

The Effects of Preliminary Tests of Sphericity before Repeated-Measures ANOVAs on Type I Error Rates and Statistical Power.

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Background

■ **Assumptions for statistical hypothesis testing** is important for valid inferences.
- Control of type I error, robustness, etc.

■ **Preliminary tests** of equality of variance was sometimes conducted before t tests.
- However, this practice did not produce desirable results.

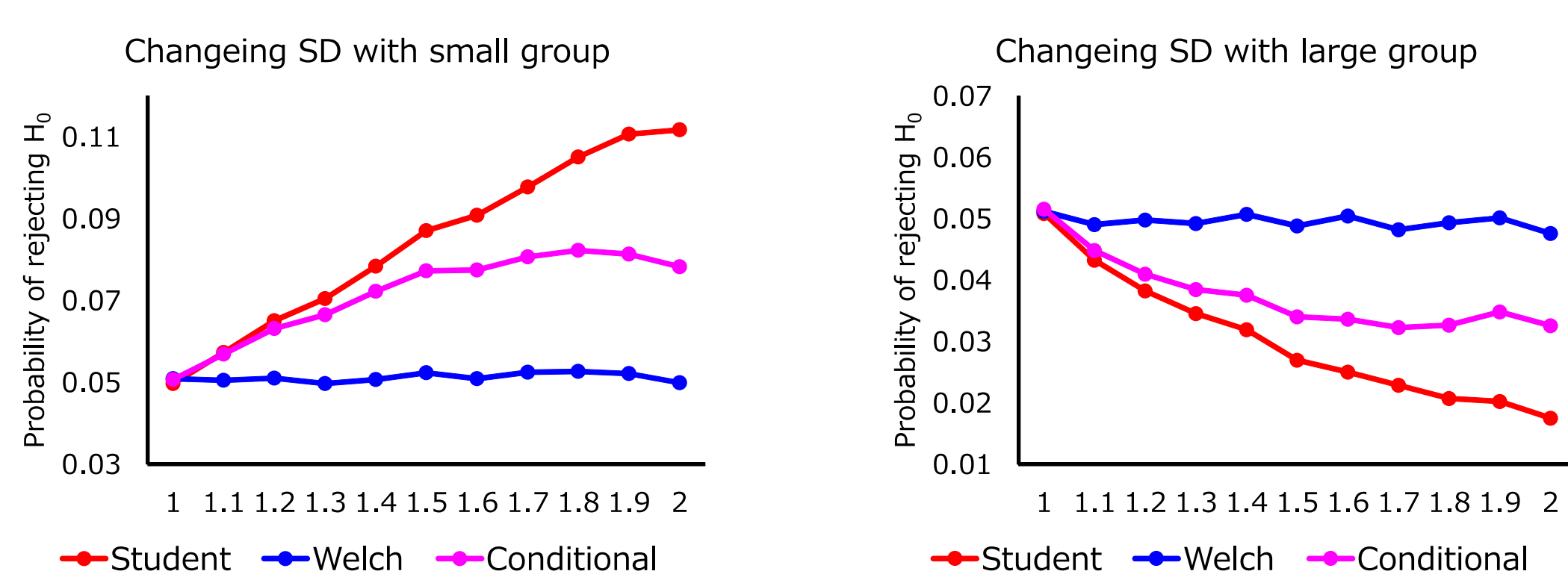


Fig. 1. Replication of Zimmerman et al. (2004) simulation. Sample size of two groups were 10 and 20 and sampling was repeated 50,000 times.

■ **Sphericity assumption** is critical for repeated measures ANOVAs.
- Mauchly's test is used for checking sphericity.
- The effect of the preliminary testing of sphericity is not investigated in simulation studies.
-> This study examined the effects of preliminary sphericity test on ANOVA!!

Method

■ Random number that follows Gaussian distribution were generated by `mvrnorm` function in R 3.2.3. Mauchly's test was used for preliminary tests of sphericity.

