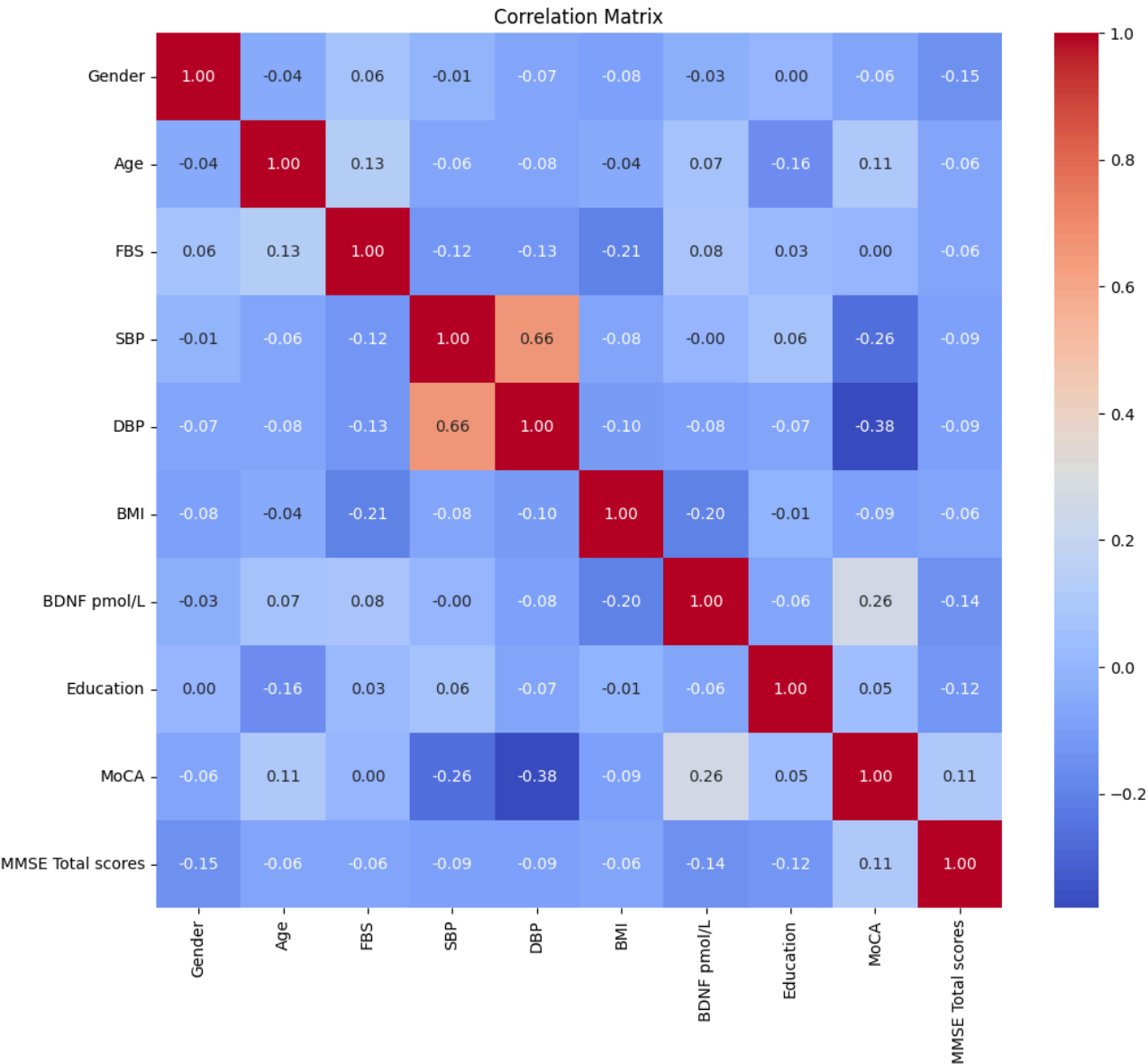


We are going to analyze the relationship between BMI and MoCA (including all its subtest categories). Next, we will examine the relationship between BMI and MMSE (including all its subtest categories). Finally, we will explore the relationship between BMI and BDNF.

First, let's start by understanding the relationship between these overall parameters.

Conclusion of Correlation Analysis concerning BMI



BMI vs Gender:

- Correlation: -0.081
- Conclusion: There is a very weak negative correlation between BMI and Gender, suggesting that BMI does not vary significantly with Gender in this dataset.

BMI vs Age:

- Correlation: -0.041
- Conclusion: There is a very weak negative correlation between BMI and Age, indicating that age has a negligible impact on BMI in this dataset.

BMI vs FBS (Fasting Blood Sugar):

- Correlation: -0.206
- Conclusion: A weak negative correlation suggests that higher BMI is associated with lower fasting blood sugar levels, though the relationship is not strong.

BMI vs SBP (Systolic Blood Pressure):

- Correlation: -0.076
- Conclusion: There is a very weak negative correlation between BMI and SBP, indicating a minimal impact of BMI on systolic blood pressure.

BMI vs DBP (Diastolic Blood Pressure):

- Correlation: -0.104
- Conclusion: There is a weak negative correlation between BMI and DBP, suggesting a slight decrease in diastolic blood pressure with increasing BMI.

BMI vs BDNF pmol/L (Brain-Derived Neurotrophic Factor):

- Correlation: -0.204
- Conclusion: A weak negative correlation implies that higher BMI is associated with lower levels of BDNF, though the association is not strong.

BMI vs Education:

- Correlation: -0.008
- Conclusion: There is a negligible correlation between BMI and Education, indicating that BMI is almost independent of educational level.

BMI vs MoCA (Montreal Cognitive Assessment):

- Correlation: -0.089
- Conclusion: There is a weak negative correlation, suggesting that higher BMI is slightly associated with lower MoCA scores, though the relationship is weak.

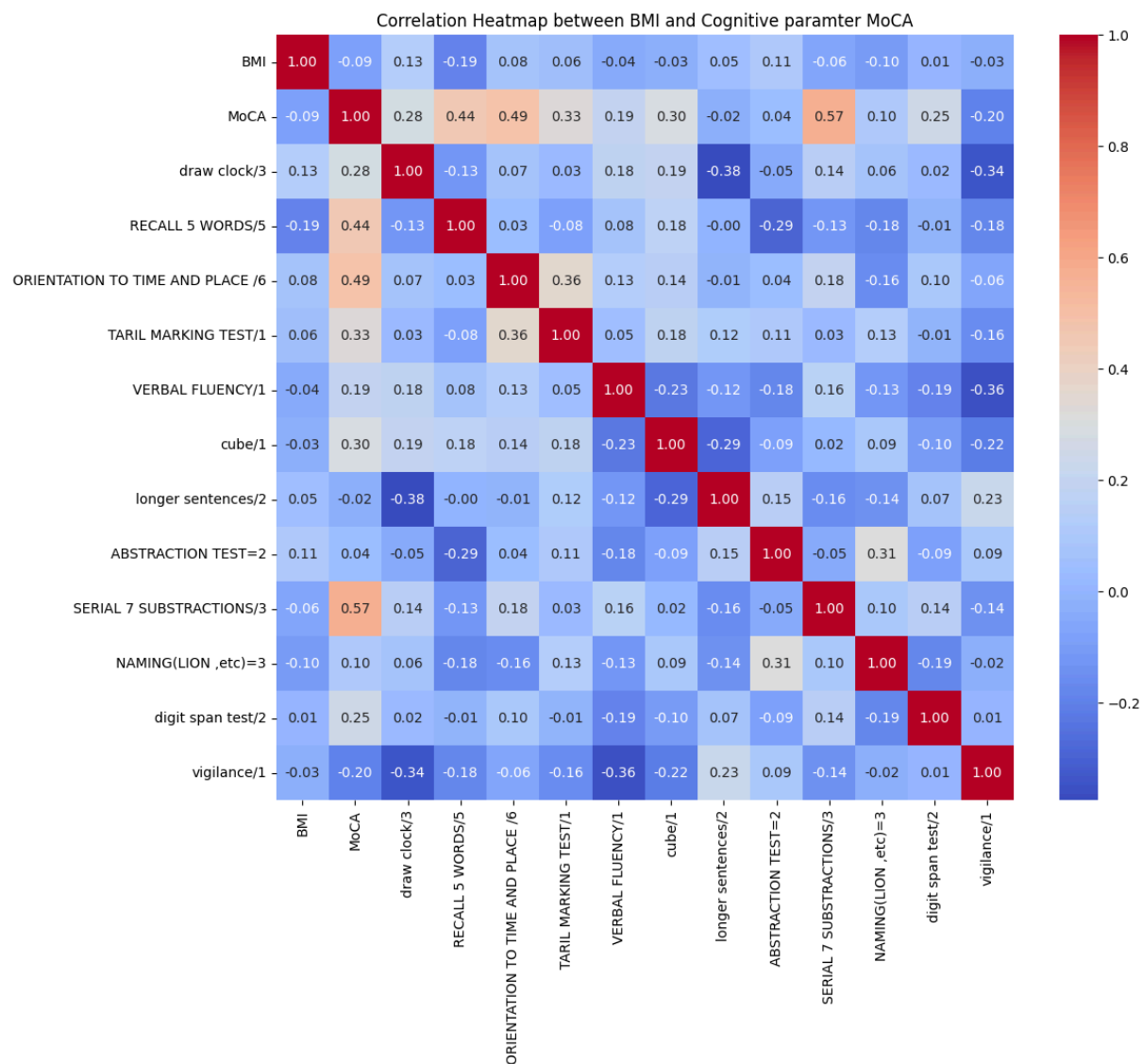
BMI vs MMSE Total Scores (Mini-Mental State Examination):

