

Title: “Exploring the Cognitive and Physiological Effects of Ārepa Formulation under Cognitive Stress Conditions: A Systematic Approach Integrating Qualitative and Quantitative Analyses”

LEEDS BECKETT UNIVERSITY

PhD Projects in Psychology

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I have created an official website on GitHub and a dedicated Lab for Leeds Beckett University. These platforms will be used to store research materials and execute the project methodologies online using Python code I developed.

You can access them via the following links:

- **GitHub:** <https://github.com/HeiderJeffer/PhD-Leeds-Beckett-University>
- **Lab - LEEDS BECKETT UNIVERSITY:**
 - [ANOVA, regression, and t-tests - Developed using Python by Heider Jeffer](#)
 - [Distribution of cognitive scores - Developed using Python by Heider Jeffer](#)
 - [Histogram, regression, and scatter - Developed using Python by Heider Jeffer](#)

This proposal outlines a structured approach to investigating the cognitive benefits of Ārepa formulation under conditions of cognitive stress, aiming to contribute significantly to the field of nutritional neuroscience and cognitive enhancement.

Introduction

Plants rich in phytonutrients have been shown to benefit cognitive function due to their effects on metabolic pathways, blood flow, antioxidant activity, and neuroprotection. Blackcurrants, particularly rich in polyphenolic flavonoids like anthocyanins, are of interest for their potential cognitive benefits. The Ārepa formulation, derived from New Zealand Blackcurrants, has shown promise in enhancing cognitive function, especially under conditions of cognitive stress induced by factors like high altitude and sleep deprivation. This PhD project aims to further investigate these effects through rigorous scientific inquiry.

Background Literature

The literature review will focus on studies investigating the cognitive effects of flavonoids and anthocyanins, emphasizing mechanisms of action such as improved blood flow, antioxidant properties, and modulation of neurotransmitter systems (Bell et al., 2015; Cox & Scholey, 2017; Li et al., 2021). Additionally, research on dietary interventions under cognitive stress conditions, such as high altitude and sleep deprivation, will be explored to contextualize the study (Shannon et al., 2016, 2017a, 2017b; Cook & Willems, 2019).

1.1 Aims and Objectives

1. To assess the efficacy of the Ārepa formulation in mitigating the cognitive and physiological effects of high altitude exposure.
2. To evaluate the Ārepa formulation's effectiveness in protecting cognitive function during periods of sleep deprivation.
3. To explore the potential benefits of Ārepa under conditions of cold or heat stress, or to delve deeper into its effects at high altitude or during sleep deprivation.

1.2 Research Questions

- How does Ārepa supplementation affect attentional and working memory networks during high altitude exposure?
- What are the physiological and cognitive benefits of Ārepa supplementation under conditions of sleep deprivation?
- What additional cognitive benefits can be observed under cold or heat stress conditions?

Research Approach

The proposed research aims to systematically investigate the efficacy of the Ārepa formulation in enhancing and protecting cognitive function under conditions of cognitive stress induced by high altitude, sleep deprivation, and potential cold or heat stress. This comprehensive approach integrates qualitative and quantitative methods to provide a robust understanding of Ārepa's effects on cognitive performance and physiological responses.

1.3 Systematic Literature Review

Purpose: To consolidate existing knowledge on the cognitive effects of anthocyanins and flavonoids, and the physiological responses to cognitive stressors.

Method: Conduct a systematic review of peer-reviewed literature using databases such as PubMed, Scopus, and Google Scholar. Synthesize findings to inform the design of experimental studies, including hypotheses formulation and methodological considerations.

Outcome: The review will provide a theoretical foundation for understanding the mechanisms through which Ārepa formulation may influence cognitive function under stress conditions.

1.4 Experimental Design

Purpose: To empirically test specific hypotheses regarding the cognitive and physiological effects of Ārepa supplementation under controlled conditions.

Methods

- **Randomized Controlled Trials (RCTs):** Implement double-blind, placebo-controlled trials to assess the effects of Ārepa formulation on cognitive function, mood, stress, fatigue, vascular function, and metabolism. Participants will be randomly assigned to Ārepa or placebo groups.

