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The Office of Research for Medical Students

Summer 2020 Research Analysis and Statistics Presentation

with:

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July 30, 2020 1PM
Webinar

A QUICK INTRODUCTION TO BASIC STATISTICAL TESTS

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OBJECTIVES

- Quick overview of variable types
- How Variable types are measured
- Review of for BASIC but COMMON inferential statistical tests
  - Pearson Correlation
  - T-Test
  - ANOVA
  - “Chi-squared” (χ^2)
- SPSS – Statistical Package for the Social Sciences

VARIABLE DEFINITION

Your research question(s) should inherently imply your analytic approach, variables etc.

See:

https://cirt.gcu.edu/research/developmentresources/tutorials/question

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VARIABLE TYPES

- Continuous -
  - Interval – measurable in a continuum
  - Ratio – like an interval, but interval contains 0, and 0 implies "none"

- Categorical – numbers describe categories
  - Nominal – no implied order (e.g. AA/Asian/White/AIAN etc.)
  - Dichotomous – a type of nominal that implies only two states (e.g. Female/Male)
    - A "Dummy Variable" is dichotomized into 1 and 0, with presence or absence of a state implied
  - Ordinal – there is an implied ranking in the order, but the relationship between ranks is not a ratio (e.g. Likert Scale)

VARIABLE TYPES, CONTINUED

- Nominal by Nominal (e.g. Treatment yes/no by Cure yes/no)
  - "Chi-squared" χ^2
  - Fisher's Exact Test (when sample or categories are very small)

- Continuous by Nominal
  - T-Test - Comparing mean of two groups
  - Analysis of Variance – comparing means across more that two groups
  - Ordinal – can be treated like a continuous variable in many cases (and we often do! Think of Likert Scales on surveys)

- Continuous by Continuous
  - Correlation – Tests the extent to which one variable changes with another
  - Pearson – best for linear relationships
  - Spearman – better for ordinal or non-linear relationships

TODAY'S DEMONSTRATION

- <u>Continuous by Continuous</u> - Pearson Correlation
- <u>Continuous by Nominal</u>
  - T-Test - Comparing mean of two groups
  - Analysis of Variance – comparing means across more that two groups
- <u>Nominal by Nominal</u> - "Chi-square" χ^2

FIRST – THE DATA

SPSS

- We will be using SPSS – available on all (most?) Upstate computers.
- There are also student annual licenses available.
- GUI-driven, but can also run on code.
- https://www.ibm.com/us-en/marketplace/spss-statistics-gradpack/details#product-header-top

Data Set

- From ***Biostatistics: An Applied Introduction for the Public Health Practitioner | 1st Edition |Heather M. Bush***
- https://www.cengage.com/c/biostatistics-an-applied-introduction-for-the-public-health-practitioner-1e-bush/9781111035143/
- 995 pregnant women from a large farming community
- ***See write-up and data set***

TODAY'S DEMONSTRATION

- **Continuous by Continuous - Pearson Correlation**

A Pearson correlation is a number between -1 and 1 that indicates the extent to which two variables are linearly related. The Pearson correlation is also known as the "product moment correlation coefficient" (**PMCC**) or simply "**correlation**".

Pearson correlations are suitable only for metric variables (which include dichotomous variables).
•For **ordinal variables**, use the Spearman correlation or Kendall's tau and
•for **nominal variables**, use Cramér's V.

