Blood Pressure Analysis

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Research Question:

How does physical activity affect blood pressure after controlling for demographic information, BMI and smoking/alcohol use?

Data Description

Our data came from the National Health and Nutrition Examination Survey (NHANES) from 2017-2018. This survey is a major program of studies designed to assess the health and nutritional status of adults and children in the United States. It combines demographic and health interviews with physical examinations and lab tests to collect the data.

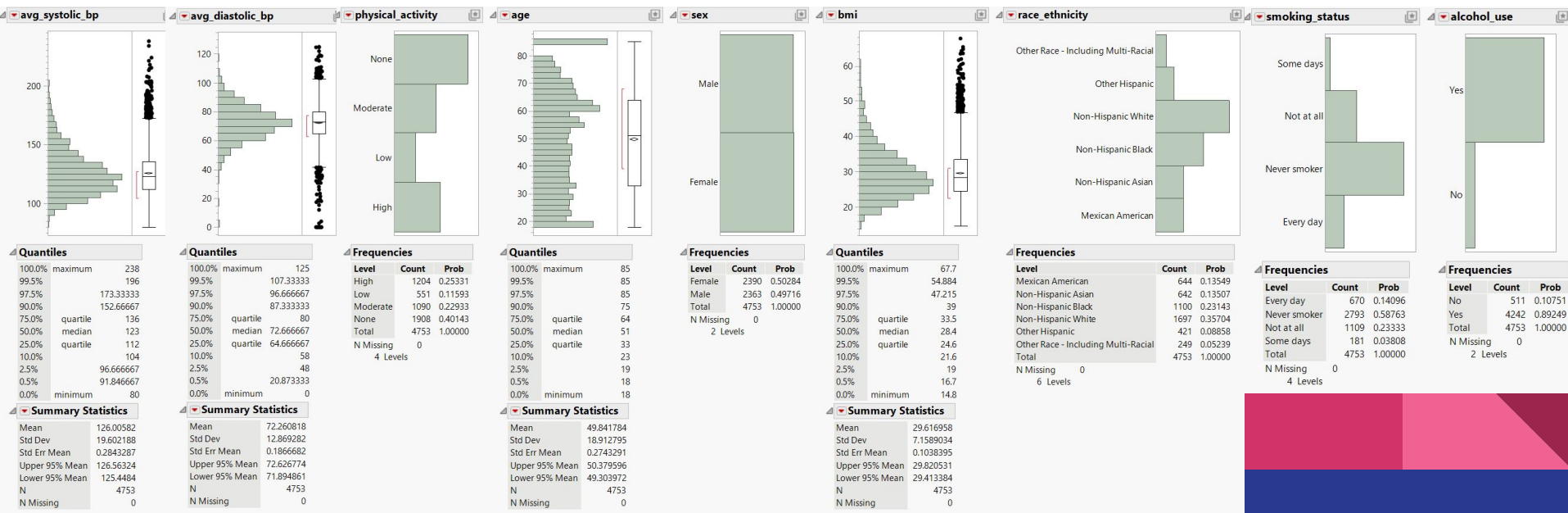We used the following variables (some that we combined/created):

- Responses
    - Systolic blood pressure (Continuous)
    - Diastolic blood pressure (Continuous)
- Treatment
    - Physical activity (Nominal - 4 levels)
- Covariates
    - Age (Continuous)
    - Sex (Nominal)
    - Race/ethnicity (Nominal)
    - BMI (Continuous)
    - Smoking status (Nominal)
    - Alcohol use (Nominal)
- Systolic and diastolic blood pressure were recorded separately. Thus, we run two analyses, one on each type of blood pressure. Systolic and diastolic are our two outcomes.
    - Systolic - measures pressure in arteries when heart beats and pumps blood out to your body (top number)
        - Major risk factor for cardiovascular disease, especially in older adults
    - Diastolic - measures pressure in arteries when heart rests between beats and refills with blood (bottom number)

Data Preparation

- This dataset was imported, prepped, and cleaned using R.
- Blood pressure was recorded at three different intervals. For analysis purposes, we created one factor that averaged the three recordings.
- There are over 200 recorded variables in the 2017-2018 survey. As seen by our research question, we only wanted variables about blood pressure, physical activity, and possible covariates.
- As a result, we intuitively removed all variables not related to one of these categories.
- Additionally, we only used data points with complete data. This still left us with 4,753 data points to analyze.
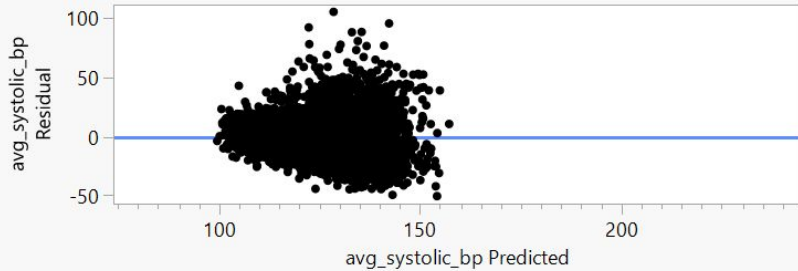- Finally, we renamed the variables to be easier to read.