- **Experimental Conditions:** Participants will undergo simulated high altitude exposure (e.g., hypobaric chamber or high-altitude location), controlled sleep deprivation protocols, and potentially cold or heat stress conditions (temperature-controlled environments).
- **Outcome Measures:** Utilize validated cognitive assessments (e.g., attention tasks, working memory tests), physiological measurements (e.g., blood pressure, heart rate variability), and self-report scales (e.g., mood and fatigue questionnaires) to quantify quantitative data.

1.5 Data Collection and Analysis:

Purpose: To gather comprehensive empirical evidence on Ārepa formulation's effects across diverse stress conditions.

Quantitative Data Analysis

- **Statistical Methods:** Employ ANOVA, regression analysis, and t-tests to analyze quantitative data. ANOVA will assess differences in cognitive performance and physiological responses between Ārepa and placebo groups across stress conditions. Regression analysis will explore relationships between cognitive outcomes and physiological measures. T-tests will evaluate changes in specific variables pre- and post-supplementation.
- **Software:** Use statistical software such as SPSS or R for rigorous data analysis, ensuring accuracy and reliability of results.

Qualitative Data Analysis

- **Thematic Analysis:** Conduct thematic analysis of qualitative data obtained through semi-structured interviews or open-ended questionnaires. Identify recurring themes related to participants' experiences with Ārepa supplementation, including perceived cognitive benefits, emotional responses, and challenges during stress conditions.
- **Integration of Qualitative and Quantitative Data:** Triangulate findings from both data sets to enrich understanding of Ārepa's effects. This integration enhances the validity and depth of interpretations, providing a comprehensive perspective on cognitive resilience and physiological responses.

1.6 Ethical Considerations:

Purpose: To ensure ethical conduct and participant welfare throughout the research process.

Methods:

- **Ethical Approval:** Secure authorization from the institutional ethics committee prior to beginning data collection. Follow ethical standards for research involving human participants.
- **Informed Consent:** Obtain informed consent from all participants, ensuring voluntary participation and confidentiality of data. Communicate potential risks and benefits clearly.

1.7 Knowledge Integration and Dissemination:

Purpose: To contribute new knowledge to the field of nutritional neuroscience and cognitive enhancement.

Methods:

- **Integration:** Synthesize research findings with existing literature to advance understanding of Ārepa's mechanisms on cognitive function under stress. Discuss implications for public health and potential applications in enhancing cognitive resilience across populations.
- **Dissemination:** Publish research outcomes in peer-reviewed journals and present findings at conferences to share insights with the scientific community. Foster dialogue and collaboration with researchers and stakeholders in the field.

