**Assignment 1**

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PSYR 6003

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**Methods**

**Study Design and Objectives**

This study examined a dataset gathered as part of the Avengers' final battle against Thanos across two battlefields. We were interested in summarising the performance of Avengers' without superpowers who have died across two battlefields by examining differences in combat effectiveness, kills, and injuries across the South battlefield and North battlefield. Additionally, we interested in assessing the effect of superpowers on IQ score by examining the difference between IQ scores for avengers with superpowers and avengers without superpowers. We hypothesized that Avengers' with superpowers would have a higher average IQ compared to Avengers' without superpowers.

**Sample Size and Power Analysis**

The dataset obtained for this study included 813 Avengers' across two battlefields (South and North). Although we could specify nearly the entire population of Avengers' due to most attending the final battle (South and North battlefields), we conducted a prospective power analysis to minimize the risk of Type II error and ensure that the sample obtained was sufficient—based on the pre-selected parameters of interest—to assess the effect of superpowers on IQ scores. This approach was chosen to ensure confidence in detecting whether there was a meaningful difference in IQ scores between Avengers' with and without superpowers.

The prospective power analysis was conducted using the R *pwr* package based on a large effect size (*d* = 0.8), an alpha (α) of 0.05, and a power of 0.85. An effect size of 0.8 was selected based on previously reported large effect sizes in studies examining IQ differences among military personnel—a population highly skilled in combat strategies and battlefield decision-making, similar to the Avengers. Furthermore, 0.8 represents the smallest effect size that has been associated with practically meaningful differences. An alpha (α) of 0.05 was chosen based on prior research on IQ-related effects, and a power of 0.85 was selected to ensure sufficient sensitivity for detecting IQ-related differences, as described in previous literature.

The required sample size to achieve 85% power, given the aforementioned parameters, was estimated to be n = 29.05 per group. This suggests that the study had sufficient power to assess the effect of superpowers on IQ scores, as the smallest group sample size was n = 32 for Avengers with superpowers.

To assess equivalence between groups, a two one-sided test (TOST) was conducted to determine whether the observed difference in IQ between Avengers with and without superpowers was small enough to indicate no meaningful difference. Equivalence bounds were set at -0.8 and 0.8, with α = 0.05. A power analysis using the *TOSTER* package in R estimated a required sample size of n = 29.73 per group. This indicates that the study had sufficient power to assess equivalence between the groups, as the smallest group sample size was n = 32 for Avengers with superpowers.

**Results**

The mean combat effectiveness score for avengers without superpowers who have died was higher for the North battlefield (M=499.78, SD=174.07; see Table 2), compared to the South battlefield (M=491.68, SD=189.53; see Table 2). The mean injury score for avengers without superpowers who have died was higher for the North battlefield (M=4.60, SD=0.68; see Table 2) compared to the South battlefield (M=4.43, SD=0.88; see Table 2). The mean number of kills for avengers without superpowers who have died was higher in the South battlefield (M=4.75, SD=14.99; see Table 2) compared to the North battlefield (M=1.71, SD = 4.57; see Table 2).

Kill scores for avengers without superpowers who have died exhibited the greatest variability, particularly for the South battlefield, compared to combat effectiveness and injuries, indicating kills as the most erroneous variable in the mean model.

An Independent samples t-test analysis revealed a statistically significant difference in IQ scores between avengers with and without superpowers (t=4.24; see Table 3). However, the observed effect was small and not highly precise, as the lower bound would indicate no effect (Cohen's d = 0.3, 95% CI [0.16, 0.44]; see Table 3).

**Discussion**

A higher number of kills observed in the South battlefield may suggest that the South battlefield in the final battle against Thanos was more dangerous. The higher number of injuries observed in the North battlefield may have been due to less kills and may further suggest that South battlefield was more dangerous, or alternately may suggest that this battlefield included stronger avengers. However, a limitation of this study is the weaker reliability of kill scores in measures compared to combat effectiveness and injuries.

The observed small effect suggests that superpower do not meaningfully predict IQ differences, given the smallest practically meaningful effect for IQ indicated in prior research is d=0.8, failing to reject the null hypothesis of this study. Results from this study indicate no meaningful difference in IQ scores between Avengers’ with superpower and Avengers' without superpowers.

**Appendices**

**Table 1**

*Descriptive summary of Avengers’ final battle*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Mean | SD |
| Combat Effectiveness | | 497.53 | 177.56 |
| Kills |  | 2.55 | 8.81 |
| Injuries |  | 4.55 | 0.74 |

*Note.* SD, standard deviation.

**Table 2**

*Descriptive summary of Avengers’ final battle by battlefield location*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Battlefield | Mean | SD |
| Combat Effectiveness | North | 499.78 | 174.07 |
|  | South | 491.68 | 189.53 |
| Kills | North | 1.71 | 4.57 |
|  | South | 4.56 | 14.99 |
| Injuries | North | 4.60 | 0.68 |
|  | South | 4.43 | 0.88 |

*Note.* Battlefield, battlefield location; SD, standard deviation.

**Table 3**

*Independent samples t-test*

|  |  |  |
| --- | --- | --- |
| t | d | 95% CI |
| 4.25 | 0.30 | [0.16, 0.44] |

*Note.* t, test-statistic; d, Cohen’s d; 95% CI, 95% confidence intervals