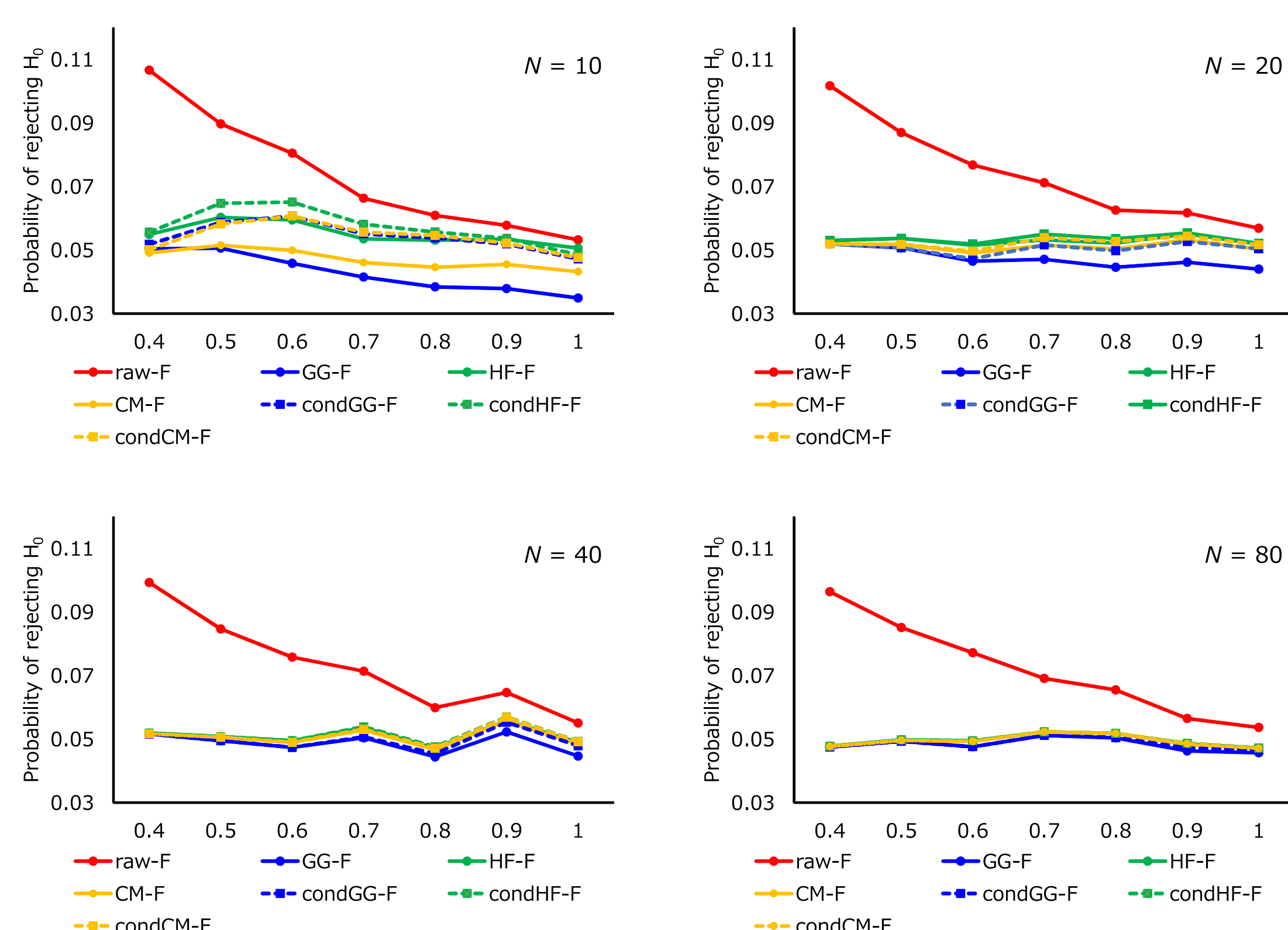
■ **Type I error simulation** (10,000 replications)
- Oneway-repeated measures ANOVA with 3, 4, and 5 levels for same means.
- Covariance matrix was generated to have a specific degree of departure from sphericity (Cornell et al., 1990). Epsilons were set to 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, and 1.0.
- Sample sizes were 10, 20, 40, and 80.

■ **Power simulation** (10,000 replications)
- Oneway-repeated measures ANOVA with 4 levels.
- Specific 4 types of covariance structures were adopted. Each epsilon was 0.40, 0.57, 0.75, and 1.00.
- Population effect sizes f were 0.1, 0.2, 0.3, 0.4, and 0.5.
- Sample sizes were 10, 20, 40, and 80.