Research Plan

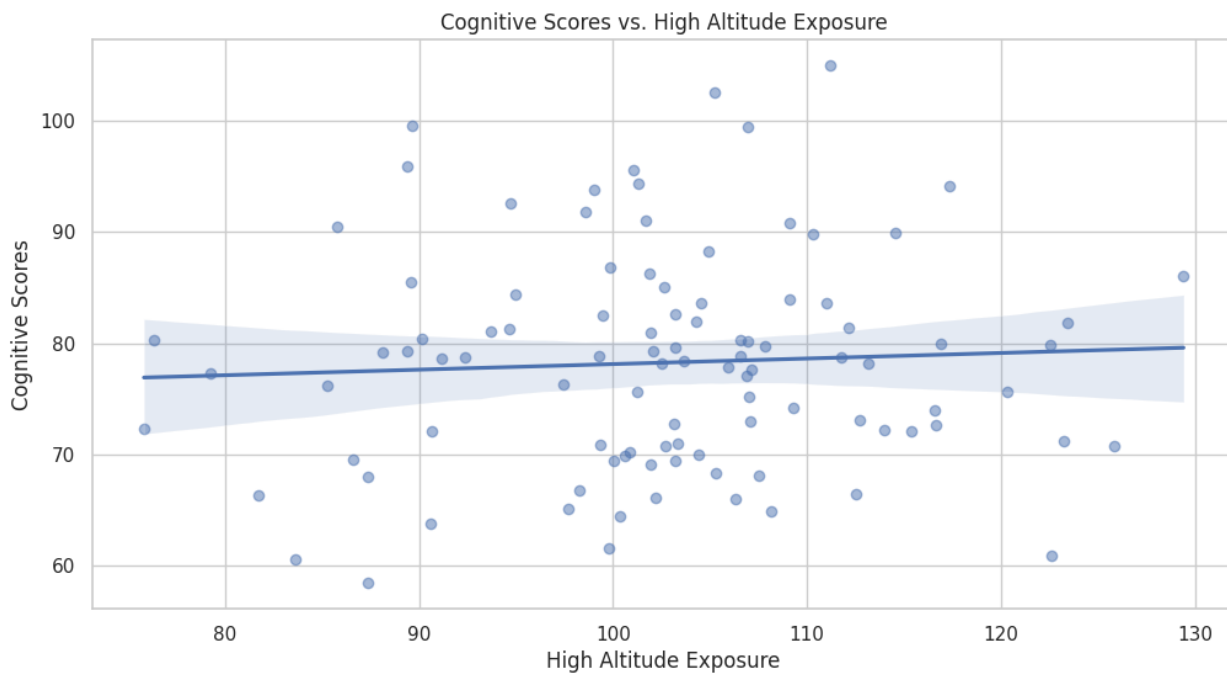
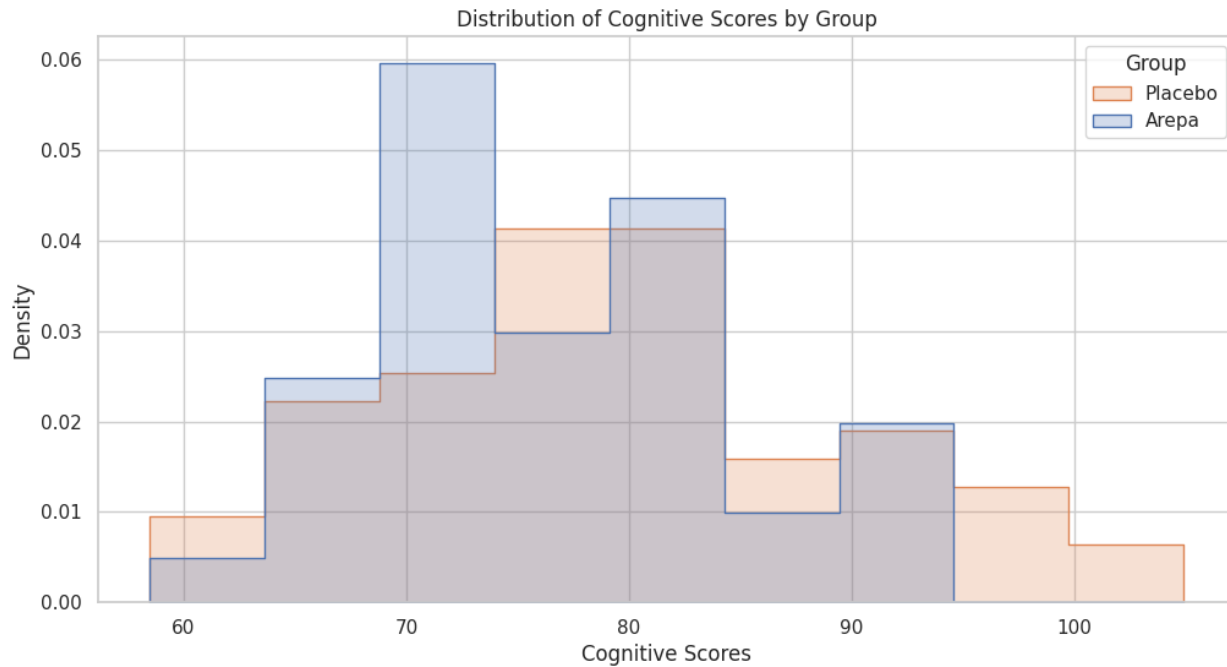
- **Year 1:** Conduct systematic literature review, refine research questions, and obtain ethical approval.
- **Year 2:** Initiate RCTs under controlled conditions of high altitude and sleep deprivation, with data collection and preliminary analysis.
- **Year 3:** Complete RCTs, analyze data, prepare manuscripts for publication, and disseminate findings through conferences and academic journals.