Exploratory Data Analysis

- We re-coded ages 80+ to be the weighted mean age for ages 80+, 85 (stated in NHANES documentation). This is because the original dataset sets a ceiling age of 80 which underestimates the true age of the oldest participants. This change treats the 80+ group as having an average age of 85 which is statistically more accurate for regression
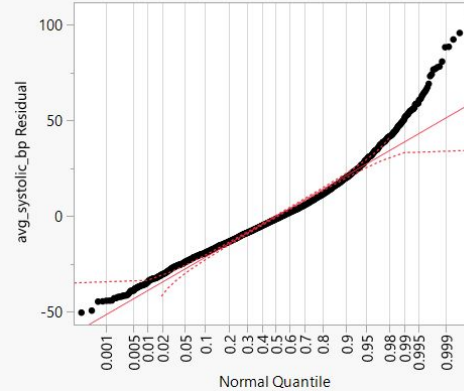
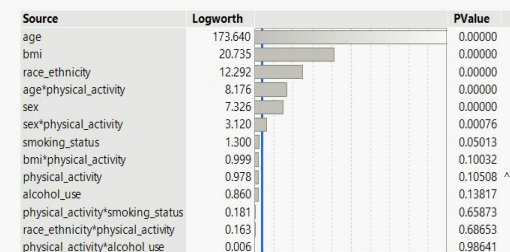# Assumptions Check: Systolic

- Looking at the residual QQ plot, we can see that while not perfectly normal, the skewness is moderate. With a sample size of over 4,000, this only moderate skewness is acceptable as ANCOVA is generally considered robust to violations of normality with such a large sample size.
- The residual by predicted plot shows our homogeneity of variances assumption is satisfied

Model (Systolic)

$Y_i = \beta_0 + \beta_1 x_{physical\ activity} + \beta_2 x_{age} + \beta_3 x_{sex} + \beta_4 x_{bmi} + \beta_5 x_{race} + \beta_6 x_{smoking} + \beta_7 x_{alcohol} + PA*age + PA*sex + PA*bmi + PA*Race + PA*smoking + PA*alcohol + \varepsilon$

- We used an ANCOVA model.
- Y_i is the model outcome: avg_systolic_bp
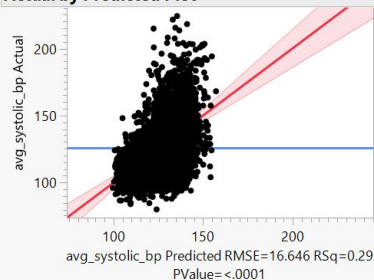- β_0 is the model intercept.

Effect Summary

Source	Logworth	PValue
age	173.640	0.00000
bmi	20.735	0.00000
race_ethnicity	12.292	0.00000
age*physical_activity	8.176	0.00000
sex	7.326	0.00000
sex*physical_activity	3.120	0.00076
smoking_status	1.300	0.05013
bmi*physical_activity	0.999	0.10032
physical_activity	0.978	0.10508 ^
alcohol_use	0.860	0.13817
physical_activity*smoking_status	0.181	0.65873
race_ethnicity*physical_activity	0.163	0.68653
physical_activity*alcohol_use	0.006	0.98641