From: https://www.spss-tutorials.com/pearson-correlation-coefficient/

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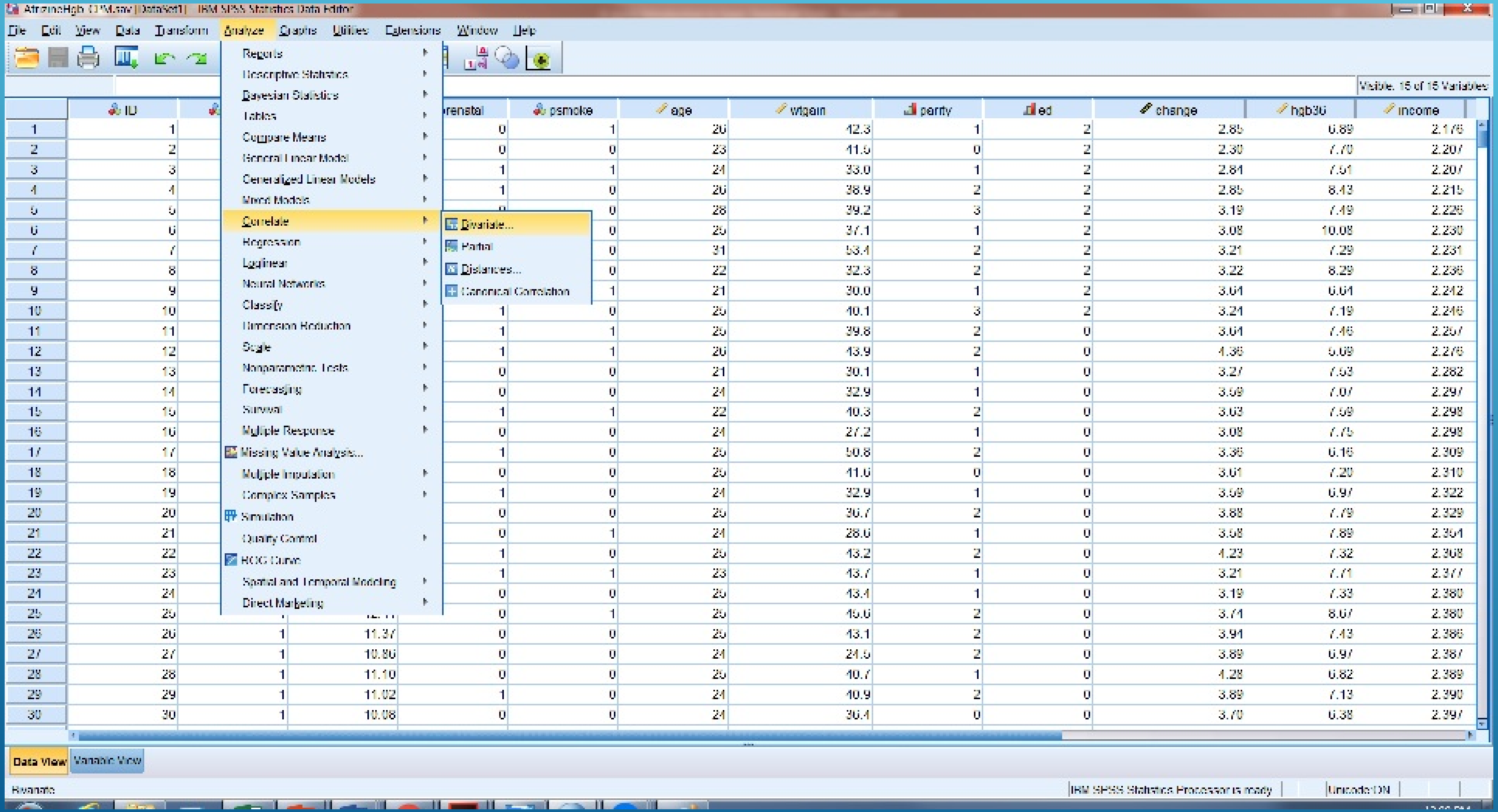
PEARSON CORRELATION