References

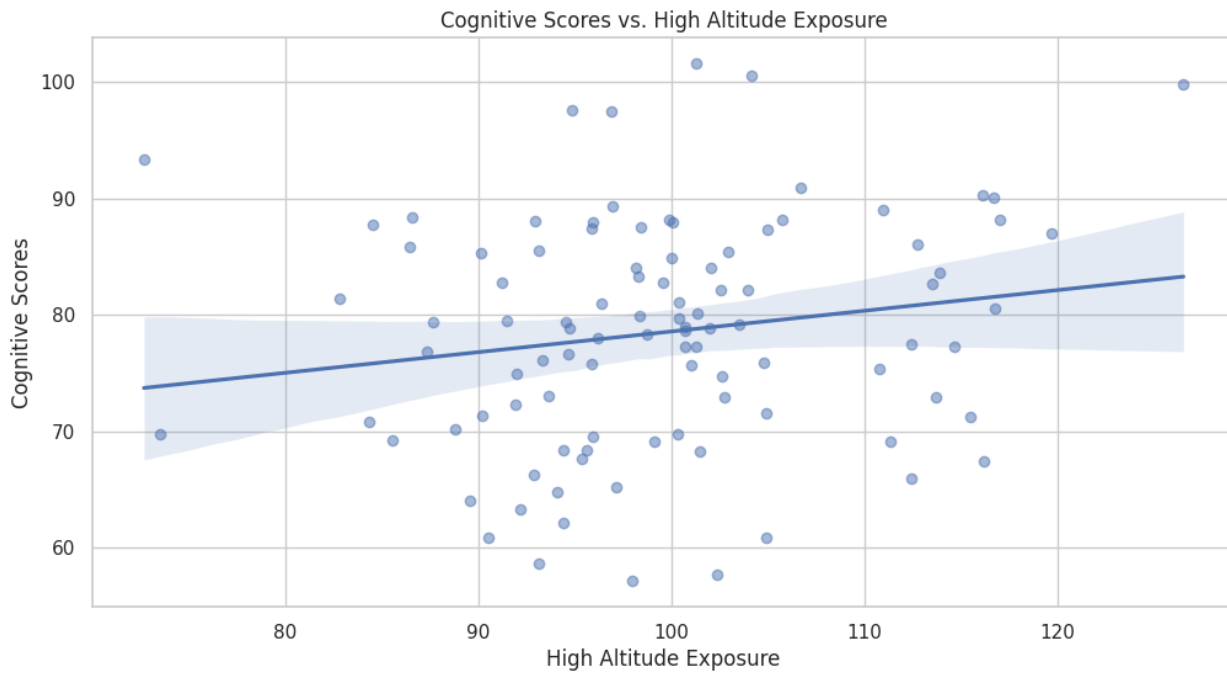
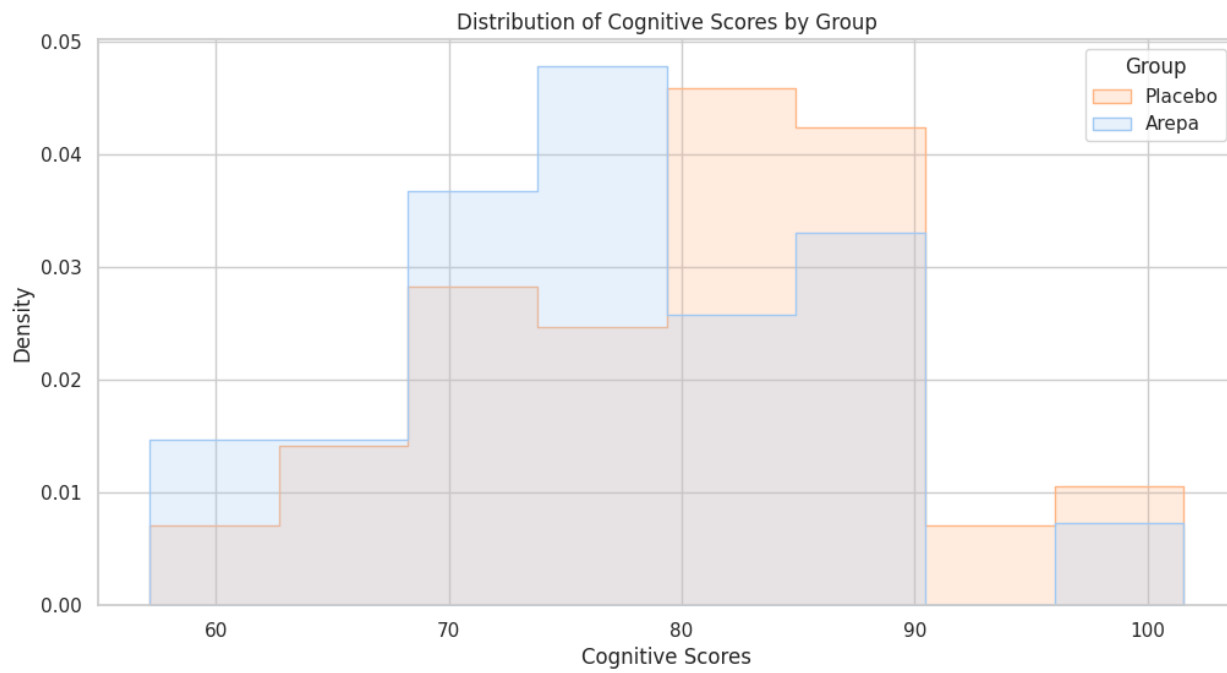
- Bell, L., et al. (2015). A review of the cognitive effects observed in humans following acute supplementation with flavonoids, and their associated mechanisms of action. *Nutrients*, 7(12), 10290-10306.
- Cook, M. D., & Willems, M. E. T. (2019). Dietary anthocyanins: A review of the exercise performance effects and related physiological responses. *International Journal of Sport Nutrition and Exercise Metabolism*, 29(3), 322-330.
- Cox, K. H., & Scholey, A. (2017). Polyphenols for brain and cognitive health. In *Recent Advances in Polyphenol Research* (pp. 259-288).
- Li, P., et al. (2021). Protective effects of anthocyanins on neurodegenerative diseases. *Trends in Food Science & Technology*, 117, 205-217.
- Shannon, O. M., et al. (2016). Dietary nitrate supplementation enhances high-intensity running performance in moderate normobaric hypoxia, independent of aerobic fitness. *Nitric Oxide*, 59, 63-70.
- Shannon, O. M., et al. (2017a). "Beet-ing" the mountain: A review of the physiological and performance effects of dietary nitrate supplementation at simulated and terrestrial altitude. *Sports Medicine*, 47, 2155-2169.
- Shannon, O. M., et al. (2017b). Effects of dietary nitrate supplementation on physiological responses, cognitive function, and exercise performance at moderate and very-high simulated altitude. *Frontiers in Physiology*, 8, 401.

