.

Bundle tested: VAT + ASAT; common complete-case n = 55,724. No bundle reached the predefined modeling gate.