AY26-2 MA206X COURSE PROJECT

Brigade Lethality Analysis

1 Purpose & Background

Purpose: Execute a complete statistical analysis from raw data to actionable recommendations, apply inference techniques to real Army data, communicate technical findings through professional military reports, and think critically about data-driven decision making.

The Problem: Brigade commanders must assess the readiness of thousands of Soldiers across multiple battalions and companies. The AFT (max 500 points) and M4 qualification serve as two readily available, universal metrics at every echelon - but raw scores alone do not answer the questions commanders need answered: How does our brigade compare to Army standards? What factors predict performance? Are there significant differences between companies, MOS categories, or experience levels? What interventions might improve readiness?

1.1 The Data

You and your partner will be assigned one brigade-level dataset from Army Vantage with individual Soldier records:

Unit:	`company`, `battalion`, `BrigadeName`
Weapons:	`m4_qual_category`, `m4_score`
Demographics:	`grade_unmapped`, `billet_specialty`, `time_in_active_service_years`, `age_bracket`, `sex`
Qualifications:	`asi_and_sqi` (ASI/SQI array)
Body Comp:	`height`, `weight`, `height_weight_pass`, `body_fat_percent`
AFT Scores:	`aft_pass`, `aft_score_total` (0–500), `aft_score_plank`, `aft_score_push_up`, `aft_score_sprint_drag_carry`, `aft_deadlift_score`, `aft_score_2mi_run`, `aft_score_alt_aerobic`
AFT Raw:	`aft_raw_plank`, `aft_raw_plank_seconds`, `aft_raw_deadlift`, `aft_raw_push_up`, `aft_raw_sprint_drag_carry`, `aft_raw_sprint_drag_carry_seconds`, `aft_raw_2mi_run`, `aft_raw_2mi_run_seconds`, `aft_raw_alt_aerobic`

2 Research Questions

Your team's analysis must demonstrate proficiency across multiple statistical techniques by including **at minimum**: one one-sample hypothesis test, one two-sample hypothesis test, and one multiple linear regression model. The specific research questions you investigate should be directly relevant to your assigned brigade's readiness concerns and address issues that would matter to unit leadership.

2.1 Developing Your Research Questions

Begin by considering your brigade commander's priorities. What information would inform critical decisions? Where are the readiness gaps that require attention? What interventions might prove effective? These practical considerations should guide your question selection.

Allow your exploratory data analysis to inform your hypothesis testing. If you observe patterns during data exploration – such as one company consistently underperforming or a particular MOS category showing unexpected trends – formulate specific statistical questions to test these observations rigorously.

Ensure your questions have practical implications. Frame investigations that could inform real decisions: Should the brigade target physical training interventions to specific groups? Do certain qualifications correlate with overall fitness? Would resources be better allocated to junior enlisted development or NCO sustainment programs?

Finally, verify statistical appropriateness before committing to specific analyses. Confirm adequate sample sizes in each comparison group (preferably $n \geq 30$ for t-tests to satisfy normality assumptions). For regression models, carefully select predictors to avoid perfect multicollinearity – for instance, do not include individual AFT event scores when predicting AFT total score, as the total is simply the sum of its components. Similarly, `aft_pass` is determined by `aft_score_total` and should not be used as a predictor for it.

2.2 One-Sample Hypothesis Test

One-sample tests compare your brigade's performance against established Army standards or historical benchmarks. Example ideas include, but are not limited to:

- Mean AFT score vs. Army promotion standard of 360 points
- Mean time in service vs. Army-wide average of 6.5 years
- Mean body fat percentage vs. regulatory standards
- Mean M4 qualification score vs. historical brigade performance
- Average 2-mile run time vs. doctrinal fitness expectations

2.3 Two-Sample Hypothesis Test

Two-sample comparisons identify performance differences between meaningful subgroups within your brigade. Example ideas include, but are not limited to:

- **MOS/Role:** Combat Arms vs. Combat Support, Infantry vs. CSS, line vs. HQ elements
- **Rank/Experience:** Junior Enlisted (E1–E4) vs. NCOs (E5–E6), <3 years TIS vs. >10 years
- **Qualifications:** Expert M4 vs. non-Expert, Soldiers with ASI/SQI vs. without, Airborne/Ranger-qualified vs. not
- **Physical Standards:** H/W pass vs. fail, high body fat (>20%) vs. low (<15%)
- **Unit:** Company vs. company, battalion vs. battalion
- **Demographics:** Age brackets (18–25 vs. 30+), male vs. female