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	90.598966	1.50425	60.23	<.0001*
age	0.4721459	0.016069	29.38	<.0001*
sex[Female]	-1.529164	0.279527	-5.47	<.0001*
race_ethnicity[Mexican American]	-0.135975	0.686014	-0.20	0.8429
race_ethnicity[Non-Hispanic Asian]	-0.459725	0.715741	-0.64	0.5207
race_ethnicity[Non-Hispanic Black]	3.920968	0.573715	6.83	<.0001*
race_ethnicity[Non-Hispanic White]	-2.156322	0.527928	-4.08	<.0001*
race_ethnicity[Other Hispanic]	-0.274247	0.814466	-0.34	0.7363
bmi	0.3975737	0.041587	9.56	<.0001*
physical_activity[High]	1.3712466	1.073303	1.28	0.2015
physical_activity[Low]	-2.347168	1.580101	-1.49	0.1375
physical_activity[Moderate]	-0.862246	1.080771	-0.80	0.4250
smoking_status[Every day]	-1.089422	0.870044	-1.25	0.2109
smoking_status[Never smoker]	-0.17274	0.531066	-0.33	0.7450
smoking_status[Not at all]	-1.304572	0.641153	-2.03	0.0419*
alcohol_use[No]	0.7225754	0.487276	1.48	0.1382
(age-49.8418)*physical_activity[High]	-0.074758	0.025759	-2.90	0.0037*
(age-49.8418)*physical_activity[Low]	-0.058592	0.03588	-1.63	0.1025
(age-49.8418)*physical_activity[Moderate]	-0.001966	0.025346	-0.08	0.9382
physical_activity[High]*smoking_status[Every day]	1.2693852	1.136362	1.12	0.2640
physical_activity[High]*smoking_status[Never smoker]	-0.765578	0.799751	-0.96	0.3385
physical_activity[High]*smoking_status[Not at all]	0.2861791	0.944373	0.30	0.7619
physical_activity[Low]*smoking_status[Every day]	-1.091265	2.230244	-0.49	0.6246
physical_activity[Low]*smoking_status[Never smoker]	0.8394064	1.176811	0.71	0.4757
physical_activity[Low]*smoking_status[Not at all]	0.3825128	1.474498	0.26	0.7953
physical_activity[Moderate]*smoking_status[Every day]	0.2217241	1.255737	0.18	0.8599
physical_activity[Moderate]*smoking_status[Never smoker]	1.1065653	0.878708	1.26	0.2080
physical_activity[Moderate]*smoking_status[Not at all]	0.5632007	1.030817	0.55	0.5848
physical_activity[High]*alcohol_use[No]	0.2003486	0.849741	0.24	0.8136
physical_activity[Low]*alcohol_use[No]	-0.35468	1.057348	-0.34	0.7373
physical_activity[Moderate]*alcohol_use[No]	0.161465	0.775349	0.21	0.8350
(bmi-29.617)*physical_activity[High]	0.0357383	0.063734	0.56	0.5750
(bmi-29.617)*physical_activity[Low]	-0.011868	0.096321	-0.12	0.9019
(bmi-29.617)*physical_activity[Moderate]	0.0922453	0.064339	1.43	0.1517
race_ethnicity[Mexican American]*physical_activity[High]	-1.381453	1.064449	-1.30	0.1944
race_ethnicity[Mexican American]*physical_activity[Low]	0.9812728	1.462936	0.67	0.5024
race_ethnicity[Mexican American]*physical_activity[Moderate]	0.2598876	1.185496	0.22	0.8265
race_ethnicity[Non-Hispanic Asian]*physical_activity[High]	-0.407347	1.395392	-0.29	0.7704
race_ethnicity[Non-Hispanic Asian]*physical_activity[Low]	-0.548767	1.273373	-0.43	0.6665
race_ethnicity[Non-Hispanic Asian]*physical_activity[Moderate]	0.0437278	1.26572	0.03	0.9724
race_ethnicity[Non-Hispanic Black]*physical_activity[High]	0.4067717	0.924126	0.44	0.6598
race_ethnicity[Non-Hispanic Black]*physical_activity[Low]	-0.720088	1.221638	-0.59	0.5556
race_ethnicity[Non-Hispanic Black]*physical_activity[Moderate]	-1.197205	0.982296	-1.22	0.2230
race_ethnicity[Non-Hispanic White]*physical_activity[High]	0.2580864	0.815311	0.32	0.7516
race_ethnicity[Non-Hispanic White]*physical_activity[Low]	-0.078195	1.19315	-0.07	0.9477
race_ethnicity[Non-Hispanic White]*physical_activity[Moderate]	0.9048768	0.838275	1.08	0.2804
race_ethnicity[Other Hispanic]*physical_activity[High]	0.9262517	1.340633	0.69	0.4897
race_ethnicity[Other Hispanic]*physical_activity[Low]	0.5666975	1.708799	0.33	0.7402
race_ethnicity[Other Hispanic]*physical_activity[Moderate]	-0.573831	1.406285	-0.41	0.6833
sex[Female]*physical_activity[High]	-0.627895	0.463242	-1.36	0.1753
sex[Female]*physical_activity[Low]	-1.037954	0.590687	-1.76	0.0789
sex[Female]*physical_activity[Moderate]	0.067911	0.46297	0.15	0.8834

Response avg_systolic_bp

Actual by Predicted Plot

avg_systolic_bp Predicted RMSE=16.646 RSq=0.29
PValue=<.0001

Summary of Fit

RSquare	0.286603
RSquare Adj	0.278864
Root Mean Square Error	16.64613
Mean of Response	126.0058
Observations (or Sum Wgts)	4753