- Correlation: -0.062
- Conclusion: There is a very weak negative correlation between BMI and MMSE scores, indicating minimal association between BMI and cognitive function as measured by MMSE.

Summary

Overall, BMI shows weak negative correlations with most of the other variables in the dataset. The strongest associations are with fasting blood sugar (FBS) and BDNF levels, although these are still relatively weak. The correlations with cognitive measures (MoCA and MMSE) are minimal, suggesting that BMI has a limited direct impact on cognitive performance and biomarkers in this dataset.

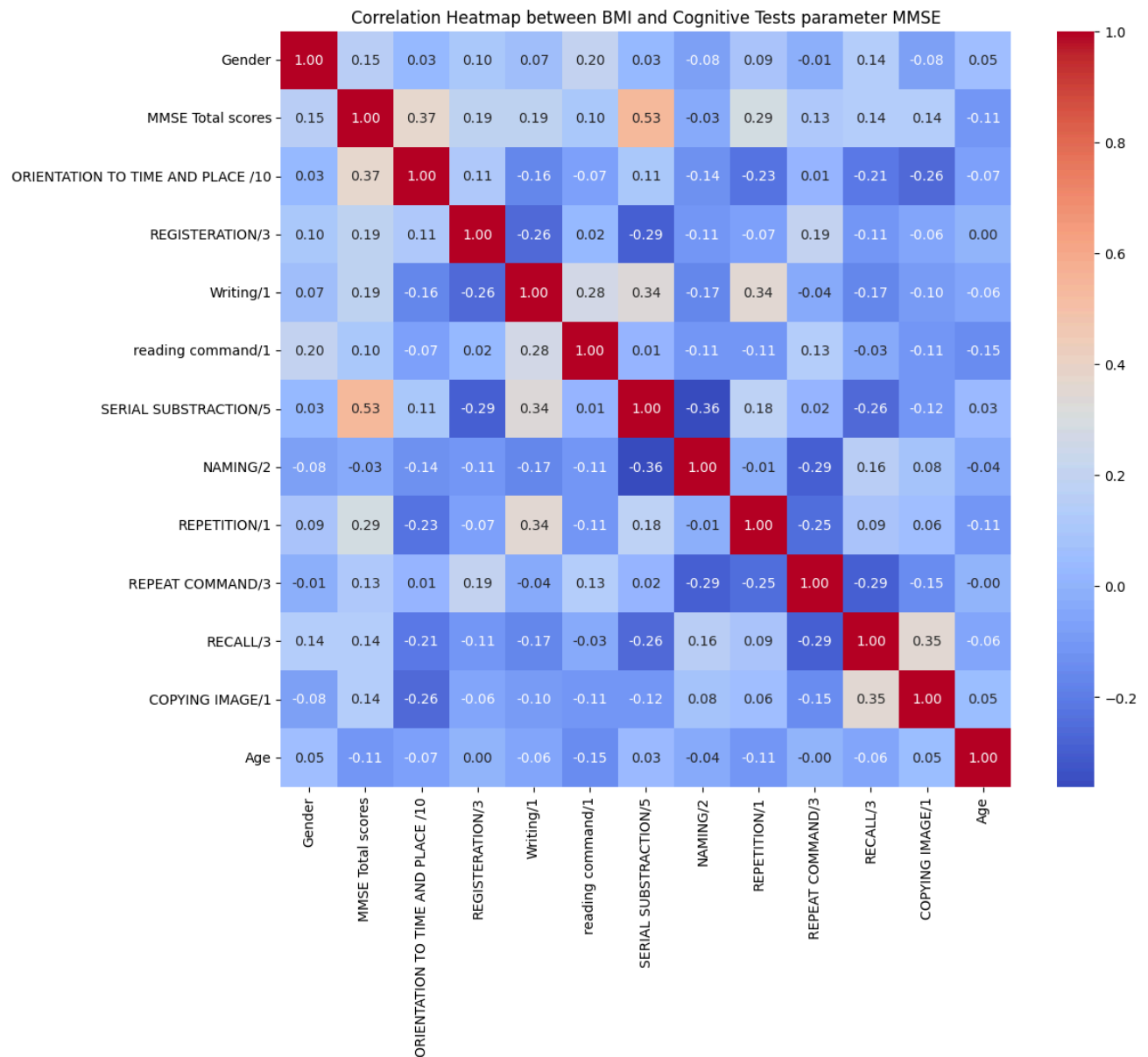
Now, we are going to examine the relationship between BMI and all subtest categories of MMSE and MoCA.



Based on the correlation matrix concerning BMI, here are the key conclusions:

- RECALL 5 WORDS/5: Exhibits a moderate negative correlation with BMI (-0.1888). This suggests that individuals with higher BMI tend to have slightly lower recall ability for 5 words.
- draw clock/3: Shows a small positive correlation with BMI (0.1343). This indicates a slight tendency for individuals with higher BMI to perform better on this test.
- ORIENTATION TO TIME AND PLACE /6: Displays a very weak positive correlation with BMI (0.0758). The effect of BMI on this orientation task is minimal.
- TARIL MARKING TEST/1: Has a very weak positive correlation with BMI (0.0594), indicating almost no effect of BMI on this test.
- VERBAL FLUENCY/1: Shows a weak negative correlation with BMI (-0.0389), suggesting a minimal inverse relationship between BMI and verbal fluency.
- cube/1: Demonstrates a very weak negative correlation with BMI (-0.0256), indicating almost no impact of BMI on the cube test.
- longer sentences/2: Displays a weak positive correlation with BMI (0.0530), suggesting a slight association where higher BMI could correspond with better performance.
- ABSTRACTION TEST=2: Shows a weak positive correlation with BMI (0.1099). BMI has a minor positive effect on abstraction abilities.
- SERIAL 7 SUBTRACTIONS/3: Exhibits a weak negative correlation with BMI (-0.0621). The relationship between BMI and this serial subtraction task is minimal.
- NAMING (LION, etc)=3: Shows a weak negative correlation with BMI (-0.1027), indicating that higher BMI might be associated with slightly poorer performance on naming tasks.
- digit span test/2: Displays a very weak positive correlation with BMI (0.0094), suggesting almost no relationship between BMI and digit span performance.
- vigilance/1: Exhibits a very weak negative correlation with BMI (-0.0348), showing almost no effect of BMI on vigilance.

Overall, the correlations between BMI and these cognitive tests are generally weak, indicating that BMI has a minimal direct impact on the performance in these tests. The strongest correlation is with the "RECALL 5 WORDS/5" test, but it is still relatively weak.



