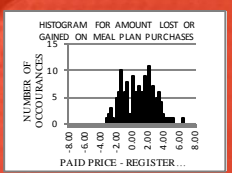# Is [RAND DINING CENTER] Stealing Our Lunch Money?

## Introduction:
We recorded the price, meal plan type, and gender for 159 Vanderbilt students at RAND[1]. We calculated the cost per meal for each meal plan type based on the price for each plan[2]. Using a difference of means hypothesis test, we surprisingly were able to show that students on average gain a dollar on each meal purchase.

## Assumptions:
1. Rand Breakfast and lunch is an accurate predictor of all Rand Meals. We ignored the dinner meals because Rand only serves one dinner a week .
2. An SRS from Mondays and Tuesday accurately represents all meals throughout the week. We had to make this assumption in order to know the students meal plan because the meals left on Monday and Tuesday depicts the meal plan.

---

HISTOGRAM FOR AMOUNT LOST OR GAINED ON MEAL PLAN PURCHASES

NUMBER OF OCCURRENCES

PAID PRICE - REGISTER…

### Test for Normality and Independence
Simple Random Sample? Yes
Independence? Yes, because our sample is less than 10% of the population
Normal? Histogram distribution is not heavily skewed and we have a sample size that is greater than 50

Note: These hold for the Green Tray tests as well and since these tests describe the populations which are the underlying samples for the Orange Trays, the Orange Trays hold as well.

---

### Two Sample Paired Z-Test for Population Mean
**Population**: Vanderbilt Students who eat at RAND using a Vanderbilt Meal Plan
**Sample**: A SRS of students eating at RAND on Mondays and Tuesdays
Define: $\bar{x}_{diff} = \bar{x}_{register\ price} - \bar{x}_{meal\ plan\ price}$
$\bar{x}_{diff} = 1.006$,  $s_{diff} = 2.143469$,  $n = 159$
$H_0: \mu_{diff} = 0$ , Students "break even", i.e. on average, their meal plan cost is the same as the amount they spend at RAND
$H_0: \mu_{diff} > 0$ , Students "make money" on average via the meal plan at RAND.
$$p-value = P(\bar{x}_{diff} > 1.006 \mid \mu_{diff} = 0) = P\left(Z > \frac{1.006-0}{\frac{2.14247}{\sqrt{159}}}\right) = P(Z > 5.92) \rightarrow p \sim .0002$$
This p-value provides statistically significant evidence to reject the view that students just break even on meal plan at RAND on a significance level $\alpha = .05$ and conclude that, in fact, students actually make money on meal plan at RAND.

---

NO, in fact, students "make money" on average.

---

## Do Students Lose Money At Breakfast?
**Two Sample Paired Z-Test for Population Mean**
**Population**: Vanderbilt Students who eat breakfast at RAND using a Meal Plan
**Sample**: A SRS of students eating breakfast at RAND on a Monday
Define: $\bar{x}_{diff} = \bar{x}_{register\ price} - \bar{x}_{meal\ plan\ price}$
$\bar{x}_{diff} = -0.4944286$,  $s_{diff} = 1.433819$,  $n = 70$
$H_0: \mu_{diff} = 0$ , Students "break even" on average at RAND breakfast.
$H_0: \mu_{diff} < 0$ , Students "lose money" on average at RAND breakfast
$pvalue = P(\bar{x}_{diff} < -0.49 \mid \mu_{diff} = 0)$
$= P(Z > \frac{-0.49-0}{\frac{1.4338}{\sqrt{70}}}) = P(Z < -2.89) \rightarrow p = .002$

**YES!**

This p-value provides statistically significant evidence to reject the view that break even on meal plan for breakfast at RAND on a significance level $\alpha = .005$ and conclude that, in fact, students actually lose money on meal plan for breakfast at RAND.

Distribution of Money Gained/Lost for Breakfast

---

## Do Students Make Money At Lunch?
**Two Sample Paired Z-Test for Population Mean**
**Population**: Vanderbilt Students who eat lunch at RAND using a Meal Plan
**Sample**: A SRS of students eating lunch at RAND on a Monday

**YES!**

Define: $\bar{x}_{diff} = \bar{x}_{register\ price} - \bar{x}_{meal\ plan\ price}$
$\bar{x}_{diff} = 2.186742$,  $s_{diff} = 1.85375$,  $n = 89$
$H_0: \mu_{diff} = 0$ , Students "break even" on average at lunch at RAND.
$H_0: \mu_{diff} > 0$ , Students "make money" on average at lunch at RAND.
$pvalue = P(\bar{x}_{diff} > 2.187 \mid \mu_{diff} = 0) = P\left(Z > \frac{2.187-0}{\frac{1.85375}{\sqrt{89}}}\right)$
$= P(Z > 11.13) \rightarrow p \sim .0002$
This p-value provides statistically significant evidence to reject the view that students break even on meal plan for lunch at RAND on a significance level $\alpha = .001$ and conclude that, in fact, students actually make money on meal plan for lunch at RAND.