Analysis of Variance

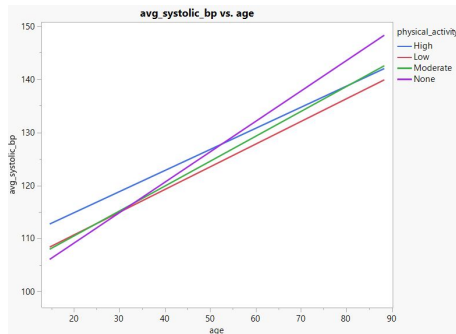| Source	DF	Sum of Squares	Mean Square	F Ratio
Model	51	523318.7	10261.2	37.0314
Error	4701	1302617.2	277.1	Prob > F
C. Total	4752	1825935.9		<.0001*

- **Significant main effects:**
  - Age, sex, race_ethnicity, and bmi

- **Significant interactions:**
  - physical_activity*sex and physical_activity*age
  → provides evidence of unequal slopes
  → the effect of physical activity on blood pressure varies depending on sex and age
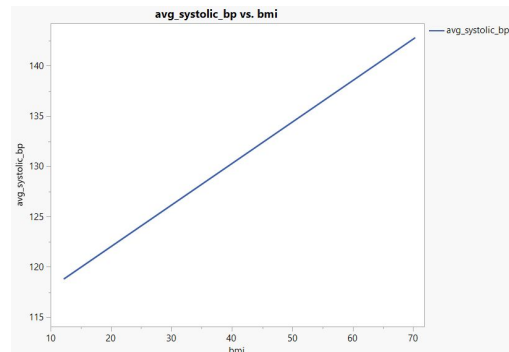
Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
age	1	1	239222.90	863.3287	<.0001*
sex	1	1	8292.55	29.9269	<.0001*
race_ethnicity	5	5	18592.27	13.4195	<.0001*
bmi	1	1	25325.31	91.3962	<.0001*
physical_activity	3	3	1701.74	2.0471	0.1051
smoking_status	3	3	2165.34	2.6048	0.0501
alcohol_use	1	1	609.32	2.1990	0.1382
age*physical_activity	3	3	11397.80	13.7111	<.0001*
physical_activity*smoking_status	9	9	1882.06	0.7547	0.6587
physical_activity*alcohol_use	3	3	39.24	0.0472	0.9864
bmi*physical_activity	3	3	1731.19	2.0826	0.1003
race_ethnicity*physical_activity	15	15	3297.23	0.7933	0.6865
sex*physical_activity	3	3	4676.52	5.6257	0.0008*

Systolic Interpretation

- The reference groups in our models are ~49.84 year old "other" race males who have a BMI of 29.62, do no physical activity, smoke some days, and do use alcohol
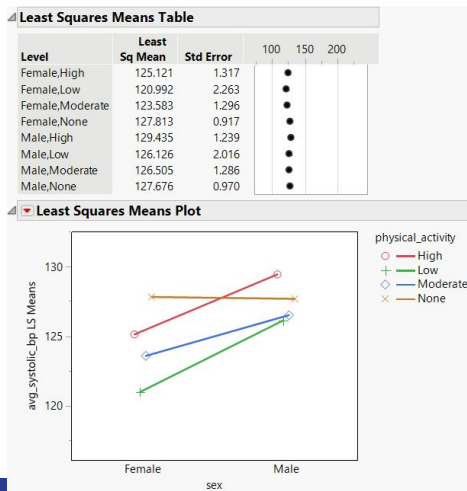
- **age*physical_activity**
  - For the reference group, systolic blood pressure rises 0.47 points per year increase in age. For the high activity group, it rises only 0.4 each year relative to the average age of 49.84. The negative interaction estimate says the slope is flatter (effect of age is weaker) for that group.
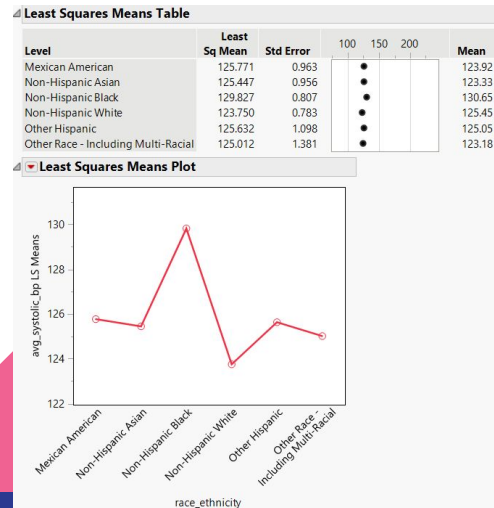

avg_systolic_bp vs. age

- **bmi**
  - For every 1 unit increase in BMI, systolic blood pressure increases by 0.39 points, holding all other variables constant
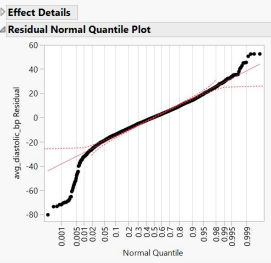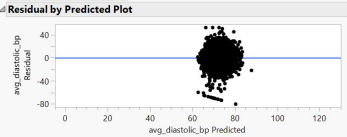

avg_systolic_bp vs. bmi

- **sex*physical_activity**
  - None of the groups are statistically different from the reference (Male-no physical activity), so there's likely differences between non-reference groups
  - LSMeans shows Males have higher BP on average compared to Females at all physical activity levels

