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Nakhon Pathom Rajabhat University

CHAPTER 4

RESEARCH METHODOLOGY

ระเบียบวิธีวิจัย

Episode 4.4 Inferential Statistics_(2)

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Inferential Statistics

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สถิติเชิงอนุมาน

Chi-square test

t-test

F-test

T-Test

T-TEST

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- The t-test is used to test the differences in groups of mean
- The t-test can be used when there are two independent groups (e.g., experimental versus control, male versus female)

Degree of freedom (df)

The degree of freedom (df) describes the number of events or observations that are free to vary.

FORMULA

t-Test

$$t = \frac{\overline{X}_A - \overline{X}_B}{\sqrt{\frac{\Sigma_{x_A^2} + \Sigma_{x_B^2}}{n_A + n_B - 2}\left(\frac{1}{n_A} + \frac{1}{n_B}\right)}}$$

Degrees of freedom (df)

$$df = n_A + n_B - 2$$

The t-test basic assumption

1. Data are independent.
2. Data are (approximately) normally distributed.
3. Data have a similar amount of variance within each group being compared (homogeneity of variance).

If data do not fit these assumptions, the researcher can try a nonparametric alternative to the t-test, such as the **Wilcoxon Signed-Rank test** for data with unequal variances.

(Frederick, Faltin, Kenett &Ruggeri, 2012)

Type of t-test

One-sample, two-sample, or paired t-test?

1. If there is one group being **compared against a standard value** (e.g., comparing the acidity of content from the stomach to a pH of 7), perform a **one-sample t-test.**
2. If the groups come from two different populations (e.g., two different groups), perform a two-sample t-test (independent t-test).

This is a between-subjects design.

3. If the groups come from a single population (e.g., measuring before and after an experimental treatment), perform a *paired t-test*.

This is a within-subjects design.

1. One-sample t-test

One-sample t-test— compares the mean of one group against the specified mean generated from a population.

The formula used to obtain one-sample t-test results is:

$$t = \frac{m - \mu}{s/\sqrt{n}}$$

Where, (Frederick, Faltin, Kenett &Ruggeri, 2012)

t = t-statistic

m = mean of the group

μ = theoretical mean value of the population

s = standard deviation of the group

n = sample size

For example, a researcher wishes to figure out the mean level of the systolic blood pressure of all patients and compare the normal criteria of no more than 139 mmHg.

Print out interpretation

If Sig. from SPSS print out < 0.05
Accept H_1 Reject H_0

$H_0: \mu 1 = 139$

$H_1: \mu 1 \neq 139,\ \mu 1 > 139,\ \mu 1 < 139$

The mean level of the systolic blood pressure of all patients was significantly lower than the normal criteria of 139 mmHg. at p-value <.05.

Accept H1

Table Presentation

Variable	Mean	SD	Criteria	t	P-value
Systolic blood pressure	123	2.40	139	3.325	<.001**

2. An Independent two-sample t-test

An Independent two-sample t-test is used to analyze the mean comparison of two independent groups.

The T-test formula used to calculate this is:

$$t = \frac{m_A - m_B}{\frac{\sqrt{s^2}}{\sqrt{n_A}} + \frac{\sqrt{s^2}}{\sqrt{n_B}}}$$

(Frederick, Faltin, Kenett &Ruggeri, 2012)

Where,

mA – mB = means of samples from two different groups or populations

nA – nB = respective sample sizes

s2 = standard deviation or common variance of two samples

For example, if a researcher wants to compare the mean level of the systolic blood pressure of male patients and female patients.

Hypothesis

If Sig. from SPSS print out < 0.05
Accept H_1 Reject H_0

$$H_0 : \mu 1 = \mu_2$$

$$H_1 : \mu 1 \neq \mu_2 \, , \; \mu 1 > \mu 2, \; \mu 1 < \mu 2$$

Interpretation

Reject H_1 Accept H_0

Case 1 Equal variances assume

Independent Samples Test

		Levene's Test for Equality of Variances		t		
		F	Sig.	t	df	Sig. (2-tailed)
post	Equal variances assumed	.153	.697	1.769	122	.079
	Equal variances not assumed			1.765	116.492	.080

Case 2 Equal variances not assume

Independent Samples Test

		Levene's Test for Equality of Variances		t		
		F	Sig.	t	df	Sig. (2-tailed)
CLEAR	Equal variances assumed	6.071	.014	-.136	390	.892
	Equal variances not assumed			-.141	372.530	.888

Example of Presentation Table

Table 2. Comparison of self-care behaviors between the experimental group and the comparison group in the period before and after the experiment using independent t-test (n = 60).