- **Continuous by Continuous - Pearson Correlation**



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PEARSON CORRELATION

- **<u>Continuous by Continuous</u> - Pearson Correlation**

		Week 9 Hemglobin (g/dL)	Week 36 Hemoglobin (g/dL)	Age at Initial Visit (Yrs)	Annual Household Income (USD, Thousands)	Number of previous births	Educational Attainment
Week 9 Hemglobin (g/dL)	Pearson Correlation	1	.766**	.076*	.012	.015	.083**
	Sig. (2-tailed)		.000	.017	.708	.641	.010
	N	979	979	979	975	979	979
Week 36 Hemoglobin (g/dL)	Pearson Correlation	.766**	1	.351**	.078*	-.143**	.340**
	Sig. (2-tailed)	.000		.000	.015	.000	.000
	N	979	979	979	975	979	979
Age at Initial Visit (Yrs)	Pearson Correlation	.076*	.351**	1	.083**	-.052	.162**
	Sig. (2-tailed)	.017	.000		.010	.105	.000
	N	979	979	979	975	979	979
Annual Household Income (USD, Thousands)	Pearson Correlation	.012	.078*	.083**	1	-.043	.273**
	Sig. (2-tailed)	.708	.015	.010		.179	.000
	N	975	975	975	975	975	975
Number of previous births	Pearson Correlation	.015	-.143**	-.052	-.043	1	-.038
	Sig. (2-tailed)	.641	.000	.105	.179		.241
	N	979	979	979	975	979	979
Educational Attainment	Pearson Correlation	.083**	.340**	.162**	.273**	-.038	1
	Sig. (2-tailed)	.010	.000	.000	.000	.241	
	N	979	979	979	975	979	979

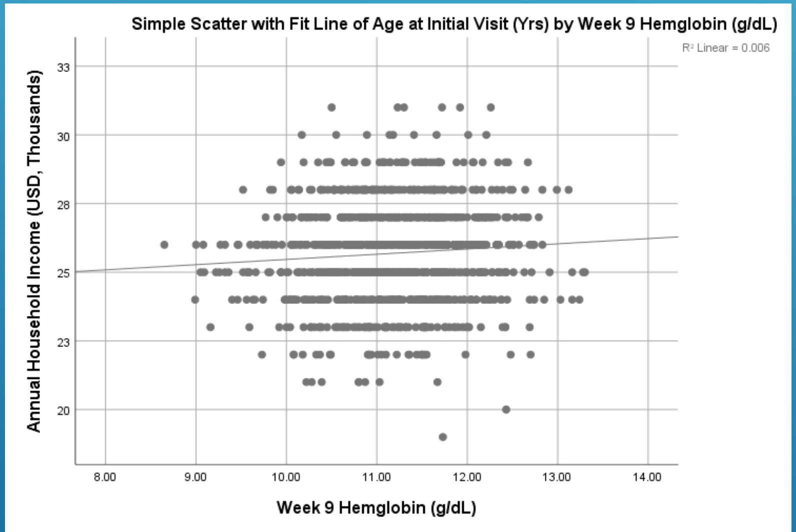
**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

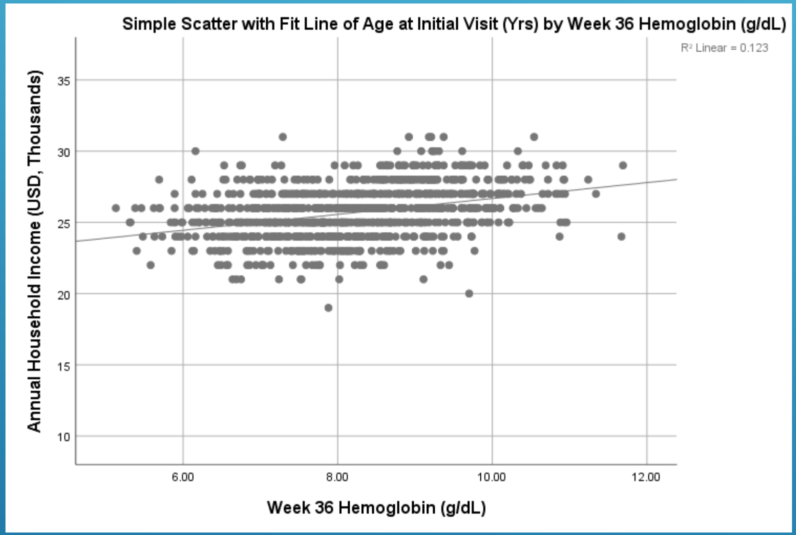
PEARSON CORRELATION

- **<u>Continuous by Continuous</u> - Pearson Correlation (What does this LOOK like, graphically?)**