Least Squares Means Table

Level	Least Sq Mean	Std Error	100 150 200
Female,High	125.121	1.317	
Female,Low	120.992	2.263	
Female,Moderate	123.583	1.296	
Female,None	127.813	0.917	
Male,High	129.435	1.239	
Male,Low	126.126	2.016	
Male,Moderate	126.505	1.286	
Male,None	127.676	0.970	

Least Squares Means Plot

- **Race_ethnicity**
  - Non-Hispanic Black individuals have a systolic blood pressure that's, on average, 3.92 points higher than the reference group
  - Non-Hispanic White individuals have a systolic blood pressure that's, on average, 2.15 points lower than the reference group

Least Squares Means Table

Level	Least Sq Mean	Std Error	100 150 200	Mean
Mexican American	125.771	0.963		123.92
Non-Hispanic Asian	125.447	0.956		123.33
Non-Hispanic Black	129.827	0.807		130.65
Non-Hispanic White	123.750	0.783		125.45
Other Hispanic	125.632	1.098		125.05
Other Race - Including Multi-Racial	125.012	1.381		123.18

Least Squares Means Plot

Assumptions Check: Diastolic

<- Non-transformed data

Goodness-of-Fit Test

	A²	Simulated p-Value
Anderson-Darling	17.010034	<.0001*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.
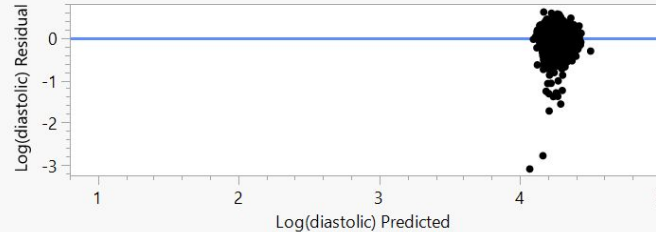
Analysis of Variance

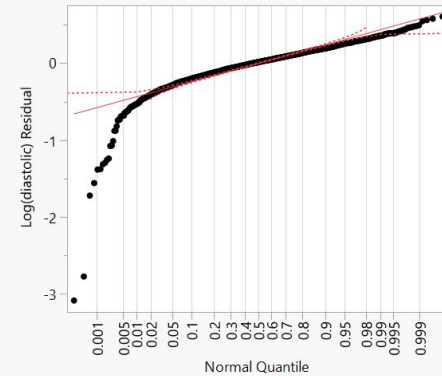| Source	DF	Sum of Squares	Mean Square	F Ratio
Model	51	53957.72	1057.99	6.7847
Error	4701	733061.06	155.94	Prob > F
C. Total	4752	787018.78		<.0001*

Log-Transformed data
->

- We chose to use log(avg_diastotlic_bp) rather than avg_diastolic because when looking at the avg_diastolic Normal Quantile Plot, there was much more severe left skewness in the non-transformed version.
- Looking at the residual by predicted plot, our homogeneity of variance assumption is satisfied.

Goodness-of-Fit Test

	A²	Simulated p-Value
Anderson-Darling	51.141488	<.0001*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	51	11.70644	0.229538	6.5500
Error	4687	164.25034	0.035044	Prob > F
C. Total	4738	175.95679		<.0001*

Model (Diastolic)

$Y_i = \beta_0 + \beta_1 x_{\text{physical activity}} + \beta_2 x_{\text{age}} + \beta_3 x_{\text{sex}} + \beta_4 x_{\text{bmi}} + \beta_5 x_{\text{race}} + \beta_6 x_{\text{smoking}} + \beta_7 x_{\text{alcohol}} + PA*age + PA*sex + PA*bmi + PA*Race + PA*smoking + PA*alco$

- We used an ANCOVA model.   -PA is physical activity abbreviated
- Y_i is the model outcome: Log(avg_diastolic_bp)
- β_0 is the model intercept.

