MAT5317 Categorical Assignment 1

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Introduction

We were given the data set of The National Health and Nutrition Examination Survey (NHANES). The survey program has been conducted as a series of surveys designed to assess the health and nutritional status of adults and children in the United States since the 1960s, according to CDC (2023). It combines in-person face-to-face interviews and physical examinations of participants for data collection.

The survey data wasn't a simple random sample, however. According to CDC's National Health and Nutrition Examination Survey: Plan and Operations, 1999–2010 (G et al. 2013), the sampling strategy consists of several stages: 1. Selection of counties as primary sampling units (PSU). 2. selection of segments within PSUs that constitute blocks of households. 3. Selection of specific households within segments. 4. Selection of individuals within a household.

We aim to study the relationship between the weight variable and the other health related variables of the data.

Method

We began our study by doing an exploratory analysis among the variables through various tables and charts. We then performed several hypothesis tests on some of the variables. Lastly we did a linear regression model fit to the response variable "weight" with other variables and confounders.

Part 1: Exploratory Analysis

We began our analysis by giving a data dictionary of the data shown in Table 1 below. As one can see that some variables have a high percentage of missing values. In Part 2 we made hypothesis tests to decide if some of these variables could be excluded from the regression analysis in Part 3.

The weight variable was a continuous random variable in our data. A simple way of categorizing it was to consider the BMI indicator. As one could see there was an obese variable in the data. The weight variable was categorized by giving a threshold of 35 to the BMI value. A person is considered healthy if the BMI is below 35, and obese otherwise. Therefore, we used the obese variable as the categorical random variable in our project.

Table 1: Data Variable Definition

Variables	Type	Example	Number.Unique	MissingPct	Comment
id	integer	1, 2, 3	6482	0%	Identification Code (1 - 6482)
gender	factor	Male, Female	2	0%	Gender (1: Male, 2: Female)
age	integer	34, 16, 60	65	0%	Age (Years)
marstat	factor	Married, NA, Widowed	6	9.7%	Marital Status (1: Married, 2: Widowed, 3: Divorced, 4: Separated, 5: Never Married, 6: Living Together)
samplewt	numeric	80100.544, 13953.078, 20090.339	2499	0%	Statistical Weight (4084.478 - 153810.3)
psu	integer	1, 2	2	0%	Pseudo-PSU (1, 2)
strata	integer	9, 10, 1	15	0%	Pseudo-Stratum (1 - 15)
tchol	integer	135, 192, 202	251	6.09%	Total Cholesterol (mg/dL)
hdl	integer	50, 60, 45	112	6.09%	HDL-Cholesterol (mg/dL)
sysbp	integer	114, 112, 154	61	8.53%	Systolic Blood Pressure (mm Hg)
dbp	integer	88, 62, 70	40	9.16%	Diastolic Blood Pressure (mm Hg)
wt	numeric	87.400002, 72.300003, 116.8	957	0.57%	Weight (kg)
ht	numeric	164.7, 181.3, 166	527	0.57%	Standing Height (cm)
bmi	numeric	32.22, 22, 42.39	2276	0.57%	Body mass Index (Kg/m^2)
vigwrk	factor	No, Yes, NA	2	0.02%	Vigorous Work Activity (1: Yes, 2: No)
modwrk	factor	No, Yes, NA	2	0.02%	Moderate Work Activity (1: Yes, 2: No)
wlkbik	factor	No, Yes, NA	2	0.02%	Walk or Bicycle (1: Yes, 2: No)
vigrecexr	factor	No, Yes, NA	2	0.02%	Vigorous Recreational Activities (1: Yes, 2: No)
modrecexr	factor	No, Yes, NA	2	0.03%	Moderate Recreational Activities (1: Yes, 2: No)
sedmin	integer	480, 240, 720	37	1.22%	Minutes of Sedentary Activity per Week (0 - 840)
obese	factor	No, Yes, NA	2	0.57%	BMI>35 (1: No, 2: Yes)

Part 2: Hypothesis Tests

We first test the independence between obesity and marital status. We form the following contingency table:

Table 2: Contingency Table

		Obesity	
		No	Yes
Marital Status	Married	2530	474
	Widowed	418	86
	Divorced	528	112
	Separated	158	35
	Never Married	863	160
	Living Together	388	66

Let X be the categorical random variable for Marital Status and Y be the one for Obesity. Define the count random variable $N_{ij} := \sum_{i=1}^{I} \sum_{j=1}^{J} \mathbb{I}(X = i, Y = j)$, then the joint random variables $[N_{11}, ..., N_{IJ}]$ has a Multinomial distribution $\vec{p} = [p_{11}, ..., p_{IJ}]$. Our hypothesis test is therefore:

$$H_0 : p_{ij} = p_{i.} \cdot p_{.j} \ \forall i, j$$
$$H_1 : p_{ij} \neq p_{i.} \cdot p_{.j} \ \forall i, j$$

We use the chi-squared test to conclude that there is not enough evidence to reject the null hypothesis with a p-value equal to 0.689. In other words, we cannot conclude that there is a relationship between obesity and marital status.

We do the same test for other variables compared with obesity:

From Table 2 we can see that we can reject the independence between obesity and wlkbik, vigrecexr and modrecexr variables.

Table 3: p-values of Independence Tests between Different Variables and Obesity

	vigwrk	modwrk	wlkbik	vigrecexr	modrecexr
p-value	0.569	0.304	0	0	0

Part 3: Regression Analysis

Conclusion

References

2023. https://www.cdc.gov/nchs/nhanes/about_nhanes.htm.

G, Zipf, Chiappa M, Porter KS, et al. 2013. "National Health and Nutrition Examination Survey: Plan and Operations, 1999–2010." *National Center for Health Statistics* 1 (56).