STATISTICAL ANALYSIS PLAN (SAP)

Official Title: The Impact of Stationary Combined Exercise on Adiponectin and High-Sensitivity C-Reactive Protein Levels in Overweight Women

NCT Number: NCT number pending

Document Type: Statistical Analysis Plan (SAP)

Document Date: January 15, 2024

Version: v1.0

Sponsor/Institution: College of Physical Education and Health, Chongqing College of International Business and Economics, Hechuan District, Chongqing, China

This SAP accompanies the Study Protocol and is submitted for ClinicalTrials.gov posting. No participant names are included in this document.

1. Administrative Information

Trial Acronym: SCEX-ADCRP (Stationary Combined Exercise – Adiponectin and C-Reactive Protein)

Principal Investigator: Prof. Xianjie Zheng, College of Physical Education and Health, Chongqing College of International Business and Economics

Ethics Approval: Research Ethics Committee of Chongqing College of International Business and Economics (Approval No. K2016038; January 15, 2024)

Study Period: January 20, 2024 – April 10, 2024

Study Design: Interventional, randomized, two-arm, parallel assignment, open-label

2. Objectives and Endpoints

Primary Objective: Evaluate the effect of an 8-week high-intensity circuit-based combined exercise program on (a) serum adiponectin and (b) hs-CRP in overweight young women.

Secondary Objectives: Evaluate changes in body weight, BMI, body fat percentage, and VO■max.

Endpoint Class	Endpoint	Units	Time Frame
Primary	Serum adiponectin (ELISA)	μg/mL	Baseline; 48 h post-intervention
Primary	Serum hs-CRP (ELISA)	mg/dL	Baseline; 48 h post-intervention
Secondary	Body weight	kg	Baseline; 48 h post-intervention
Secondary	Body mass index (BMI)	kg/m²	Baseline; 48 h post-intervention
Secondary	Body fat percentage (BIA)	%	Baseline; 48 h post-intervention
Secondary	VO■max (Bruce protocol; Pollock equation)	mL·kg■¹·min■¹	Baseline; 48 h post-intervention
Other	Correlation between Δadiponectin and Δhs-CRP	Pearson r (or Spearman ρ)	Change from baseline to post-interv

3. Estimands and Analysis Populations

Primary Estimand: Mean difference between groups (Exercise vs Control) in change from baseline to 48 hours post-intervention for each primary endpoint, adjusted for baseline value.

Analysis Populations:

Intent-to-Treat (ITT): All randomized participants analyzed according to assigned group.

Per-Protocol (PP): Subset of ITT who completed ≥ 90% of sessions (exercise arm) and had no major protocol deviations; used for sensitivity analyses.

Safety Set: Not applicable (behavioral intervention); adverse events during sessions will be tabulated descriptively.

4. General Analysis Principles

All tests two-sided with $\alpha = 0.05$. Continuous variables summarized by mean±SD (or median [IQR] if non-normal); categorical variables by counts and percentages. Assumptions checked by Shapiro–Wilk (normality) and Levene's test (homogeneity of variance). When assumptions are violated, appropriate transformations (e.g., log for hs-CRP) or non-parametric methods are used.

Effect sizes and precision will be reported: adjusted mean differences with 95% confidence intervals (CI) from ANCOVA; within-group standardized mean changes (Cohen's d); and partial η^2 for ANCOVA.

5. Primary Endpoint Analyses

Endpoints: Change in adiponectin; change in hs-CRP (baseline to 48 h post-intervention).

Between-group comparison: ANCOVA with post-intervention value as the dependent variable, treatment group as fixed effect, and baseline biomarker value as covariate. Secondary covariates (age, baseline BMI) may be included in sensitivity models.

Within-group change: Paired t-test (or Wilcoxon signed-rank if non-normal) for descriptive purposes.

Assumption handling: If normality is violated, log-transform hs-CRP; if variance heterogeneity persists, use robust standard errors or non-parametric Mann–Whitney U for change scores as sensitivity.

6. Multiplicity Control

Two primary endpoints (adiponectin and hs-CRP) will control family-wise error at 0.05 using Holm–Bonferroni adjustment. Secondary outcomes are exploratory; nominal p-values will be reported with 95% CIs.

7. Secondary Endpoint Analyses

Weight, BMI, Body Fat %, VO■max: ANCOVA framework analogous to primary endpoints (post-intervention as dependent variable, baseline value as covariate; group as fixed effect). Within-group changes summarized with paired tests.

8. Correlation and Exploratory Analyses

Correlation between ∆adiponectin and ∆hs-CRP assessed using Pearson's r (or Spearman's ρ if non-normal). Scatterplots with regression lines may be produced. Additional exploratory associations with changes in body composition may be examined with linear models (unadjusted and adjusted for age and baseline BMI).

9. Missing Data Handling

Primary analysis will be complete-case under ITT. If >5% of primary endpoint data are missing, multiple imputation by chained equations (MICE, m=20) will be performed assuming missing at random (MAR), including baseline value, group, age, BMI, and other outcomes as predictors. Sensitivity analyses will compare complete-case and MI results. Last Observation Carried Forward (LOCF) will not be used.

10. Outliers, Data Cleaning, and Assumptions

Continuous outcomes will be screened for extreme values using studentized residuals (> |3|), leverage, and Cook's distance. Suspected data-entry errors will be queried and corrected if verified. Valid outliers will be retained; robustness will be assessed using non-parametric methods and influence diagnostics.

11. Protocol Deviations

Major deviations include missing >2 consecutive training sessions (exercise arm), receiving non-study exercise training, or violating key eligibility criteria. A deviation log will be maintained. PP analyses will exclude major deviations; ITT remains primary.

12. Interim Analyses and Data Monitoring

No interim analyses or formal stopping rules were planned due to the short duration and minimal risk of the behavioral intervention.

13. Sample Size Considerations

A total sample of 22 participants (11 per arm) was planned based on feasibility. No formal power calculation was performed; the study is powered for detecting moderate-to-large effects and intended as hypothesis-generating with controlled Type I error through multiplicity adjustment for co-primary endpoints.

14. Statistical Software

Analyses will be performed using SPSS version 17.0. Where applicable, confirmatory and sensitivity analyses may be replicated in R (version ≥4.0).

15. Tables, Listings, and Figures (TLFs)

Pre-specified TLFs include: CONSORT flow; baseline characteristics; primary and secondary endpoint summaries (means, SDs, mean change, 95% CIs); ANCOVA results (adjusted mean differences, SEs, 95% CIs, p-values, partial η^2); correlation matrix; and adverse events (counts, percentages).

16. Data Presentation Standards

Report means with one decimal where appropriate; hs-CRP to two decimals; exact p-values to three decimals (e.g., p=0.047). Confidence intervals at 95% two-sided. Units consistent with laboratory reports (adiponectin µg/mL; hs-CRP mg/dL).

17. Signatures and Version Control

SAP Version v1.0 dated January 15, 2024. Any amendments will be documented with rationale and dated version history prior to database lock.