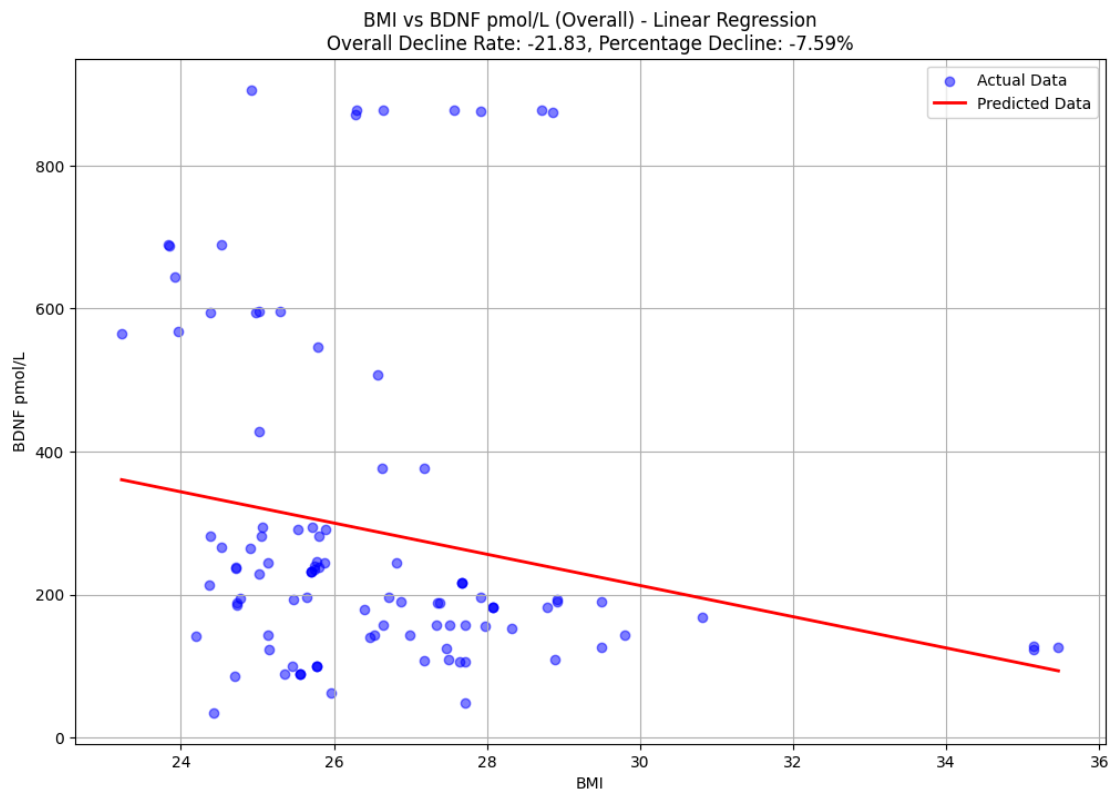
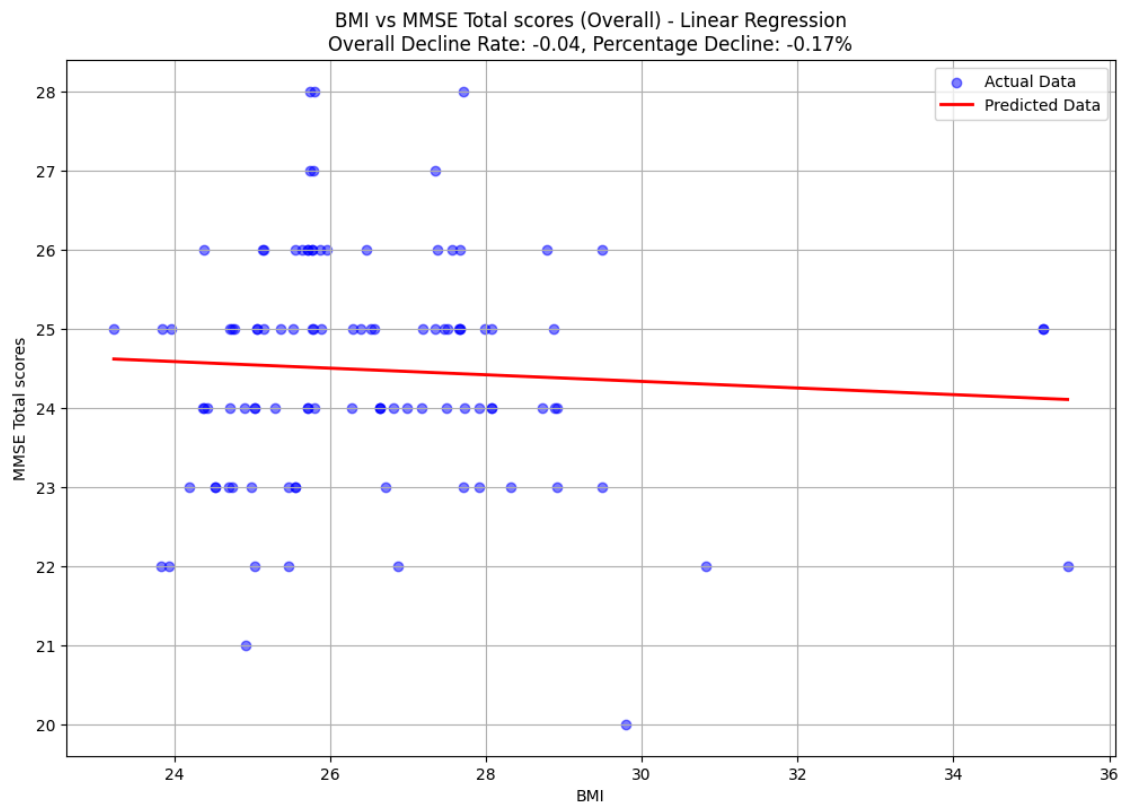
Here are some conclusions from the correlation heatmap concerning BMI:

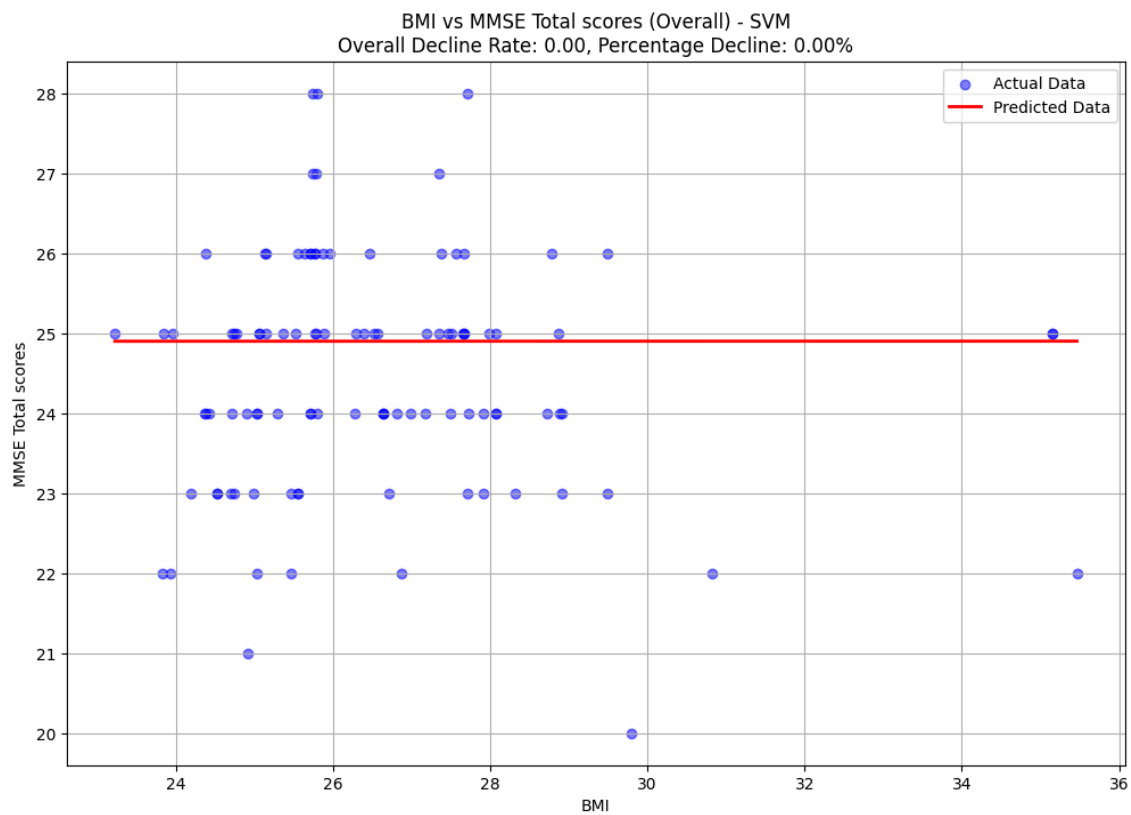
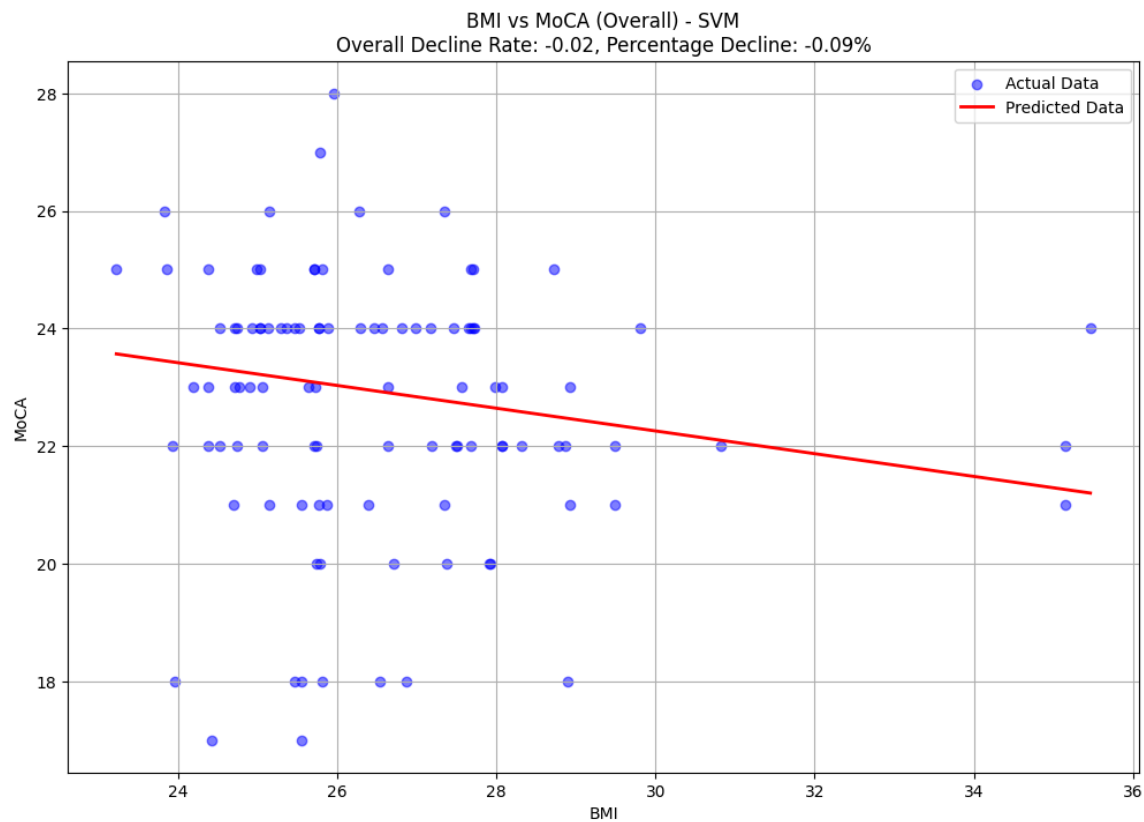
- Gender: There is a weak positive correlation between gender and BMI (0.15). This suggests that gender has a slight influence on BMI in this dataset, but the relationship is not very strong.
- MMSE Total Scores: The correlation with BMI is close to zero (0.15), indicating a very weak relationship. MMSE scores may not significantly impact or be impacted by BMI.
- Orientation to Time and Place: The correlation with BMI is quite low (0.03), suggesting minimal or no relationship.

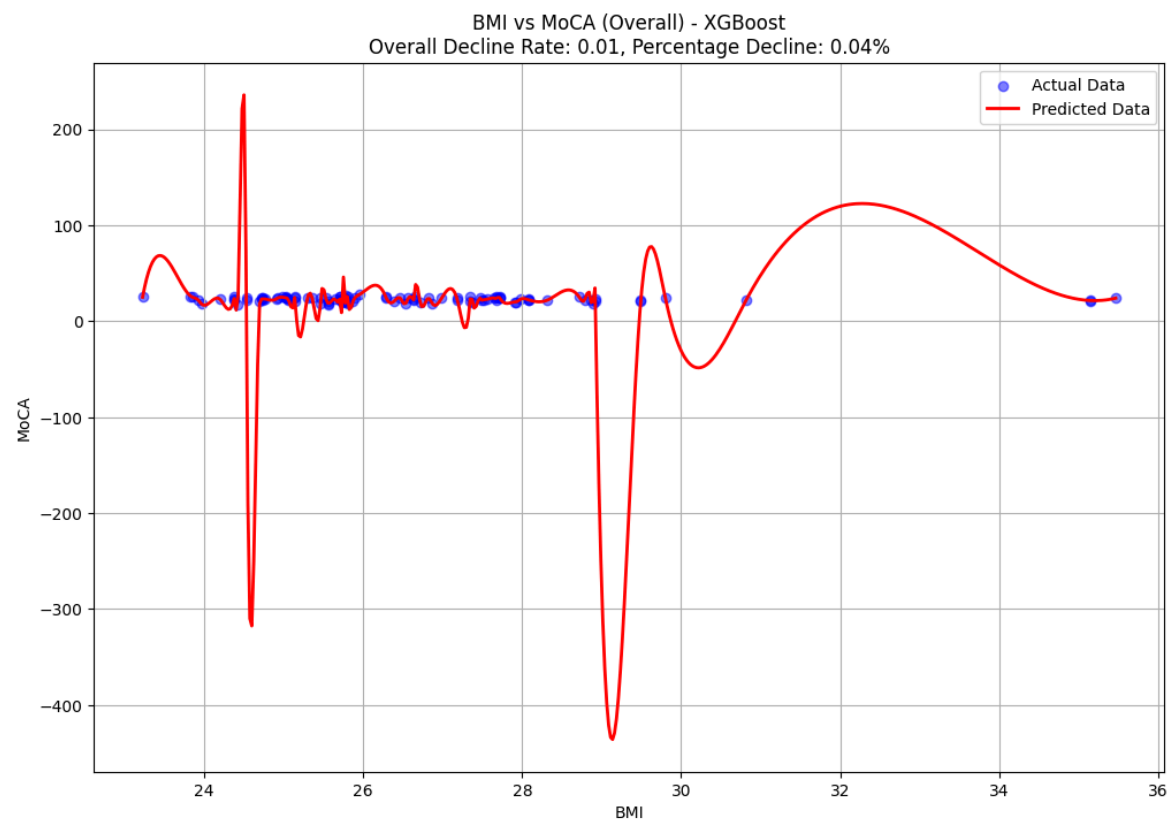
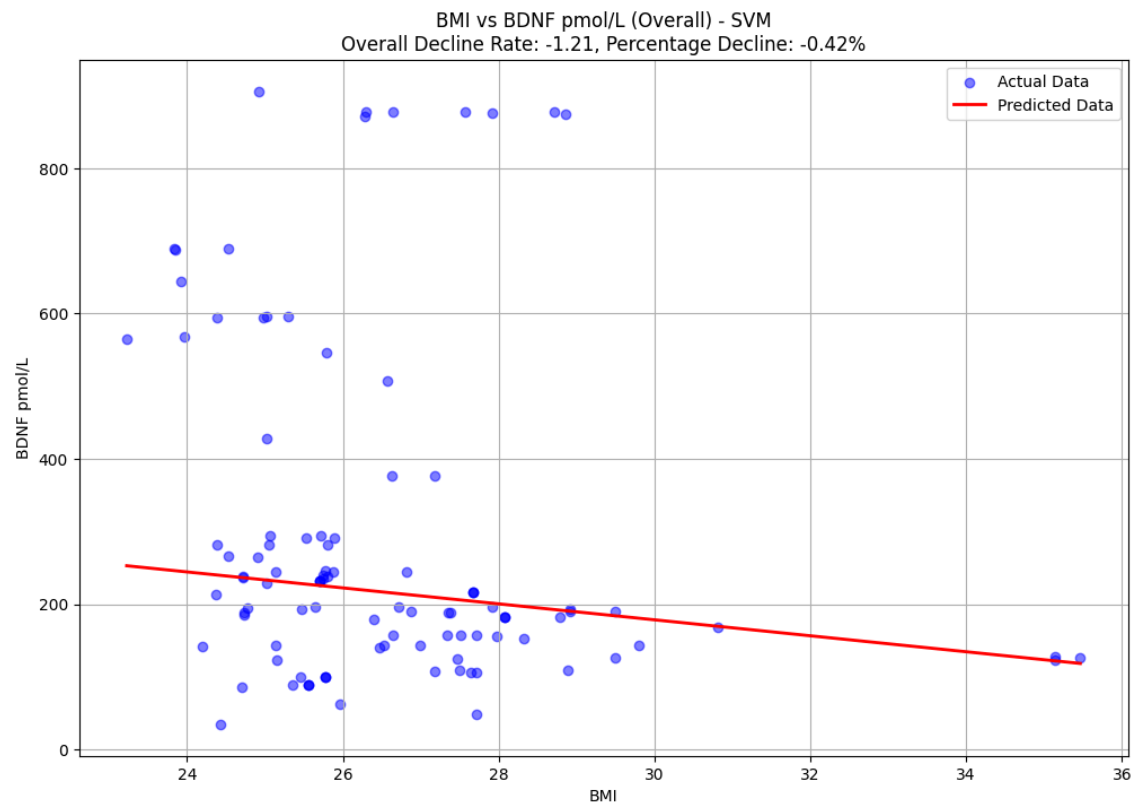
- Registration/3: The correlation with BMI is also low (0.10), indicating a weak relationship.
- Writing/1: Shows a low positive correlation with BMI (0.07), suggesting a minor relationship.
- Reading Command/1: There is a small positive correlation with BMI (0.20), indicating a slight relationship.
- Serial Substraction/5: The correlation with BMI is very weak (0.03), showing almost no relationship.
- Naming/2: This shows a very weak negative correlation with BMI (-0.08), indicating a minimal relationship.
- Repetition/1: Has a weak positive correlation with BMI (0.09), indicating a slight relationship.
- Repeat Command/3: The correlation with BMI is very weak (-0.01), showing almost no relationship.
- Recall/3: This shows a weak positive correlation with BMI (0.14), suggesting a minor relationship.
- Copying Image/1: Has a weak negative correlation with BMI (-0.08), indicating a slight inverse relationship.
- Age: There is a very weak positive correlation with BMI (0.05), suggesting a minimal relationship between age and BMI in this dataset.