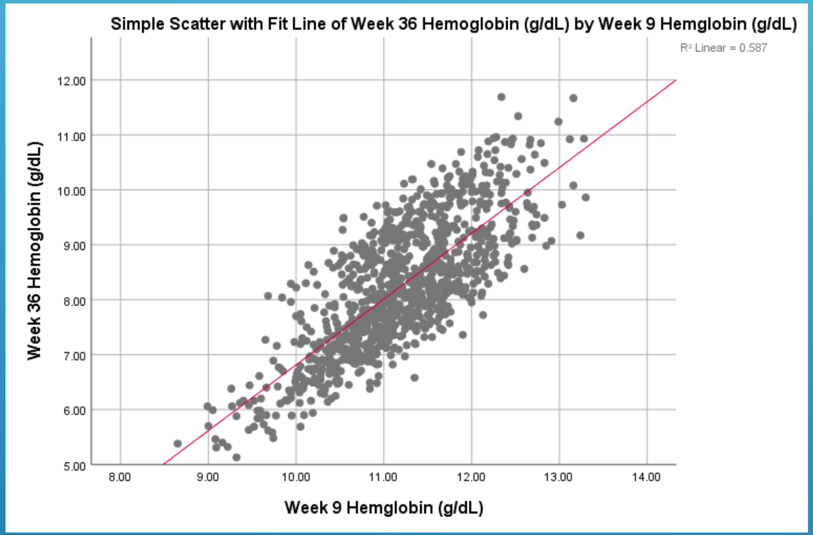
r =.012, p=.708



r =.078, p<.015

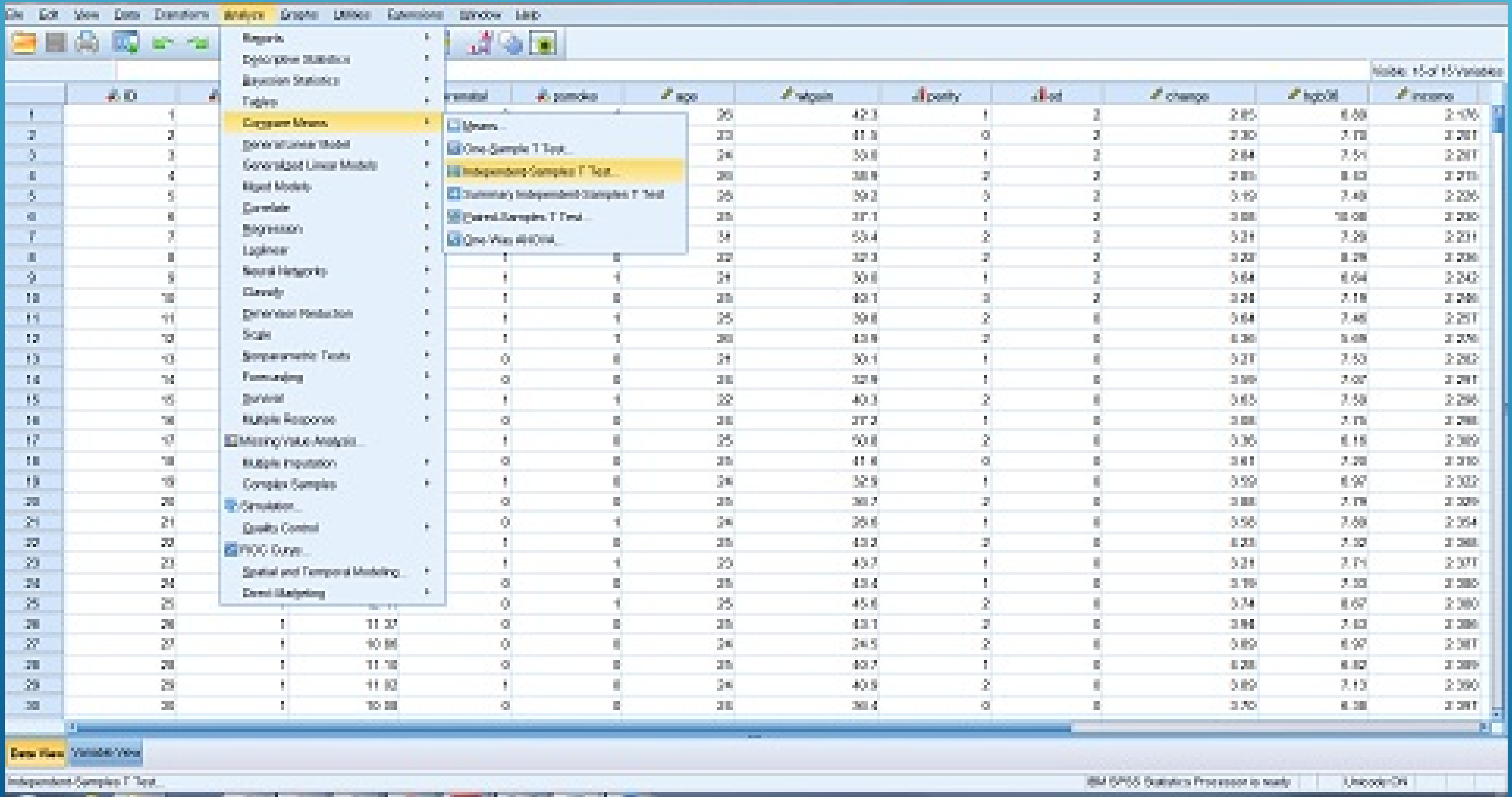


r =.766, p<.001



COMPARISON OF MEANS – T-TEST

- **Continuous by Nominal**
  - T-Test - Comparing Hemoglobin at week 36 across pre-pregnancy smoking status
  - So your two groups have different means. Are they REALLY different, or simply different by chance?



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COMPARISON OF MEANS – T-TEST

- **Continuous by Nominal**
  - **T-Test - Comparing Hemoglobin at week 36 across pre-pregnancy smoking status**
  - **So your two groups have different means. Are they REALLY different, or simply different by chance?**

