Data S1. Additional methodological details and supplementary analyses.

Assessment of registry documentation completion. In order to evaluate the comprehensiveness of registry data, the proportion of patients with missing information regarding tumor-bed boost(boost) therapy was analyzed across the designated calendar years. Overall, missing data were rare, with figures standing at 0.5% in 2016, 0.2% in 2017-2019 and 0.9% in 2020-2022, indicating a high level of documentation completeness for boost allocation throughout the study period (Table SI).

Sensitivity analyses using multiple imputation. To test the robustness of the present findings, sensitivity analyses were performed using multiple imputation for missing covariates[five imputed datasets (DSs); predictive mean matching]. Multivariate logistic regression models for predictors of boost administration and Cox proportional hazards models for overall survival (OS) were repeated on the imputed DSs.

Results were consistent with the complete-case analyses. Boost irradiation was not significantly associated with OS [hazard ratio (HR), 1.01; 95% CI, 0.63-1.63; P>0.9]. Established prognostic factors such as age and higher T-stage remained significant, while progesterone receptor positivity showed a non-significant trend toward improved survival (HR, 0.56; 95% CI, 0.28-1.11; P=0.10). Similarly, logistic regression confirmed that age, tumor stage and radiation target volume (RT target volume) were key determinants of boost allocation.

These results confirmed that the main conclusions of the study were robust and not materially influenced by missing data or model specification. Detailed results are presented inTables SII and SIII.

Predictors of missing boost documentation. To further evaluate data completeness, a logistic regression including all n=7,549 patients, irrespective of fractionation or boost status, was performed, using missing boost information as the outcome variable. Predictor variables included age, tumor and nodal stage, hormone receptor and HER2 status, histologic grade, resection status (R-status), and RT target volume.

Older age was associated with slightly lower odds of missing documentation [odds ratio (OR), 0.99 per year; 95% CI, 0.98-0.99]. Compared with partial breast irradiation, partial breast irradiation with lymph node coverage was associated with higher odds of missing boost data (OR, 2.26; 95% CI, 1.70-3.00), whereas partial breast irradiationwithout the lymph node region was associated with lower odds (OR, 0.40; 95% CI, 0.30-0.54).

Intermediate tumor stage (T2-3) and HER2 positivity were also associated withincreased odds of missing data, whereas advanced nodal stage and uncertain R-status were associated with lower odds. Other covariates were not significantly related to documentation completeness.

Overall, the proportion of missing boost documentation was low (<1%), confirming the high completeness and internal consistency of the registry data (Table SIV).

Propensity score matching analysis. Propensity score matching was performed as a sensitivity analysis in order to reduce potential indication bias between patients receiving boost irradiation and those treated without a boost. Amongst the total of n=2,206 patients with complete data on all matching variables, the 1:1 nearest-neighbor matching yielded 900 matched pairs. Following the implementation of matching, there was a substantial improvement in covariate balance. The mean differences for all matching variables were reduced to ≤0.10, indicating adequate balance between treatment groups (Fig. S1; Table SV). In the matched cohort, boost irradiation remained not significantly associated with OS (HR, 0.87; 95% CI, 0.50-1.49; P=0.60). The consistency of the estimates across complete-case, multiple-imputation and propensity score-matched analyses further supported the robustness of the primary findings (Table SVI).

Eastern Co-operative Oncology Group (ECOG) sensitivity analysis. Due to the unavailability of ECOG performance status data for a significant proportion of patients, it was not incorporated into the primary multivariate models or the multiple imputation procedure. In order to assess the potential influence of performance status, an additional sensitivity analysis was performed, including ECOG as a covariate.

The incorporation of ECOG performance status did not result in a substantial alteration of the study's outcomes. The association between boost irradiation and OS remained non-significant (HR, 1.01; 95% CI, 0.62-1.64; P=0.97). It was demonstrated that age, tumor stage and progesterone receptor status retained their significance as prognostic factors. As anticipated, a lower performance status was associated with a diminished OS, with patients categorized as ECOG ≥2 demonstrating a substantially elevated mortality risk compared with patients categorized as ECOG 0 (HR, 14.43; 95% CI, 3.67-56.81; P<0.001) (Table SVII).

Figure S1. Love plot showing standardized mean differences before and after propensity score matching. ER, estrogen receptor; PR, progesterone receptor.