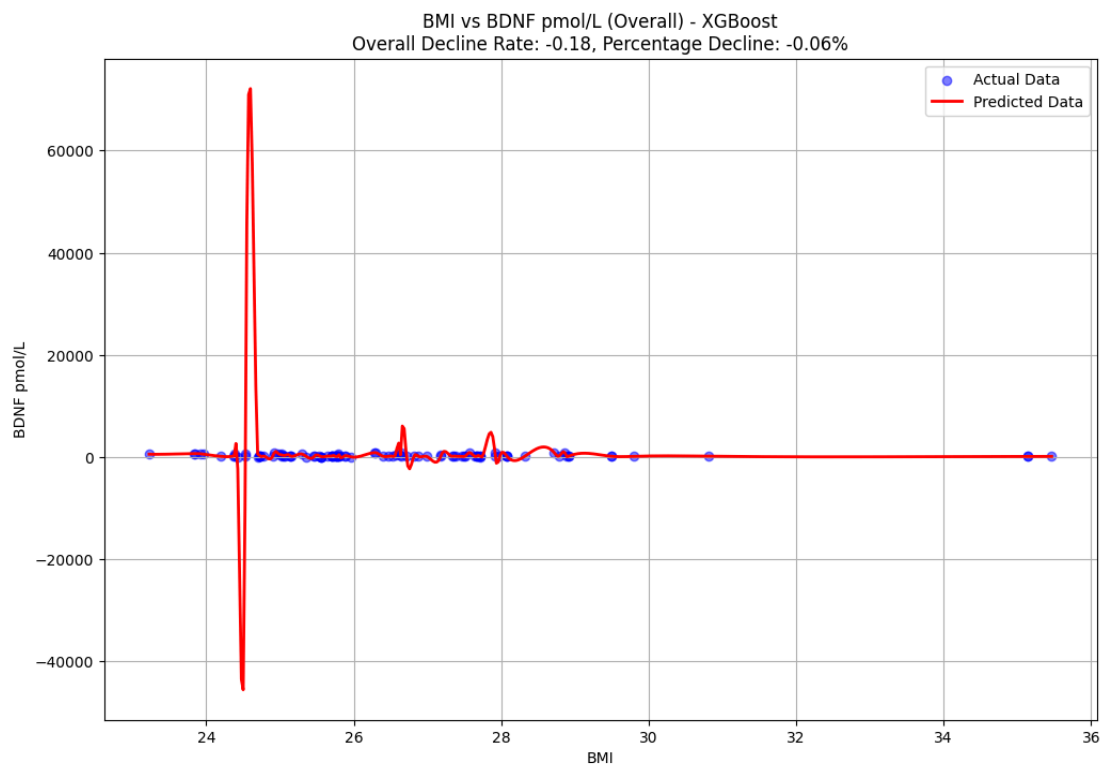
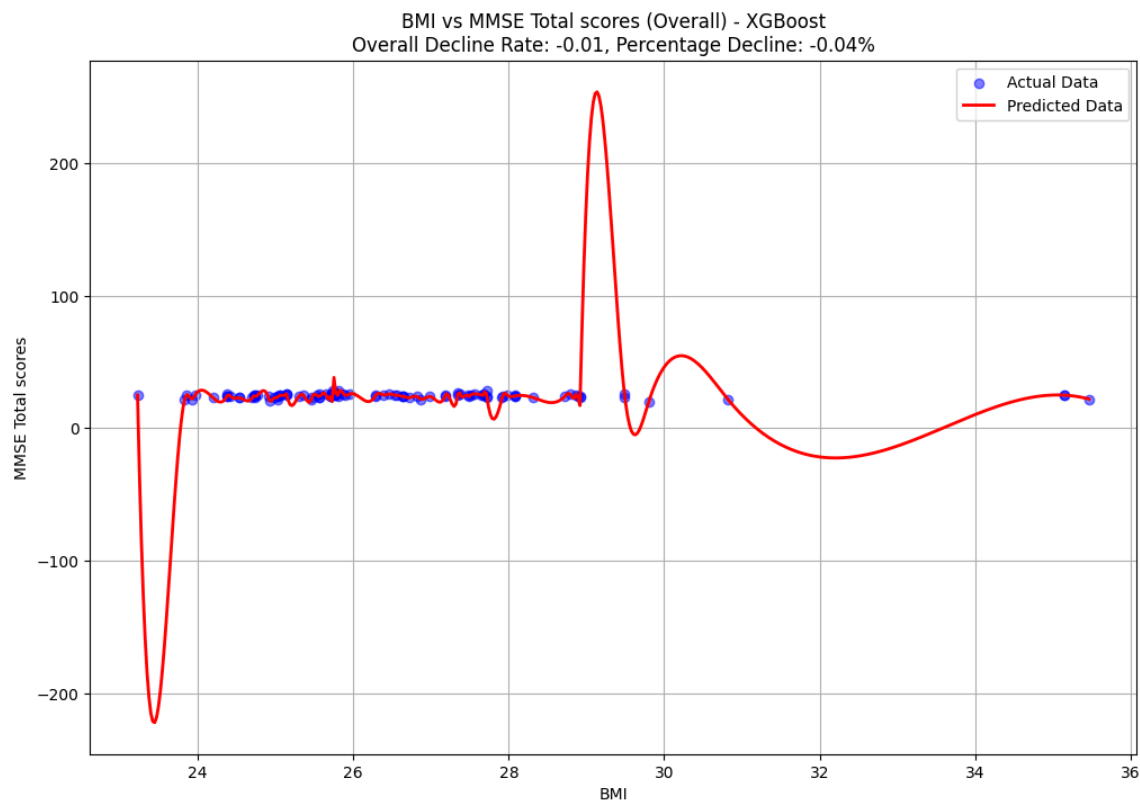
Overall: The correlations between BMI and other variables are generally weak. There is no strong evidence to suggest that any specific variable strongly influences or is influenced by BMI in this dataset.