Time	Experimental group (n = 30)		Comparison group (n = 30)		t	p-value
	M	SD	M	SD		
Before experiment	121.23	11.60	120.57	13.59	0.204	.839
After experiment	145.30	6.90	136.57	14.49	**2.980**	**.005**

Before the experiment, pregnant women with diabetes in the experimental group and the comparison group had no difference in self-care behavior (t = 0.204).

After the experiment, pregnant women with diabetes in the experimental group had self-care behaviors higher than the comparison group (t = 2.980) at statistical significance at the .05 level.

(Pasuwan, Waelveerakup, Tepsuwan, Netpinyo, Chayathab, Wichientanont, 2023)

3. Paired sample t-test

- Compares the means of two measurements taken from the same individuals, objects, or related units.

The formula used to obtain the t-value is:

$$t = \frac{m}{s/\sqrt{n}}$$

Where,
T = t-statistic
m = mean of the group
= theoretical mean value of the population
s = standard deviation of the group
n = sample size

(Frederick, Faltin, Kenett &Ruggeri, 2012)

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
SCORE	1	6	52.83	2.229	.910
	2	6	47.50	1.871	.764

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SCORE	Equal variances assumed	.385	.549	4.490	10	.001	5.33	1.188	2.687	7.980
	Equal variances not assumed			4.490	9.709	.001	5.33	1.188	2.676	7.991

$$H_0 : \mu_{male} = \mu_{female}$$

$$H_1 : \mu_{male} \neq \mu_{female}$$

P-Value = Sig.(2-tailed) = 0.001

Example of Table Presentation

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Table 1: Comparison of self-care behaviors before and after the experimental group and the comparison group using Paired t-test (n = 30).

Set sig < .05

Group		**Before Intervention**		**After Intervention**		t	p-value
	n	M	SD	M	SD		
Experimental	30	121.23	11.60	145.30	6.90	**9.991**	**< .001**
Comparison	30	120.57	13.59	136.57	14.49	**6.018**	**< .001**

After the experiment, pregnant women with diabetes in the experimental group and the comparison group had self-care behaviors significantly higher than before the experiment at the .05 level (t = 9.991 and t = 6.018, respectively) (Table 1).

(Pasuwan, Waelveerakup, Tepsuwan, Netpinyo, Chayathab, Wichientanont, 2023)

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F-test

(Analysis of Variance)
(ANOVA)

TYPES of ANOVA

One-way ANOVA

It is used with one independent variable and one dependent variable.

Two-way ANOVA or Factorial Analysis of Variance

Factorial analysis of variance permits the investigator to analyze the effects of two or more independent variables on the dependent variable.

Formulas

MEAN SQUARE (MS)

$$MS_B = \frac{SS_B}{df_B} \qquad MS_W = \frac{SS_W}{df_W}$$

F- Ratio

$$F = \frac{MS_B}{MS_W}$$

(Frederick, Faltin, Kenett &Ruggeri, 2012)

ANOVA Assumptions

There are three primary assumptions in ANOVA:

1. The responses for each factor level have a normal population distribution.
2. These distributions have the same variance.
3. The data are independent.

(Frederick, Faltin, Kenett &Ruggeri, 2012)

Hypothesis

A null hypothesis (H0):
There is no difference between the groups or means.

An alternative hypothesis (H1):
There is a difference between groups and means.

If Sig. from SPSS print out < 0.05
Accept H_1 Reject H_0

$$H_0 : \mu 1 = \mu 2 = \mu 3$$

$$H_1 : \mu 1 \neq \mu 2 \neq \mu 3$$

Descriptives

SCORE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	4	5.00	.816	.408	3.70	6.30	4	6
2	4	6.25	.957	.479	4.73	7.77	5	7
3	4	8.50	.577	.289	7.58	9.42	8	9
Total	12	6.58	1.676	.484	5.52	7.65	4	9

ANOVA

SCORE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25.167	2	12.583	19.696	.001
Within Groups	5.750	9	.639		
Total	30.917	11			

Multiple Comparisons

Dependent Variable: SCORE

LSD

(I) LEVEL	(J) LEVEL	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-1.25	.565	.054	-2.53	.03
	3	-3.50*	.565	.000	-4.78	-2.22
2	1	1.25	.565	.054	-.03	2.53
	3	-2.25*	.565	.003	-3.53	-.97
3	1	3.50*	.565	.000	2.22	4.78
	2	2.25*	.565	.003	.97	3.53

*. The mean difference is significant at the .05 level.

Example of Table Presentation

ANOVA

distancing

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6416.293	4	1604.073	.821	.519
Within Groups	87967.727	45	1954.838		
Total	94384.020	49			

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Inferential statistics

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Chi-square test

t-test

F-test

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Thank you

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