Appendix

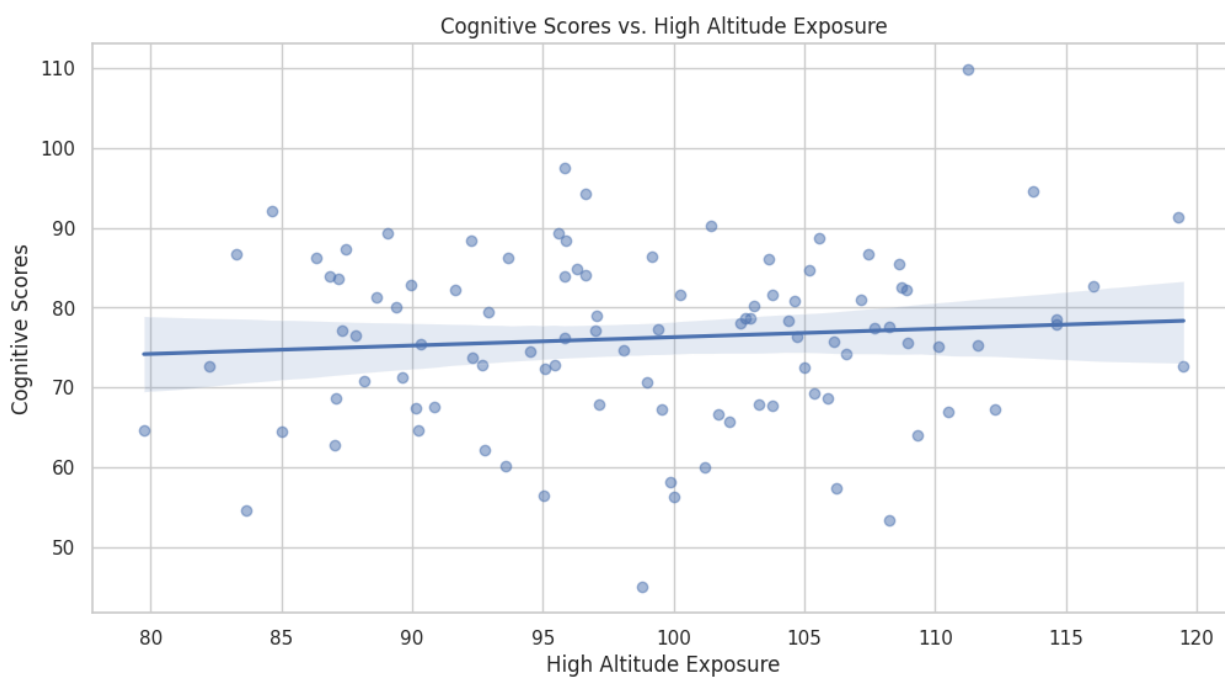
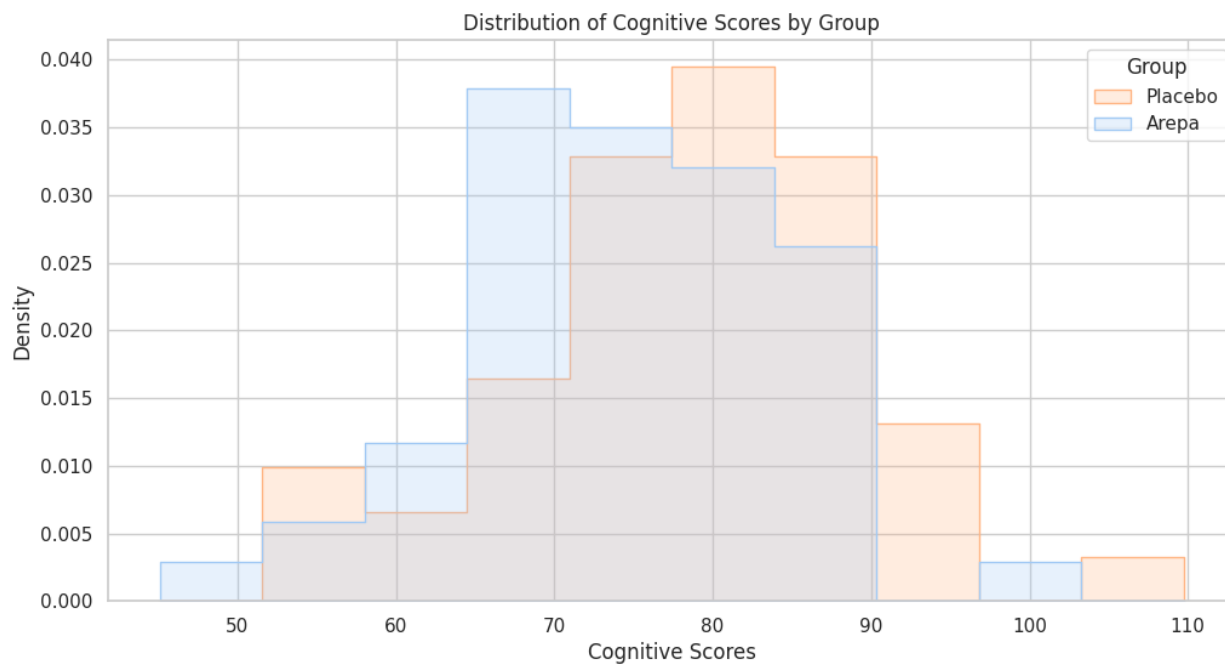
1.8 ANOVA, regression, and t-tests - Developed using Python by Heider Jeffer