A scatter plot showing the relationship between BMI (X-axis) and MoCA (Y-axis). The X-axis ranges from 24 to 36, and the Y-axis ranges from 18 to 28. Blue dots represent 'Actual Data' points, which are widely scattered across the plot. A solid red line represents the 'Predicted Data' or a linear regression fit, showing a slight negative correlation between BMI and MoCA. The legend in the top right corner identifies the blue dots as 'Actual Data' and the red line as 'Predicted Data'.

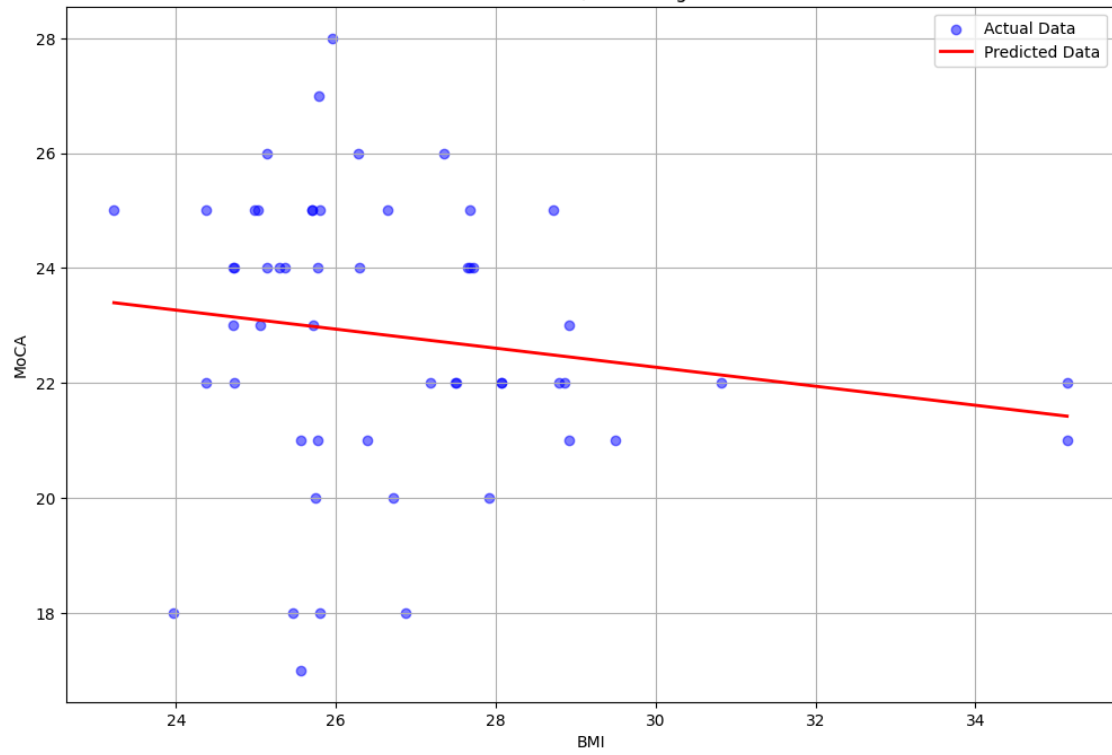


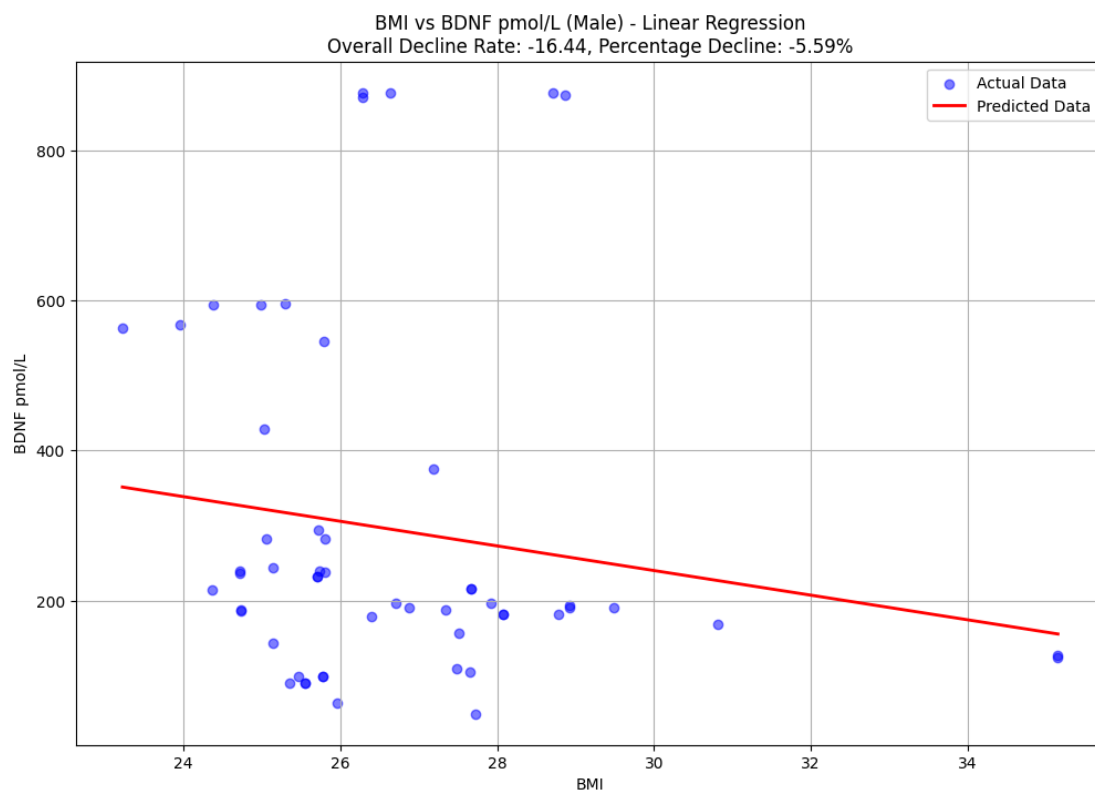
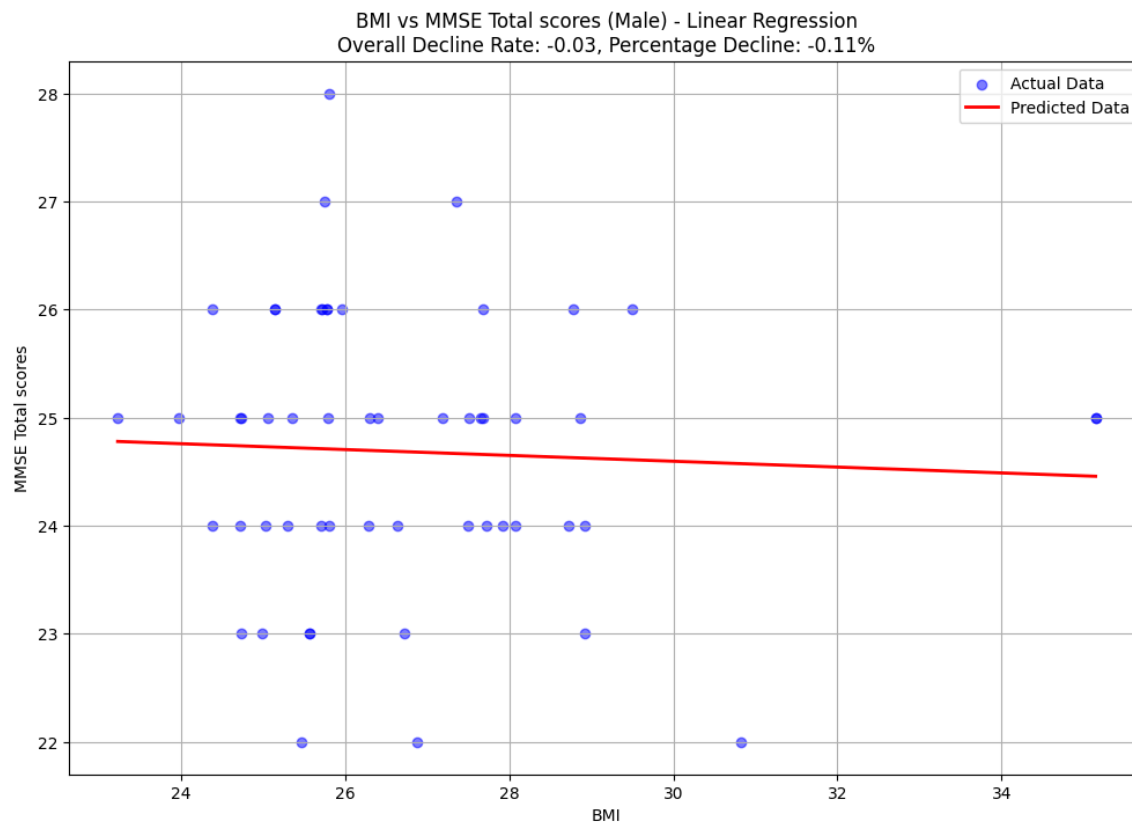