Distribution of Money Gained/Lost for Lunch

---
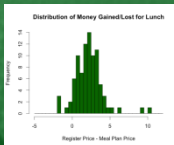
## Do Males Make Money per Meal?
**Two Sample Paired Z-Test for Population Mean**
**Population**: Male Vanderbilt students who eat at RAND using a Meal Plan
**Sample**: A SRS of male students eating at RAND on Mondays /Tuesdays
Define: $\bar{x}_{diff} = \bar{x}_{register\ price} - \bar{x}_{meal\ plan\ price}$
$\bar{x}_{diff} = 1.160556$,  $s_{diff} = 2.103881$,  $n = 90$
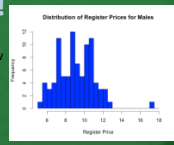$H_0: \mu_{diff} = 0$ , Male students "break even" on average on a RAND meal
$H_0: \mu_{diff} > 0$ , Male students "make money" on average on a RAND meal
$pvalue = P(\bar{x}_{diff} > 1.16 \mid \mu_{diff} = 0) = P\left(Z > \frac{1.16-0}{\frac{2.1038}{\sqrt{90}}}\right)$
$= P(Z > 5.233) \rightarrow p \sim .0002$  **YES!**
This p-value provides statistically significant evidence to reject the view that male students break even on meal plan at RAND on a significance level $\alpha = .001$ and conclude that, in fact, male students actually make money on meal plan at RAND.

Distribution of Register Prices for Males

---

## Do Females Make Money per Meal?
**Two Sample Paired Z-Test for Population Mean**
**Population**: Female Vanderbilt students who eat at RAND using a Meal Plan
**Sample**: A SRS of female students eating at RAND on Mondays and Tuesdays
Define: $\bar{x}_{diff} = \bar{x}_{register\ price} - \bar{x}_{meal\ plan\ price}$
$\bar{x}_{diff} = 0.8052174$,  $s_{diff} = 2.193074$,  $n = 69$
$H_0: \mu_{diff} = 0$ , Female students "break even" on avg on a RAND meal
$H_0: \mu_{diff} > 0$ , Female students "make money" on avg on a RAND meal
$pvalue = P(\bar{x}_{diff} > 0.805 \mid \mu_{diff} = 0) = P\left(Z > \frac{0.805-0}{\frac{2.19307}{\sqrt{69}}}\right)$
$P(Z > 3.05) \rightarrow p = .0011$

This p-value provides statistically significant evidence to reject the view that female students break even on meal plan at RAND on a significance level $\alpha = .005$ and conclude that, in fact, female students actually make money on meal plan at RAND. **YES!**

Distribution of Register Prices for Females

---
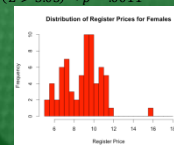
## Is More Money Spent on Breakfast or Lunch?
**Two-Sample Unmatched Difference of Means Z-Test for Population Mean**
**Two Populations** 1. Vandy students who eat RAND lunch on Meal Plan
2. Vandy students who eat RAND breakfast on Meal Plan
**Two Samples**: 1. A SRS of students RAND lunch on Mon
2. SRS of students eating RAND breakfast on Mon/Tues

**YES!**

Lunch sample: $\bar{x} = 10.13685$ s=1.574171 n =89
Breakfast sample: $\bar{x} = 7.51143$ s=1.345214 n = 70
$H_0: \mu_L - \mu_B = 0$ , The register price of a meal is the same on average for breakfast and lunch at RAND
$H_0: \mu_L - \mu_B > 0$ , Lunch register price is greater than breakfast price on average at RAND
$pvalue = P(\bar{x}_L - \bar{x}_B > 2.626 \mid \mu_L - \mu_B = 0)$
$= P\left(Z > \frac{2.63-0}{SE_{L-B}}\right) = P(Z > 5.1) \rightarrow p \sim .0002$
$SE_{L-B} = \sqrt{\frac{s_L^2}{n_L} + \frac{s_B^2}{n_B}} = \sqrt{\frac{1.574^2}{89} + \frac{1.3452^2}{70}} = 0.5184255$

This p-value provides statistically significant evidence to reject the view that a meal is equally expensive at breakfast as at lunch in RAND on a significance level $\alpha = .001$ and conclude that lunch costs more at RAND than breakfast (and thus you'll "get your money's worth" more so at lunch than at breakfast if you're on the meal plan).

---

## Is More Money Spent BY Males or Females?
**Two-Sample Unmatched Difference of Means Z-Test for Population Mean**
**Two Populations**: 1. Male Vanderbilt students who eat at RAND on Meal Plan
2. Female Vanderbilt students who eat at RAND on Meal Plan
**Two Samples**: 1. A SRS of male students eating at RAND
2. SRS of female students eating at RAND on M/T
Male sample: $\bar{x} = 9.103$ s=2.000426 n=90
Female sample: $\bar{x} = 8.821594$ s=1.932 n=69
$H_0: \mu_M - \mu_F = 0$ , Males and Females have the same register price on an average meal plan
$H_0: \mu_M - \mu_F > 0$ , Males have a greater register price for an average meal plan than females
$pvalue = P(\bar{x}_M - \bar{x}_F > .281 \mid \mu_M - \mu_F = 0)$
$= P\left(Z > \frac{.281-0}{SE_{M-F}}\right) = P(Z > .9) \rightarrow p = .1841$
$SE_{M-F} = \sqrt{\frac{s_M^2}{n_M} + \frac{s_F^2}{n_F}} = \sqrt{\frac{2.00042^2}{90} + \frac{1.932^2}{69}} = 0.31394$

This p-value does not provide statistically significant evidence to reject that males and females ring up the same amount on average at RAND on a significance level $\alpha = .001$. Thus, we maintain that males and females meals at RAND cost about the same on average in terms of the price on the register. **NO!**

Register Price Distribution by Gender

---

## Conclusion:
From the price and meal plan type recorded from an SRS of Vanderbilt students, on average, a student's meal plan costs less than the register price of their meal at RAND. And while males and females spend approximately the same amount, students "make money" at RAND lunch, but lose money on breakfast. Thus, despite what everyone has ever told you, listen to statistics and skip breakfast!

## Sources:
[1] Rand Registers
[2] www.vanderbilt.edu/dining/vumealplans.php

**Authors: Curtis Northcutt, Peter York, Hayden Kelly**