Group Statistics

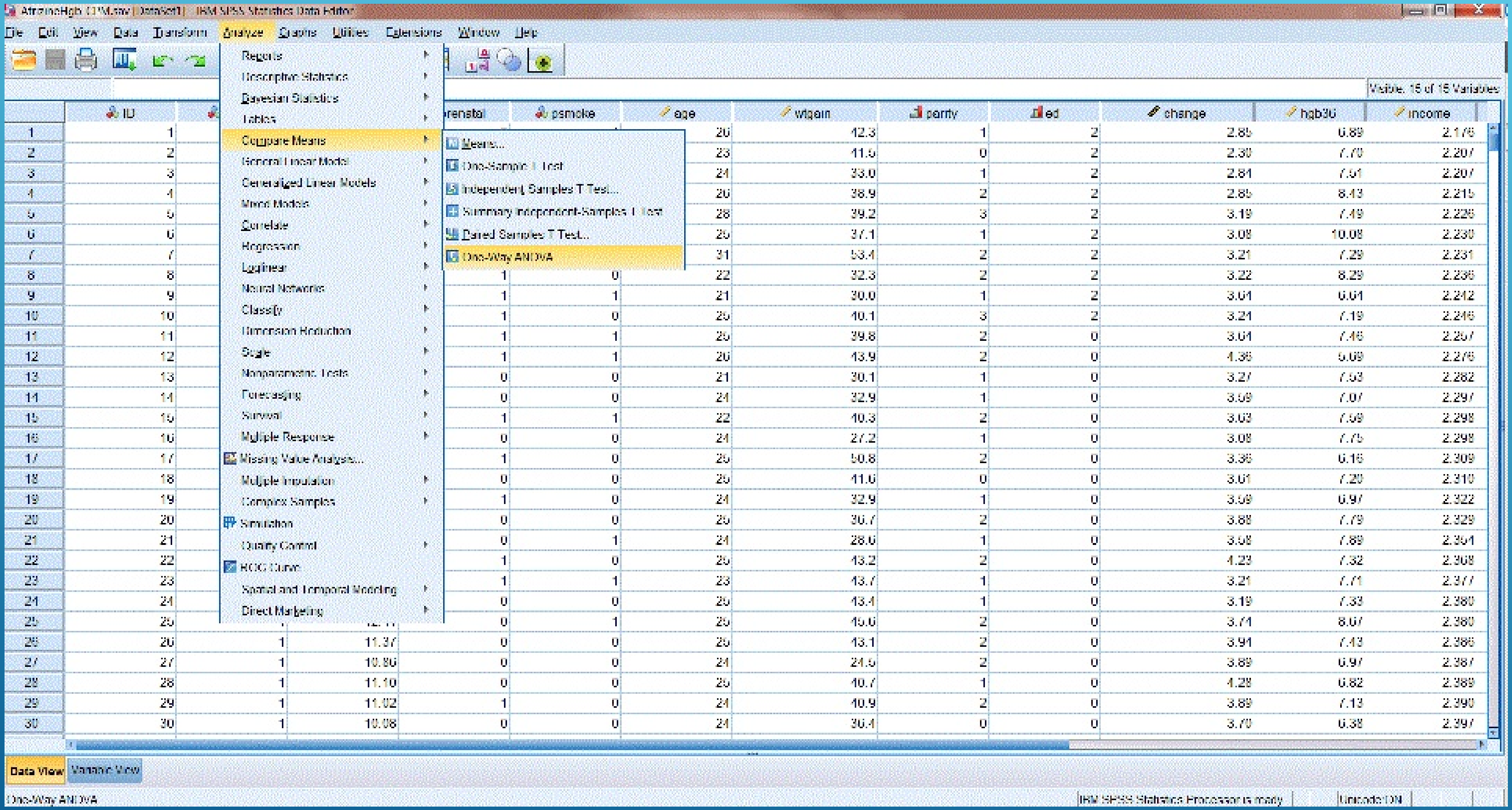
	Pre-Pregnancy Smoker	N	Mean	Std. Deviation	Std. Error Mean
Week 36 Hemoglobin (g/dL)	No	741	**8.3524**	1.16342	.04274
	Yes	238	**7.8314**	1.09255	.07082

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval Lower	95% Confidence Interval Upper
Week 36 Hemoglobin (g/dL)	Equal variances assumed	.751	.386	**6.098**	977	**.000**	.52095	.08543	.35330	.68860
	Equal variances not assumed			**6.298**	423.097	**.000**	.52095	.08272	.35836	.68353

COMPARISON OF MEANS - ANOVA

- **<u>Continuous by Nominal - *Analysis of Variance*</u> – comparing means across more that two groups**



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COMPARISON OF MEANS - ANOVA

- **Continuous by Nominal - *Analysis of Variance* – comparing means across more that two groups**

Descriptives

Week 36 Hemoglobin (g/dL)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Tap Water Only	270	**7.2596**	.85532	.05205	7.1571	7.3620	5.31	10.08
Bottled/Filtered Water Only	315	**9.3904**	.75322	.04244	9.3069	9.4739	7.09	11.69
Combination of Tab and Bottled/Filtered	394	**7.9566**	.79853	.04023	7.8776	8.0357	5.13	9.86
Total	979	**8.2257**	1.16765	.03732	8.1525	8.2990	5.13	11.69

