

S2 File — STROBE Checklist for Observational Studies

Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)

Checklist of items that should be included in reports of observational studies

Manuscript title: Heterogeneous wealth-related differences in modern contraceptive use in Bangladesh: a machine learning-based g-computation analysis of the DHS 2022 cross-sectional survey

Study design: Cross-sectional secondary analysis of nationally representative survey data (BDHS 2022). Subgroup heterogeneity analyses use Gradient Boosting T-learner individual counterfactual odds ratios.

Item No.	Recommendation	Reported on page / section
TITLE & ABSTRACT		
1 (a) & (b)	(a) Indicate the study's design with a commonly used term in the title or abstract (b) Provide an informative and balanced summary of what was done and found	Title (p. 1): "cross-sectional survey" stated in full title. Abstract (pp. 1–2): Background, Methods, Results, Conclusions — objectives, 8-covariate 6-model ML framework, key results including 6.4-fold GB OR gradient, near-null AIPW, Gini = 0.4525, conclusion on programmatic targeting framework.
INTRODUCTION		
2 Background/Rationale	Explain the scientific background and rationale for the investigation being reported	Background section, paragraphs 1–6 (pp. 2–6): OR homogeneity limitation, HTE/CATE literature, T-learner vs prediction distinction, Bangladesh family planning context and policy urgency (§1.1, pp. 7–8).
3 Objectives	State specific objectives, including any prespecified hypotheses	Background, final paragraph (p. 8): two explicit research questions stated — (1) distribution of individual-level ORs; (2) which subgroups drive heterogeneity and programmatic implications.
METHODS		
4 Study design	Present key elements of study design early in the paper	Methods, opening paragraph (p. 9): "This observational cross-sectional study"; Data source §2.1 (pp. 9–10): BDHS 2022 cross-sectional design, DHS Phase 8, stratified two-stage probability cluster sampling.
5 Setting	Describe the setting, locations, and relevant dates, including periods of data collection	Methods §2.1 (pp. 9–10): Bangladesh national cross-sectional survey; 675 PSUs, 30,018 households, response rate 98.6%; 2022 fieldwork.
6 Participants	(a) Cross-sectional: describe eligibility criteria and methods of selection (b) For matched studies, give matching criteria and number of exposed and unexposed	(a) Methods §2.1 (pp. 9–10): currently married women aged 15–49 (V501 = 1); restricted to poorest (V190 = 1) and richest (V190 = 5) wealth quintiles; n = 11,510 after excluding 18 with missing values. (b) Not applicable.

7 Variables	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers; give diagnostic criteria if applicable	Methods §2.3 (pp. 10–11): outcome V312 (binary modern method); exposure V190 (wealth quintile binary); 8 covariates defined with DHS variable codes: V012, V025, V106, V136, V201 (parity), V714 (employment), V158 (media), V632 (FP autonomy).
8 Data sources/measurement	For each variable of interest, give sources of data and details of methods of assessment; describe comparability of assessment methods if there is more than one group	Methods §2.1 (pp. 9–10): DHS Individual Recode (IR) file; wealth index via PCA (DHS standard, V190); all variables from single cross-sectional interview; DHS data access URL provided as reference [50].
9 Bias	Describe any efforts to address potential sources of bias	Methods §2.4 (pp. 11–13): DAG formalises confounding assumptions; unmeasured confounders (partner preferences, method availability) explicitly named as dashed nodes. Methods §2.8 (pp. 17–18) and §2.12 (p. 20): AIPW doubly-robust sensitivity; E-value analysis §3.7 (pp. 26–27). Limitations §4.8 (pp. 37–38): temporal plausibility argument; extreme-quintile restriction; sampling weight exclusion.
10 Study size	Explain how the study size was arrived at	Methods §2.1 (pp. 9–10): sample size determined by BDHS survey design; restriction to extreme quintiles yields $n = 11,510$. Methods §2.11 (p. 19): minimum cell size threshold $n \geq 30$ stated for subgroup analyses.
11 Quantitative variables	Explain how quantitative variables were handled in the analyses; if applicable, describe which groupings were chosen and why	Methods §2.3 (pp. 10–11): age in groups (15–24, 25–34, 35–49) consistent with DHS standard; education 4 categories (none, primary, secondary, higher); parity capped at 10; all continuous covariates standardised (zero mean, unit variance) prior to model fitting.
12 Statistical methods	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) Cross-sectional study — if applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	Methods §§2.5–2.12 (pp. 13–20): counterfactual ML framework (T-learner g-computation, §2.5, pp. 13–14); six model classes (§2.6, pp. 14–16); SHAP (§2.7, pp. 16–17); AIPW doubly-robust sensitivity (§2.8, pp. 17–18); model calibration (§2.9, p. 18); model evaluation and bootstrap CIs (§2.10, pp. 18–19); subgroup heterogeneity and interaction tests (§2.11, pp. 19–20); E-value analysis (§2.12, p. 20). Missing data: 18 observations excluded (§2.1, p. 10); complete-case analysis. Sampling weights not incorporated into ML fitting (limitation acknowledged §4.8, p. 37). Sensitivity analyses reported in §4.6 (pp. 35–36).
RESULTS		
13 Participants	(a) Report numbers of individuals at each stage of the study (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	(a) Results §3.1 (pp. 20–21): 30,078 interviewed → 28,537 currently married → 11,510 in extreme quintiles after 18 missing excluded; Table 1 (p. 21) presents full characteristics.