Effect Summary

Source	Logworth	PValue
bmi	12.781	0.00000
sex	11.872	0.00000
race_ethnicity	11.364	0.00000
alcohol_use	5.325	0.00000
age*physical_activity	5.314	0.00000
age	3.226	0.00059 ^
smoking_status	2.889	0.00129
bmi*physical_activity	2.064	0.00864
physical_activity	1.940	0.01149 ^
physical_activity*alcohol_use	1.753	0.01765
sex*physical_activity	1.567	0.02709
physical_activity*smoking_status	0.330	0.46748
race_ethnicity*physical_activity	0.182	0.65788

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▼ Response Log(diastolic)
Actual by Predicted Plot

Log(diastolic) Predicted RMSE=0.1872 RSq=0.07
PValue=<.0001

Summary of Fit

RSquare	0.06653
RSquare Adj	0.056373
Root Mean Square Error	0.1872
Mean of Response	4.26691
Observations (or Sum Wgts)	4739

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	51	11.70644	0.229538	6.5500
Error	4687	164.25034	0.035044	Prob > F
C. Total	4738	175.95679		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.131869	0.01693	244.06	<.0001*
age	0.0006242	0.000182	3.44	0.0006*
sex[Female]	-0.02237	0.003147	-7.11	<.0001*
race_ethnicity[Mexican American]	-0.017773	0.007721	-2.30	0.0214*
race_ethnicity[Non-Hispanic Asian]	0.0417081	0.008065	5.17	<.0001*
race_ethnicity[Non-Hispanic Black]	0.0120717	0.006454	1.87	0.0615
race_ethnicity[Non-Hispanic White]	-0.032172	0.005941	-5.42	<.0001*
race_ethnicity[Other Hispanic]	-0.004792	0.009161	-0.52	0.6009
bmi	0.0034602	0.000468	7.40	<.0001*
physical_activity[High]	-0.026424	0.01207	-2.19	0.0286*
physical_activity[Low]	0.0304837	0.017766	1.72	0.0863
physical_activity[Moderate]	-0.020375	0.012154	-1.68	0.0937
smoking_status[Every day]	-1.089e-5	0.009793	-0.00	0.9991
smoking_status[Never smoker]	-0.003277	0.005976	-0.55	0.5834
smoking_status[Not at all]	-0.027422	0.007215	-3.80	0.0001*
alcohol_use[No]	-0.025122	0.005483	-4.58	<.0001*
(age-49.7913)*physical_activity[High]	-0.000034	0.00029	-0.12	0.9067
(age-49.7913)*physical_activity[Low]	0.0016036	0.000407	3.94	<.0001*
(age-49.7913)*physical_activity[Moderate]	-0.000336	0.000286	-1.17	0.2402
sex[Female]*physical_activity[High]	-0.01511	0.005212	-2.90	0.0038*
sex[Female]*physical_activity[Low]	0.0135258	0.006647	2.03	0.0419*
sex[Female]*physical_activity[Moderate]	0.0027741	0.005211	0.53	0.5945
race_ethnicity[Mexican American]*physical_activity[High]	-0.018571	0.011985	-1.55	0.1213
race_ethnicity[Mexican American]*physical_activity[Low]	0.0046128	0.016455	0.28	0.7792
race_ethnicity[Mexican American]*physical_activity[Moderate]	-0.001413	0.013338	-0.11	0.9156
race_ethnicity[Non-Hispanic Asian]*physical_activity[High]	0.0028694	0.015701	0.18	0.8550
race_ethnicity[Non-Hispanic Asian]*physical_activity[Low]	0.0084746	0.014346	0.59	0.5547
race_ethnicity[Non-Hispanic Asian]*physical_activity[Moderate]	0.0016639	0.01428	0.12	0.9072
race_ethnicity[Non-Hispanic Black]*physical_activity[High]	-0.013493	0.010394	-1.30	0.1943
race_ethnicity[Non-Hispanic Black]*physical_activity[Low]	-0.005515	0.013741	-0.40	0.6882
race_ethnicity[Non-Hispanic Black]*physical_activity[Moderate]	0.0046801	0.01105	0.42	0.6719
race_ethnicity[Non-Hispanic White]*physical_activity[High]	-0.000978	0.009172	-0.11	0.9151
race_ethnicity[Non-Hispanic White]*physical_activity[Low]	-0.003831	0.013422	-0.29	0.7753
race_ethnicity[Non-Hispanic White]*physical_activity[Moderate]	0.0052346	0.009433	0.55	0.5790
race_ethnicity[Other Hispanic]*physical_activity[High]	0.0321506	0.015078	2.13	0.0330*
race_ethnicity[Other Hispanic]*physical_activity[Low]	-0.01119	0.01922	-0.58	0.5605
race_ethnicity[Other Hispanic]*physical_activity[Moderate]	-0.012101	0.015817	-0.77	0.4443
(bmi-29.6194)*physical_activity[High]	0.0016504	0.000717	2.31	0.0210*
(bmi-29.6194)*physical_activity[Low]	0.0007353	0.001083	0.68	0.4974
(bmi-29.6194)*physical_activity[Moderate]	-0.000801	0.000724	-1.11	0.2684
physical_activity[High]*smoking_status[Every day]	0.003142	0.01278	0.25	0.8058
physical_activity[High]*smoking_status[Never smoker]	0.0144342	0.008998	1.60	0.1087
physical_activity[High]*smoking_status[Not at all]	-0.002124	0.010624	-0.20	0.8416
physical_activity[Low]*smoking_status[Every day]	-0.007519	0.025081	-0.30	0.7644
physical_activity[Low]*smoking_status[Never smoker]	-0.009465	0.013244	-0.71	0.4748
physical_activity[Low]*smoking_status[Not at all]	-0.001965	0.016592	-0.12	0.9057
physical_activity[Moderate]*smoking_status[Every day]	0.0150882	0.014122	1.07	0.2854
physical_activity[Moderate]*smoking_status[Never smoker]	0.004494	0.009887	0.45	0.6495
physical_activity[Moderate]*smoking_status[Not at all]	0.0165525	0.011597	1.43	0.1535
physical_activity[High]*alcohol_use[No]	-0.02701	0.009558	-2.83	0.0047*
physical_activity[Low]*alcohol_use[No]	0.0106617	0.011894	0.90	0.3701
physical_activity[Moderate]*alcohol_use[No]	0.0028603	0.008724	0.33	0.7430

