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Section 1

MANE 6313

Subsection 1

Week 2, Module I

Student Learning Outcome

Analyze simple comparative experiments and experiments with a single factor.

Module Learning Outcome

Analyze a paired t -test.

Example: Paired t-test¹

10-55.  Ten individuals have participated in a diet-modification program to stimulate weight loss. Their weight both before and after participation in the program is shown in the following list.

Subject	Before	After
1	195	187
2	213	195
3	247	221
4	201	190
5	187	175
6	210	197
7	215	199
8	246	221
9	294	278
10	310	285

- Is there evidence to support the claim that this particular diet-modification program is effective in producing a mean weight reduction? Use $\alpha = 0.05$.
- Is there evidence to support the claim that this particular diet-modification program will result in a mean weight loss of at least 10 pounds? Use $\alpha = 0.05$.
- Suppose that, if the diet-modification program results in mean weight loss of at least 10 pounds, it is important to

Selecting Difference

$$d_1 = \text{before} - \text{after}$$
$$\text{--- } d_2 = \text{--- after --- before}$$

$$-d_1 = d_2$$
$$d_1 = -d_2$$

before > after

↓

$$\text{before} - \text{after} > \text{after} - \text{after} = 0$$

$$\text{before} - \text{after} > 0$$

Classical Approach

$$H_0: \mu_d = 0$$

$$H_1: \mu_d > 0 \quad (\alpha = .05)$$

WORKSHEET 3

Descriptive Statistics: d1 $\Rightarrow$ before - after

Statistics

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
d1	10	0	17.00	2.03	6.41	8.00	11.75	16.00	25.00	26.00

$$TS: \quad t_0 = \frac{\bar{X}_d - \mu_{d_0}}{s_d / \sqrt{n}} = \frac{17 - 0}{6.41 / \sqrt{10}} = 8.3867$$

Rejection Region & Conclusion^a

^aMontgomery and Runger (2014). *Applied Statistics and Probability for Engineers*, 6th edition. John Wiley & Sons.

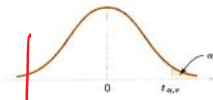
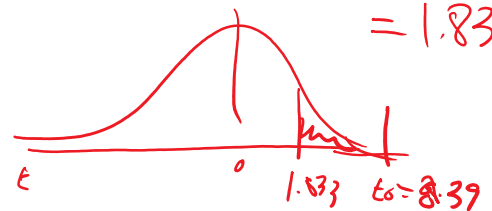


TABLE • V Percentage Points $t_{\alpha, \nu}$ of the t Distribution

α	.40	.25	.10	.05	.025	.01	.005	.0025	.001	.0005
1	.325	1.000	3.078	6.314	12.706	31.821	63.657	127.32	318.31	636.62
2	.289	.816	1.886	2.920	4.303	6.965	9.925	14.089	23.326	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	7.453	10.213	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	.265	.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	.261	.703	1.385	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	.260	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674

Reject H_0 if
 $t_0 > t_{\alpha, n-1} = t_{.05, 9}$
 $= 1.833$



Conclusion: Reject
 H_0 , mean weight
 after weight modification
 is lower than before

Paired t-Test using Minitab

WORKSHEET 3

Paired T-Test and CI: before, after

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
before	10	231.8	41.9	13.3
after	10	214.8	37.9	12.0

Estimation for Paired Difference

Mean	StDev	SE Mean	95% Lower Bound for $\mu_{\text{difference}}$
17.00	6.41	2.03	13.28

$\mu_{\text{difference}}$: population mean of (before - after)

Test

Null hypothesis	$H_0: \mu_{\text{difference}} = 0$
Alternative hypothesis	$H_1: \mu_{\text{difference}} > 0$