ANOVA

Week 36 Hemoglobin (g/dL)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	707.887	2	353.943	**552.247**	**.000**
Within Groups	625.533	976	.641		
Total	1333.420	978			

Post Hoc Tests Multiple Comparisons - Tukey HSD

Dependent Variable: Week 36 Hemoglobin (g/dL)

(I) Water Consumption Group	(J) Water Consumption Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Tap Water Only	Bottled/Filtered Water Only	-2.13089*	.06640	.000	-2.2867	-1.9750
	Combination of Tab and Bottled/Filtered	-.69709*	.06325	.000	-.8456	-.5486
Bottled/Filtered Water Only	Tap Water Only	2.13089*	.06640	.000	1.9750	2.2867
	Combination of Tab and Bottled/Filtered	1.43379*	.06051	.000	1.2918	1.5758
Combination of Tab and Bottled/Filtered	Tap Water Only	.69709*	.06325	.000	.5486	.8456
	Bottled/Filtered Water Only	-1.43379*	.06051	.000	-1.5758	-1.2918

*. The mean difference is significant at the 0.05 level.

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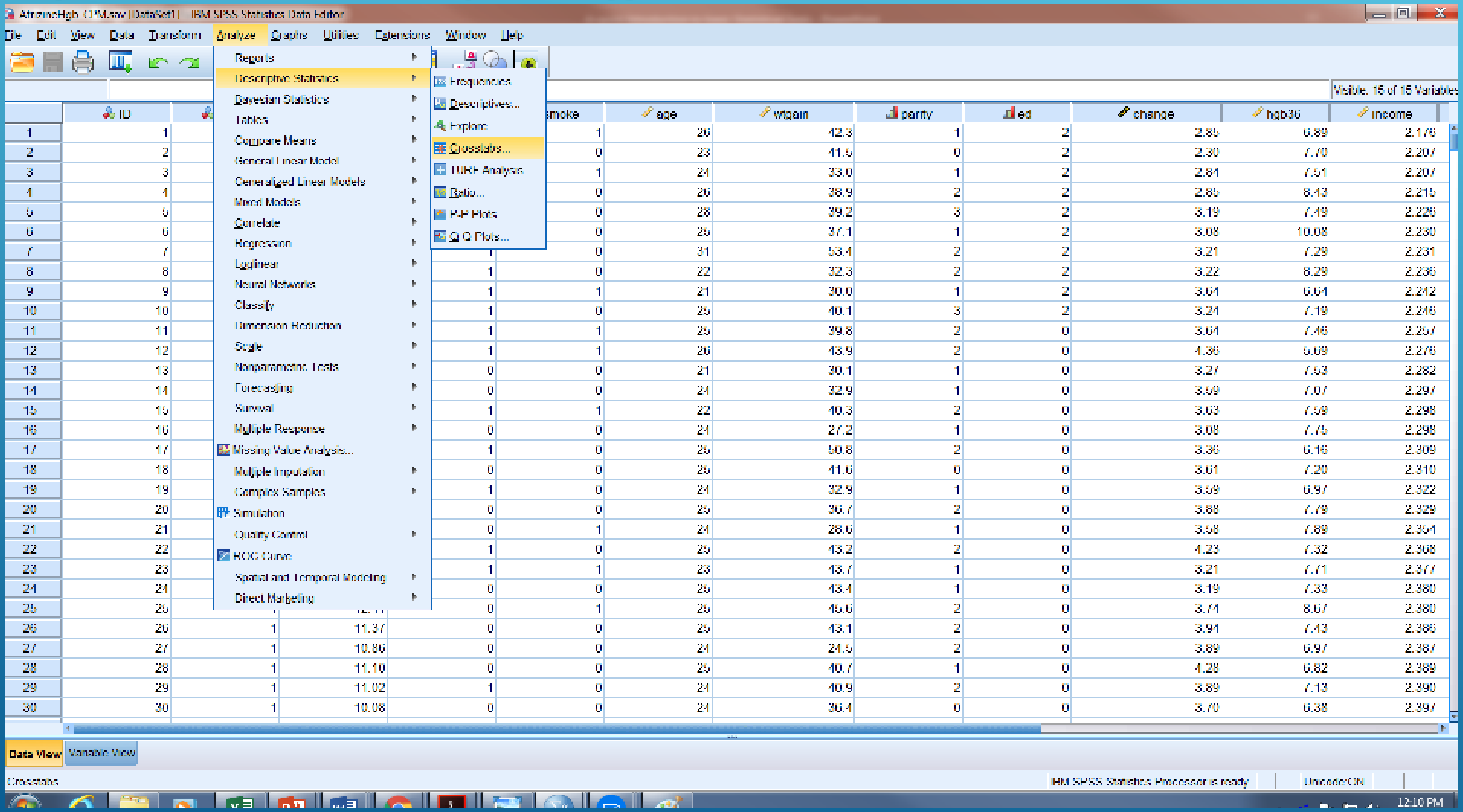
TODAY'S DEMONSTRATION