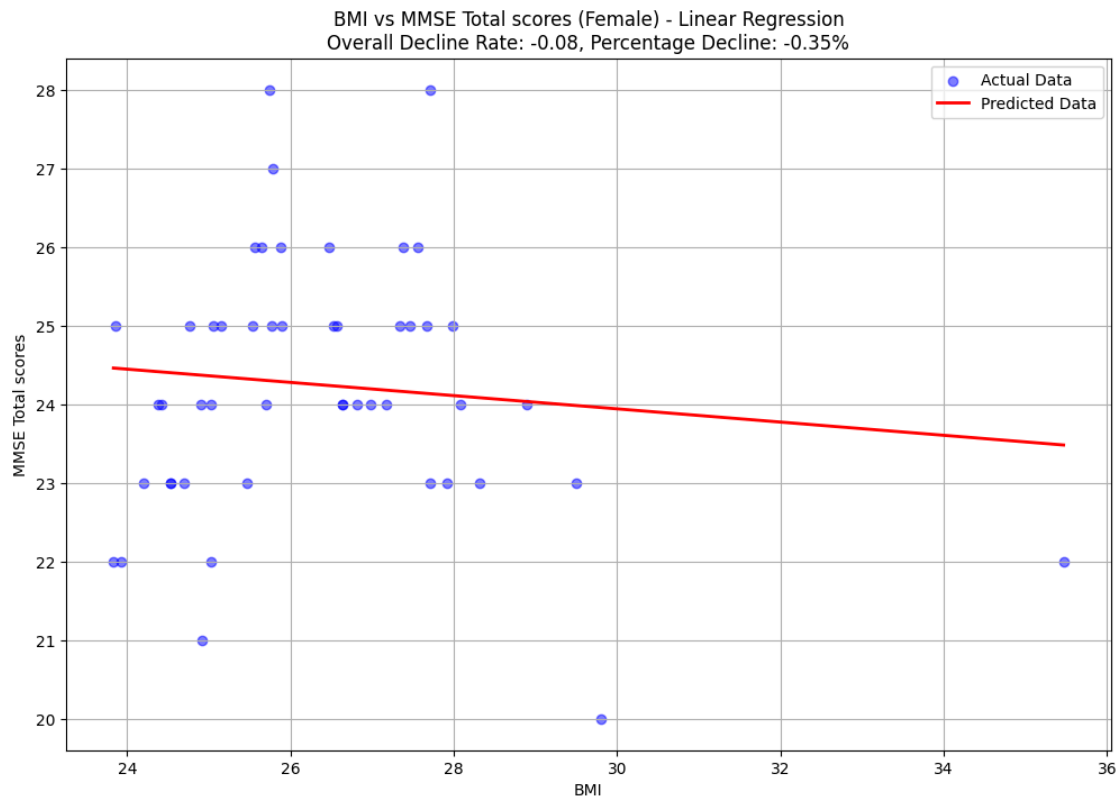
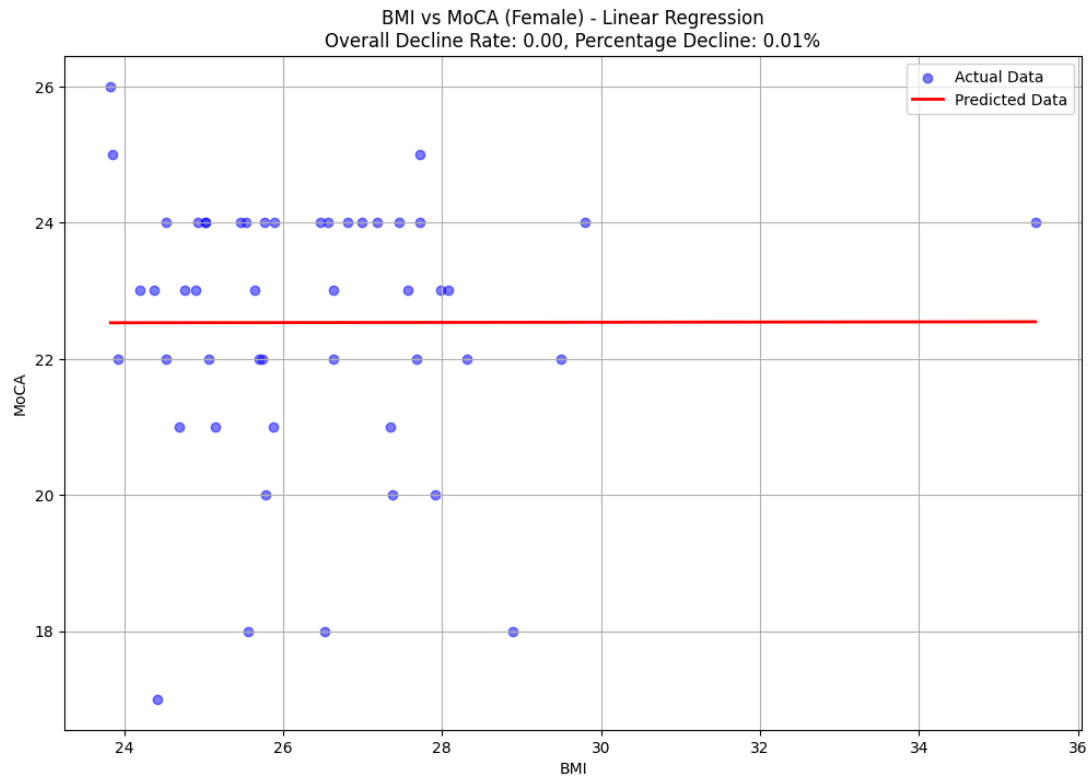