2.4 Multiple Linear Regression Analysis

Regression modeling examines how multiple factors simultaneously influence readiness outcomes. Example ideas include, but are not limited to:

- Predict AFT total score from time in service, age, body composition, M4 score, rank, MOS, and company
- Model individual AFT events (2-mile run time, deadlift score) to identify which Soldier characteristics drive specific capabilities
- Investigate what characteristics are associated with meeting or exceeding promotion standards

3 Deliverable: Technical Report

With your partner, produce a professional Army white paper formatted for a brigade commander audience. Submit one report per team. Structure your report with the following sections:

3.1 Executive Summary

Provide a bottom-line-up-front (BLUF) statement, brief methods overview, 3–4 key results, and your primary recommendation.

3.2 Introduction

Present the problem statement, analysis objectives, scope of the study (brigade identification, timeframe, sample size), data source description, variable summary table, data cleaning procedures, and descriptive statistics for key variables.

3.3 One-Sample Hypothesis Test

1. **Exploratory Data Analysis.** Visualize the variable of interest with appropriate plots (histogram, boxplot). Report descriptive statistics and summarize what you observe.
2. **Methodology.** State the null and alternative hypotheses (H_0 and H_a), verify test assumptions, specify the statistical procedure, and note the significance level ($\alpha = 0.05$).
3. **Results.** Report the test statistic, p-value, statistical decision, confidence interval, and effect size. Interpret findings in the context of brigade readiness.

3.4 Two-Sample Hypothesis Test

1. **Exploratory Data Analysis.** Visualize both groups with side-by-side plots (boxplots, density plots). Report descriptive statistics for each group and summarize observed differences.
2. **Methodology.** State H_0 and H_a, verify test assumptions, specify the statistical procedure, and note the significance level ($\alpha = 0.05$).
3. **Results.** Report the test statistic, p-value, statistical decision, confidence interval, and effect size. Interpret findings in the context of brigade readiness.

3.5 Multiple Linear Regression

1. **Exploratory Data Analysis.** Examine relationships between predictors and the response variable using scatterplots and a correlation matrix. Identify potential predictors and flag concerns (outliers, nonlinearity).
2. **Methodology.** Justify why multiple linear regression is appropriate for this data. Justify predictor selection, document all predictors initially considered, explain which were removed and why (e.g., multicollinearity, non-significance, lack of theoretical justification), and present the final model form.
3. **Results.** Report R^2 and p-values for key predictors. Interpret results in the context of the problem and explain why the findings matter to the brigade.

3.6 Discussion

Synthesize findings across all analyses, address unexpected findings, and connect results to operational considerations.

3.7 Conclusions

Answer each research question directly, tie conclusions to brigade readiness and mission capability, acknowledge limitations of your data and analysis, and provide reasonable, actionable recommendations based on your findings.

3.8 References & Appendices

Include acknowledgement of assistance (IAW DAAW), works cited, and appendices as needed (e.g., R code, additional figures, data dictionary).

4 Grading Rubric

4.1 Technical Report (125 points)

Category	Component	Points
IPR Briefing	Preparedness and content (LSN 37)	10
Exec Summary & Intro	BLUF, data description, descriptive stats	10
One-Sample Test	EDA, methodology, results, interpretation	20
Two-Sample Test	EDA, methodology, results, interpretation	20
Regression	EDA, methodology, results, diagnostics, and interpretation	30
Discussion & Conclusions	Synthesis, limitations, recommendations	15
Professionalism	Writing quality, figures, tables, formatting	20

4.2 Presentation (50 points)

LSN 38: Print your presentation slides and post them on the chalkboard. Classmates and instructors will circulate to review your work. Both partners must be prepared to explain your analysis to anyone who stops at your display.

Category	Component	Points
Statistical Rigor	One-sample test	10
	Two-sample test	10
	Regression	10
Communication	Background & data context	5
	Methodology explanation	5
	Results & diagnostics	5
	Limitations & recommendations	5

4.3 Generative AI Guidance

ALLOWED: R coding, debugging, ggplot2 syntax, error troubleshooting, R Markdown formatting, understanding function parameters

PROHIBITED: Writing analysis/interpretation/discussion, generating conclusions/recommendations, creating report narrative, analyzing results, any prose representing your intellectual work

CITATION: Must cite all GenAI use IAW DAAW. Include appendix statement: *"GenAI [tool name] was used for R code assistance. All analysis, interpretation, and written content are original author work."*

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