- **Nominal by Nominal** - "Chi-square" χ^2



TODAY'S DEMONSTRATION

- **Nominal by Nominal - "Chi-square" χ^2**
  - **Comparison of *proportions* across categories**
  - **Best used in 2 x 2, as that is easiest to interpret**

Crosstab

			Pre-Pregnancy Smoker		
			No	Yes	Total
Tap Water Only	.00	Count	558	151	709
		% within Tap Water Only	78.7%	21.3%	100.0%
	1.00	Count	183	87	270
		% within Tap Water Only	67.8%	32.2%	100.0%
Total		Count	741	238	979
		% within Tap Water Only	75.7%	24.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.683[a]	1	.000		
Continuity Correction[b]	12.096	1	.001		
Likelihood Ratio	12.219	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	12.670	1	.000		
N of Valid Cases	979				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 65.64.

b. Computed only for a 2x2 table

FOR DEEPER STUDY

- "SPSS Tutorials" site here: https://www.spss-tutorials.com/
  - I can't really vouch for what it is or who runs it (some ads are blocked by McAfee). As an intro to SPSS, it's a place to start. I would recommend people can open the lessons (anywhere it says "Read"), but be careful about opening any links. I would ONLY click on the links that lead to the lessons - NOTHING that looks like an advertisement or a link off the site. A few pointers:
    - -- Types of variables
    - -- How to set up a raw data table for analysis
    - -- A hypothesis (significance) test
    - -- Correlations (mostly Pearson)
    - -- T-test (learn the z-test if you must, but the t-test is far more widely used)
    - -- Analysis of Variance (ANOVA) - basically an extension of the t-test
    - -- Chi square - for analyzing categorical by categorical variables
  - Those feeling adventurous can start looking at regression, but most learners can get to poster stage if they can run, interpret, and explain the variables above

FOR DEEPER STUDY

- **Khan Academy:**
  - https://www.khanacademy.org/math/statistics-probability
  - **A free online statistics course**
- **Statistical Solutions Inc:**
  - https://www.statisticssolutions.com/directory-of-statistical-analyses/
  - **Designed to offer dissertation consultation, but lots of free and VERY straightforward directions**
- **Social Research Methods:**
  - http://socialresearchmethods.
  - **Not statistics, but a great guide for study design, foundations of research methods, etc.**

FINAL TIPS

- Partner with people who complement your skills
- If funding available: consult with the Center for Research & Evaluation (CRE)
  - http://www.upstate.edu/publichealth/research/cre/index.php
  - Please be aware there are charges ($110/hr after consultation) – speak w/ faculty about funding