- **Significant main effects:**
  - Age, sex, race_ethnicity, bmi, physical_activity, smoking_status, and alcohol_use

- **Significant interactions:**
  - physical_activity*sex, physical_activity*age, physical_activity*bmi, and physical_activity*alcohol_use
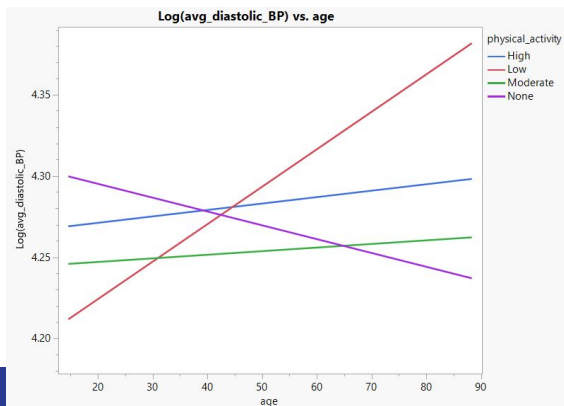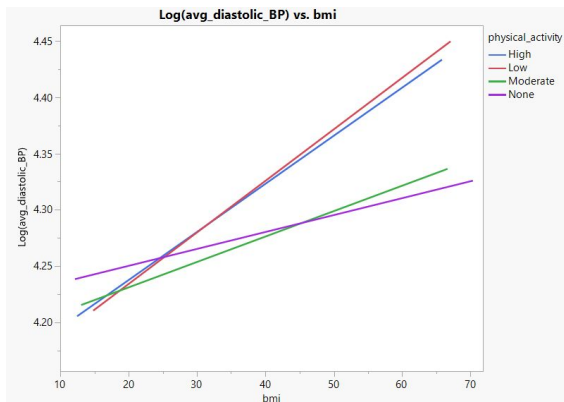 → provides evidence of unequal slopes
  → the effect of physical activity on blood pressure varies depending on age, sex, BMI, and alcohol use.

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
age	1	1	0.4138328	11.8090	0.0006*
sex	1	1	1.7712434	50.5437	<.0001*
race_ethnicity	5	5	2.1924161	12.5124	<.0001*
bmi	1	1	1.9168780	54.6995	<.0001*
physical_activity	3	3	0.3874544	3.6854	0.0115*
smoking_status	3	3	0.5519072	5.2497	0.0013*
alcohol_use	1	1	0.7356686	20.9928	<.0001*
age*physical_activity	3	3	0.9629666	9.1596	<.0001*
sex*physical_activity	3	3	0.3216950	3.0599	0.0271*
race_ethnicity*physical_activity	15	15	0.4302333	0.8185	0.6579
bmi*physical_activity	3	3	0.4091382	3.8917	0.0086*
physical_activity*smoking_status	9	9	0.3041779	0.9644	0.4675
physical_activity*alcohol_use	3	3	0.3546468	3.3734	0.0177*