1.9 Distribution of cognitive scores - Developed using Python by Heider Jeffer



1.10 Histogram, regression, and scatter - Developed using Python by Heider Jeffer



Code Breakdown

This code will generate three plots:

1. A histogram showing the distribution of cognitive scores for the Arepa and placebo groups.
2. A regression plot showing the relationship between cognitive scores and high altitude exposure.
3. A scatter plot showing the relationship between cognitive scores and sleep deprivation, differentiated by the Arepa and placebo groups.

The code and what each part does. This script simulates a research study to investigate the effects of the Arepa formulation on cognitive function under stress conditions. The main parts of the script include setting up the research framework, conducting randomized controlled trials (RCTs), analyzing the data, and plotting the results.

Initialization

The ArepaResearch class is created with several methods to simulate different stages of the research process.

```
class ArepaResearch:
    def __init__(self):
        self.literature_review_complete = False
        self.ethical_approval_obtained = False
        self.experimental_data = None
        self.qualitative_data = None
```

This initializes the class with boolean attributes to track the completion of the literature review and ethical approval, and attributes to store experimental and qualitative data.

Systematic Literature Review

This method simulates a literature review.

```
def systematic_literature_review(self):
    print("Conducting systematic literature review...")
    # Placeholder for actual literature review code
    self.literature_review_complete = True
    print("Literature review complete.")
```

Ethical Approval

This method simulates obtaining ethical approval for the study.

```
def obtain_ethical_approval(self):
    print("Obtaining ethical approval...")
    # Placeholder for actual ethical approval code
    self.ethical_approval_obtained = True
    print("Ethical approval obtained.")
```


Randomized Controlled Trials (RCTs)

This method simulates the conduct of RCTs, generating synthetic data for the participants.

```
def conduct_rcts(self):
    if not self.literature_review_complete or not self.ethical_approval_obtained:
        raise Exception("Complete literature review and obtain ethical approval first.")

    print("Starting randomized controlled trials (RCTs)...")
    n_participants = 100
    arepa_group = np.random.choice([0, 1], size=n_participants, p=[0.5, 0.5])
    high_altitude = np.random.normal(100, 10, n_participants)
    sleep_deprivation = np.random.normal(5, 1, n_participants)
    cognitive_scores = np.random.normal(75, 10, n_participants) + arepa_group * 5
    mood_scores = np.random.normal(50, 5, n_participants) + arepa_group * 3

    self.experimental_data = pd.DataFrame({
        'arepa_group': arepa_group,
        'high_altitude': high_altitude,
        'sleep_deprivation': sleep_deprivation,
        'cognitive_scores': cognitive_scores,
        'mood_scores': mood_scores
    })

    print("RCTs complete and data collected.")
```

Here, 100 participants are randomly assigned to either the Arepa or placebo group. Data for high altitude exposure, sleep deprivation, cognitive scores, and mood scores are generated using normal distributions. Cognitive scores and mood scores are adjusted based on group assignment.