■ Seven methods were compared.
- **Traditional ANOVA** (raw-F)
- Modified ANOVA by **Greenhouse-Geisser** epsilon (GG-F)
- Modified ANOVA by **Huynh-Feldt** epsilon (HF-F)
- Modified ANOVA by **Chi-Muller** epsilon (CM-F)
- Two steps ANOVA modified by **GG** (condGG-F)
- Two steps ANOVA modified by **HF** (condHF-F)
- Two steps ANOVA modified by **CM** (condCM-F)

Results and Discussion

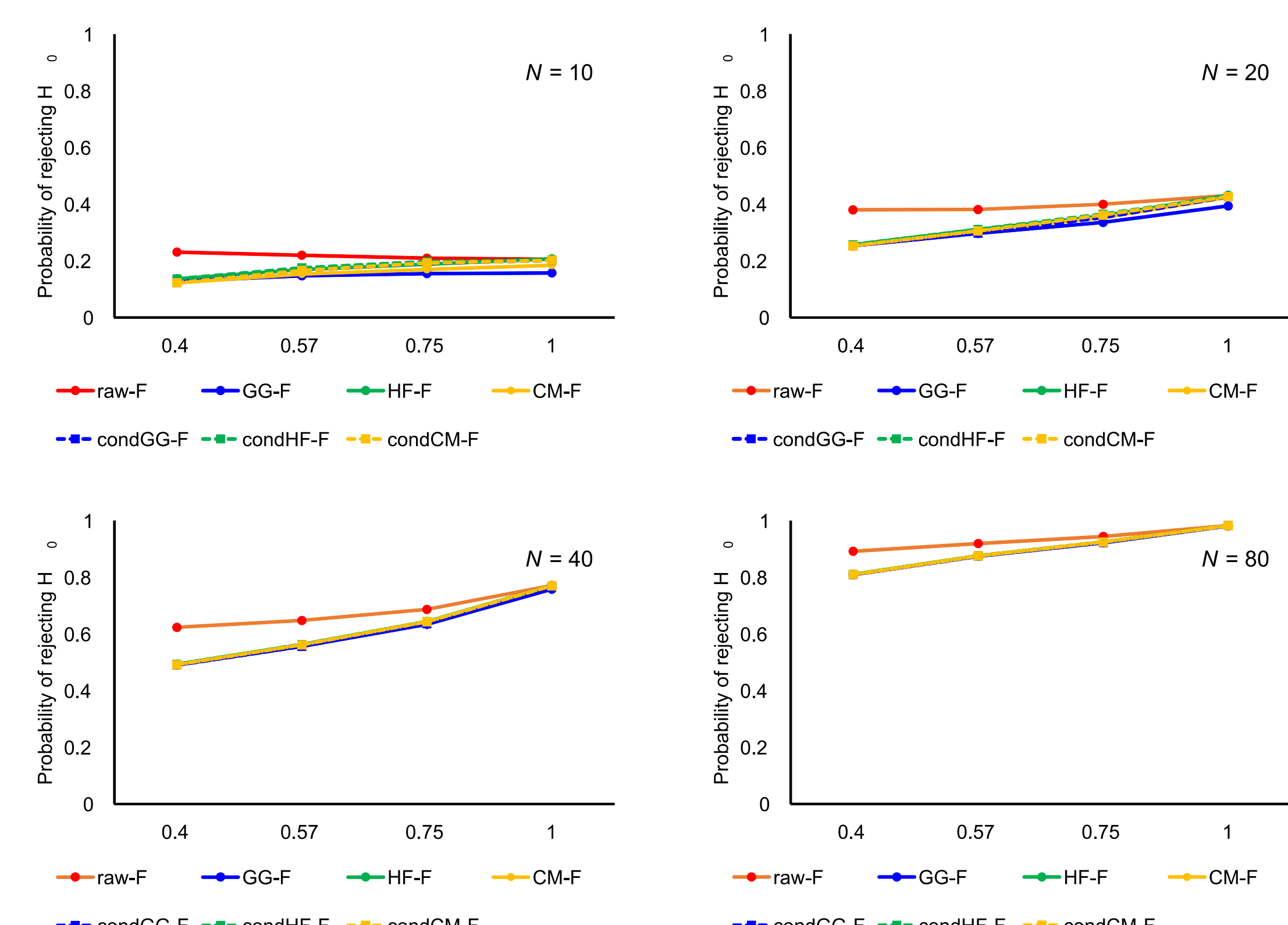
Simulation results for type I error



X-axis represents degree of sphericity (i.e., epsilons).
Only results for 4 levels design was displayed.

■ **The two steps ANOVAs** rejected more null hypotheses than one step counterparts.
- Modified ANOVA by Chi-Muller was the closest to canonical significance level (5%).
- Large sample size extinguish the difference among seven methods.

Simulation results for power



X-axis represents degree of sphericity (i.e., epsilons).
Only results for $f = 0.3$ ($\eta^2 = 0.08$) was displayed.

■ **The two steps ANOVAs** showed slightly more power than one step counterpart.
- There is a clear trade-off between power and type I error.
- Large sample size also decreased the difference.