Diastolic Interpretation

- The reference groups in our models are ~49.84 year old "other" race males who have a BMI of 29.62, do no physical activity, smoke some days, and do use alcohol
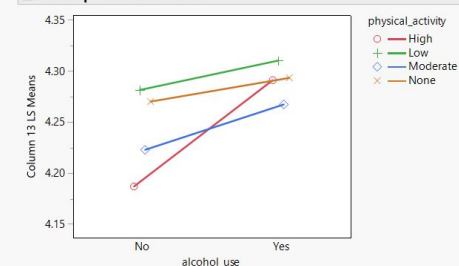

Alcohol Use

Least Squares Means Table

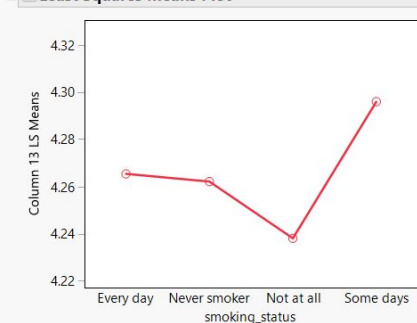| Level	Least Sq Mean	Std Error	1	2	3	4	5
High,No	4.18688	0.0225				●	
High,Yes	4.29114	0.0091				●	
Low,No	4.28146	0.0343				●	
Low,Yes	4.31038	0.0172				●	
Moderate,No	4.22280	0.0207				●	
Moderate,Yes	4.26732	0.0104				●	
None,No	4.27012	0.0143				●	
None,Yes	4.29339	0.0081				●	

Least Squares Means Plot

Sex

Least Squares Means Table

Level	Least Sq Mean	Std Error	1	2	3	4	5
Female,High	4.20153	0.0148				●	
Female,Low	4.28708	0.0254				●	
Female,Moderate	4.22547	0.0146				●	
Female,None	4.25819	0.0103				●	
Male,High	4.27649	0.0139				●	
Male,Low	4.30476	0.0227				●	
Male,Moderate	4.26466	0.0145				●	
Male,None	4.30531	0.0109				●	

Least Squares Means Plot

Smoking Status

Least Squares Means Table

Level	Least Sq Mean	Std Error	1	2	3	4	5	Mean
Every day	4.26543	0.0134				●		4.2772
Never smoker	4.26216	0.0063				●		4.2653
Not at all	4.23801	0.0090				●		4.2567
Some days	4.29615	0.0161				●		4.3163

Least Squares Means Plot

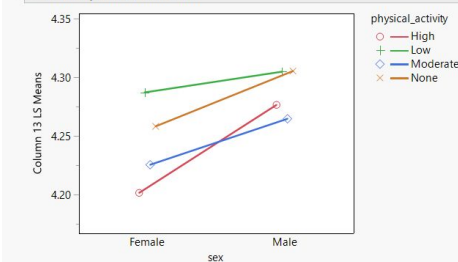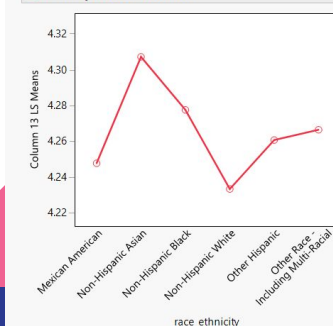
Race_Ethnicity

Least Squares Means Table

Level	Least Sq Mean	Std Error	1	2	3	4	5	Mean
Mexican American	4.24766	0.0108				●		4.2592
Non-Hispanic Asian	4.30715	0.0108				●		4.2932
Non-Hispanic Black	4.27751	0.0091				●		4.2927
Non-Hispanic White	4.23326	0.0088				●		4.2424
Other Hispanic	4.26064	0.0123				●		4.2641
Other Race - Including Multi-Racial	4.26639	0.0155				●		4.2769

Least Squares Means Plot

Results

- There is evidence that physical activity affects blood pressure in a non-uniform way, i.e., we have evidence of unequal slopes. This is concluded as we have significant interactions.
- However, which factors the slopes differ on is unique to systolic and diastolic.
- Systolic varies on age and sex.
- Diastolic varies on age, sex, BMI, and alcohol use.

Practical Conclusion

-   How much a person's physical activity affects their blood pressure depends on several different characteristics and also affects diastolic and systolic differently.
-   Many people assume that higher physical activity will bring their blood pressure closer to 120/80. However, in reality, how much physical activity helps depends on other factors.
-   Thus, those who are looking to control their blood pressure, must take into account which type they need help controlling (diastolic or systolic) as well as their age, sex, BMI, and alcohol use when considering increasing physical activity as a solution

References:

- Dataset: https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2017
- Information about blood pressure: https://www.nhlbi.nih.gov/health/high-blood-pressure#:~:text=The%20first%20number%20is%20your,day%20based%20on%20your%20activities.