Quantitative Analysis

This method conducts various statistical analyses and creates plots.

```
def quantitative_analysis(self):
    if self.experimental_data is None:
        raise Exception("No experimental data to analyze.")

    print("Conducting quantitative data analysis...")
    data = self.experimental_data

    # ANOVA
    anova_results = stats.f_oneway(
        data[data['arepa_group'] == 0]['cognitive_scores'],
        data[data['arepa_group'] == 1]['cognitive_scores']
    )
    print("ANOVA results:", anova_results)

    # Regression analysis
    X = data[['high_altitude', 'sleep_deprivation', 'arepa_group']]
    y = data['cognitive_scores']
    reg = LinearRegression().fit(X, y)
    print("Regression coefficients:", reg.coef_)

    # t-tests
    t_test_results = stats.ttest_ind(
        data[data['arepa_group'] == 0]['cognitive_scores'],
        data[data['arepa_group'] == 1]['cognitive_scores']
    )
    print("T-test results:", t_test_results)

    # Plotting
    sns.set(style="whitegrid")

    # Distribution of cognitive scores by group
    plt.figure(figsize=(12, 6))
    sns.histplot(data=data, x='cognitive_scores', hue='arepa_group', element="step",
stat="density", common_norm=False, palette="pastel")
    plt.title('Distribution of Cognitive Scores by Group')
    plt.xlabel('Cognitive Scores')
    plt.ylabel('Density')
    plt.legend(title='Group', labels=['Placebo', 'Arepa'])
    plt.show()

    # Regression plot for cognitive scores vs. high altitude
    plt.figure(figsize=(12, 6))
    sns.regplot(x='high_altitude', y='cognitive_scores', data=data,
scatter_kws={'alpha':0.5})
    plt.title('Cognitive Scores vs. High Altitude Exposure')
    plt.xlabel('High Altitude Exposure')
    plt.ylabel('Cognitive Scores')
    plt.show()

    # Scatter plot for cognitive scores vs. sleep deprivation
    plt.figure(figsize=(12, 6))
    sns.scatterplot(x='sleep_deprivation', y='cognitive_scores', hue='arepa_group',
palette="pastel", alpha=0.7, data=data)
    plt.title('Cognitive Scores vs. Sleep Deprivation')
    plt.xlabel('Sleep Deprivation (hours)')
    plt.ylabel('Cognitive Scores')
    plt.legend(title='Group', labels=['Placebo', 'Arepa'])
    plt.show()
```

- **ANOVA:** Compares cognitive scores between the two groups.
- **Regression Analysis:** Examines the relationship between cognitive scores and high altitude, sleep deprivation, and group assignment.
- **t-tests:** Compares the means of cognitive scores between groups.
- **Plotting:** Generates three types of plots:
 1. Histogram of cognitive scores by group.
 2. Regression plot of cognitive scores vs. high altitude.
 3. Scatter plot of cognitive scores vs. sleep deprivation, colored by group.

Qualitative Analysis

This method conducts a thematic analysis of qualitative data.

```
def qualitative_analysis(self):
    print("Conducting qualitative data analysis...")
    if self.qualitative_data is None:
        self.qualitative_data = [
            "Participants reported increased focus.",
            "Some participants felt no change.",
            "Several participants experienced improved mood."
        ]

    themes = {'increased_focus': 0, 'no_change': 0, 'improved_mood': 0}
    for response in self.qualitative_data:
        if "increased focus" in response.lower():
            themes['increased_focus'] += 1
        if "no change" in response.lower():
            themes['no_change'] += 1
        if "improved mood" in response.lower():
            themes['improved_mood'] += 1

    print("Identified themes:", themes)
```

Knowledge Integration and Dissemination

This method synthesizes findings and prepares for dissemination.

```
def knowledge_integration_and_dissemination(self):
    print("Integrating knowledge and disseminating findings...")
    # Synthesize findings with existing literature
    # Prepare manuscripts for publication and present at conferences
    print("Research findings integrated and ready for dissemination.")
```

Running the Research Plan

```
# Instantiate the research class and run the research plan
research = ArepaResearch()
research.systematic_literature_review()
research.obtain_ethical_approval()
research.conduct_rcts()
research.quantitative_analysis()
research.qualitative_analysis()
research.knowledge_integration_and_dissemination()
```

This code creates an instance of the `ArepaResearch` class and sequentially calls the methods to simulate the entire research process from literature review to dissemination.

Summary of Plots

1. **Histogram of Cognitive Scores:** Shows the distribution of cognitive scores for both the Arepa and placebo groups, highlighting any differences.
2. **Regression Plot:** Visualizes the relationship between cognitive scores and high altitude exposure, with a trend line to show the overall trend.
3. **Scatter Plot:** Displays the relationship between cognitive scores and sleep deprivation, with points colored by group to distinguish between Arepa and placebo groups.

These plots help visualize the impact of the Arepa formulation on cognitive performance under different stress conditions.