How Are We Matching in ACL Reconstruction Research? A Systematic Review of Methods, Reporting, and Covariate Selection

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INTRODUCTION: Matching techniques such as direct covariate matching and propensity score matching (PSM) are increasingly used in anterior cruciate ligament reconstruction (ACLR) research to reduce bias in observational study designs. However, the rationale for covariate selection, consistency in methodological reporting, and patterns of matching practices remain unclear. The purpose of this study was to systematically evaluate covariate matching practices in ACLR literature, including the types and number of covariates used, methodological transparency, and trends in matching strategies.

METHODS: A systematic literature search of the PubMed, EMBASE, and Cochrane databases was conducted to evaluate covariate matching practices in the ACLR literature. A comprehensive search identified 798 unique studies, of which 97 met eligibility criteria. Data were extracted on study design, matching technique, covariate inclusion, reporting practices, and matching ratios. Descriptive and comparative statistics were used to summarize trends.

RESULTS: The 97 included studies encompassed 91,448 ACLRs. Most studies were retrospective (91.8%) and cohort in design (92.9%). Propensity score matching was used in 41 studies (42.3%), while 56 (57.7%) used direct matching. A total of 60 unique covariates were used across 76 different combinations. PSM studies used significantly more covariates than direct matching studies (6.17 ± 2.79 vs. 3.75 ± 1.63, $p < 0.0001$), and database studies used more covariates than single-center studies (6.33 ± 2.89 vs. 4.08 ± 1.96, $p < 0.0001$). The most commonly used covariates were age (96.9%), sex (84.5%), and BMI (41.2%). Only 6 studies (6.2%) provided justification for covariate selection. While most studies reported descriptive statistics after matching (95.9%), only 10.3% did so before matching, and 13.4% failed to report pre-matching sample size.

DISCUSSION AND CONCLUSION: Matching practices in ACLR studies are highly variable, with limited justification provided for covariate selection. PSM and database-based studies tend to incorporate more covariates. Improved standardization and transparency in reporting matching methodology are needed to enhance the quality and reproducibility of ACLR research.

Figure 2: Frequency of covariates used for patient matching in at least 2 studies.