		(b) 18 excluded for missing covariate values (§2.1, p. 10). (c) No participant flow diagram is included in the manuscript; the exclusion sequence is described in §2.1 (p. 10); the STROBE checklist is provided as Additional file 2.
14 Descriptive data	(a) Give characteristics of study participants (b) Indicate number of participants with missing data for each variable of interest	(a) Results Table 1 (p. 21): full sample characteristics by wealth group including age, education, residence, parity, employment, media, FP autonomy, mCP%. (b) 18 excluded for missing data (§2.1, p. 10); no missing data in final analytic sample (n = 11,510).
15 Outcome data	Cross-sectional study: report numbers of outcome events or summary measures	Results §3.1 (pp. 20–21): overall mCP 34.9%; poorest quintile 37.7%; richest 32.6%; reversed wealth gradient explained. Results §3.2 (pp. 21–22): method mix among 4,020 modern method users described.
16 Main results	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g. 95% CI) (b) Report category boundaries when continuous variables were categorised (c) If relevant, consider translating relative risk into absolute risk	Results §3.3 (pp. 22–24): Table 2 (p. 24) — model CV-AUC, Brier scores, median individual ORs with IQR and SD, and AIPW ATE estimates with p-values for all six model classes. Results §3.4 (pp. 24–25): Table 3 (p. 25) — counterfactual ORs by age × education with bootstrap 95% CIs and FDR q-values; absolute risk difference translation provided in text (+17.6 pp and −11.3 pp). Results §3.5 (pp. 25–26): Table 4 (p. 26) — ORs by residence × education. Results §3.6 (p. 27): Table 5 — likelihood-ratio interaction tests.
17 Other analyses	Report other analyses done — e.g. analyses of subgroups and interactions, and sensitivity analyses	Subgroup OR tables: Table 3 by age × education (p. 25), Table 4 by residence × education (p. 26); interaction tests Table 5 (p. 27); E-value analysis Table 6 and Fig. 5 (pp. 27–29); SHAP importance Table 8 and Fig. 6 (pp. 30–31); Gini coefficient = 0.4525; programmatic targeting Table 7 (p. 29); sensitivity analyses (§4.6, pp. 35–36): alternative trimming threshold, restricted age sample, alternative exposure definition.
DISCUSSION		
18 Key results	Summarise key results with reference to study objectives	Discussion §4.2 (pp. 31–32): 6.4-fold GB OR gradient (0.552 to 3.557); Gini = 0.4525; near-null AIPW confirms aggregate null masks opposing subgroup effects (+17.6 pp vs −11.3 pp); interaction tests p = 0.039, p = 0.005.
19 Limitations	Discuss limitations of the study, taking into account sources of potential bias or imprecision; discuss both direction and magnitude of any potential bias	Limitations §4.8 (pp. 37–38): (1) cross-sectional design limits causal temporal ordering; (2) restriction to extreme quintiles limits generalisation to middle wealth quintiles; (3) eight covariates; AUC range 0.69–0.71; (4) SHAP values cannot be directly translated to individual OR distribution; (5) AIPW required 99th-percentile weight trimming (38.8% trimmed) due

		to limited PS overlap; (6) sampling weights not incorporated into ML fitting; (7) GB model slight overestimation in 0.6–0.8 probability range; (8) residual confounding from unmeasured variables; (9) self-reported contraceptive use subject to measurement error.
20 Interpretation	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, and results from similar studies	Discussion §§4.2–4.7 (pp. 31–36): findings contextualised against prior BDHS ML literature (§4.3, pp. 31–32) and global FP2030 literature (§4.4, pp. 33–34); AIPW near-null reframed as central empirical insight (§4.7, pp. 35–37); GB model selection justified; E-value thresholds benchmarked; causal language limited to conditional interventional contrasts under stated DAG assumptions.
21 Generalisability	Discuss the generalisability (external validity) of the study results	Limitations §4.8 (pp. 37–38): extreme-quintile design limits generalisation to women in the middle wealth quintiles; 8-covariate set may not capture all confounders. Conclusion §5 (pp. 38–40): g-computation framework is immediately applicable to any binary health equity outcome in LMIC population surveys; Gini coefficient of log OR is internationally transferable to any DHS-based study in any country.
OTHER INFORMATION		
22 Funding	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Declarations, Funding (p. 42): "The authors received no specific funding for this work." No funder had any role in study design, data collection, analysis, decision to publish, or preparation of the manuscript.

* The STROBE Statement is available at www.strobe-statement.org. Vandenberg JP et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): Explanation and Elaboration. *PLoS Med.* 2007;4(10):e297.