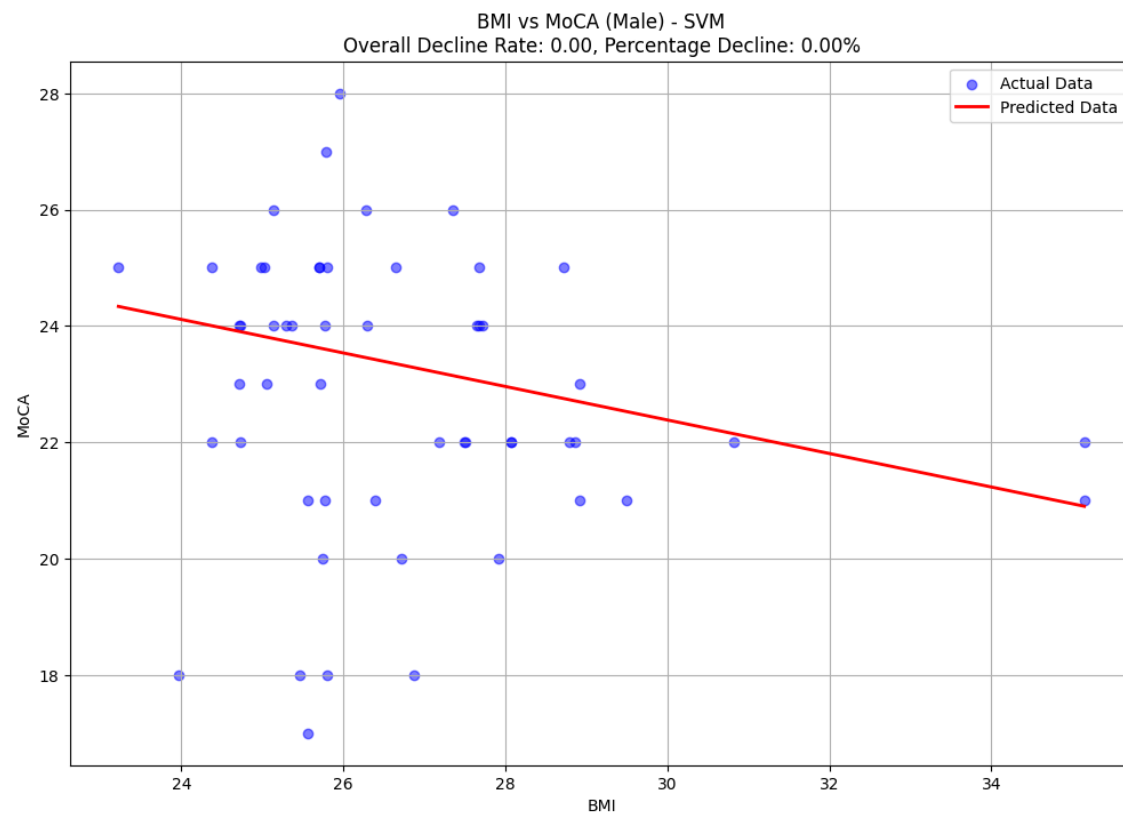
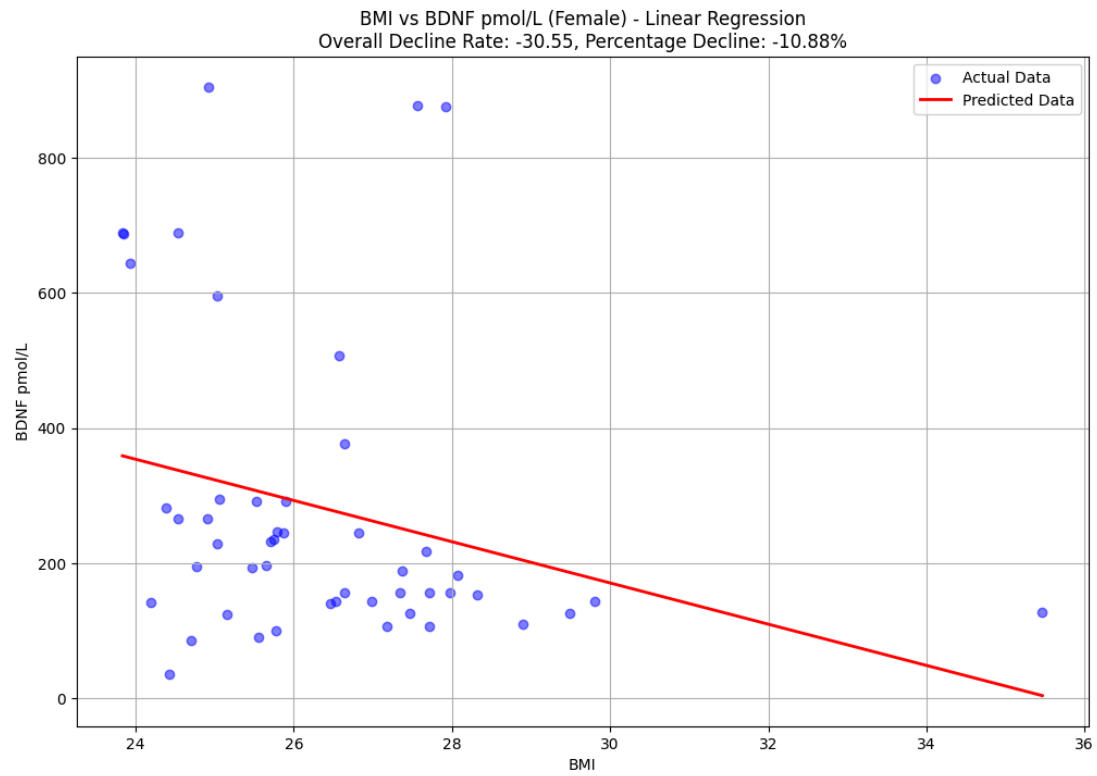


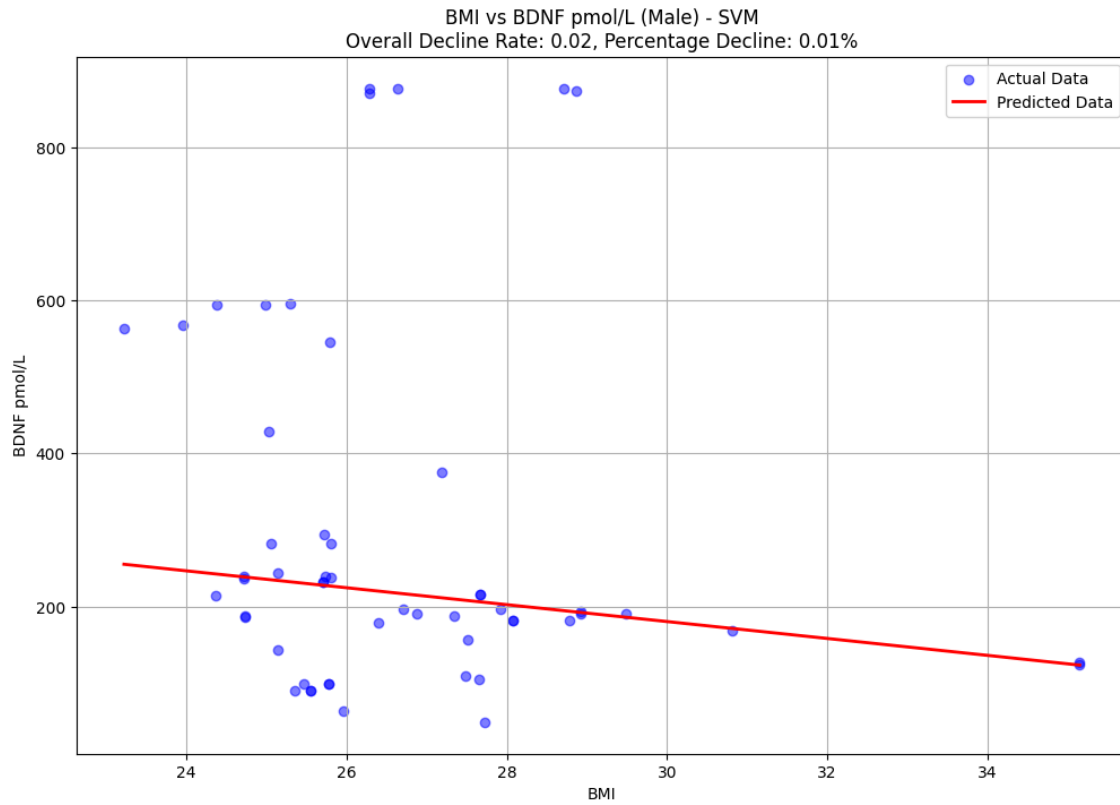
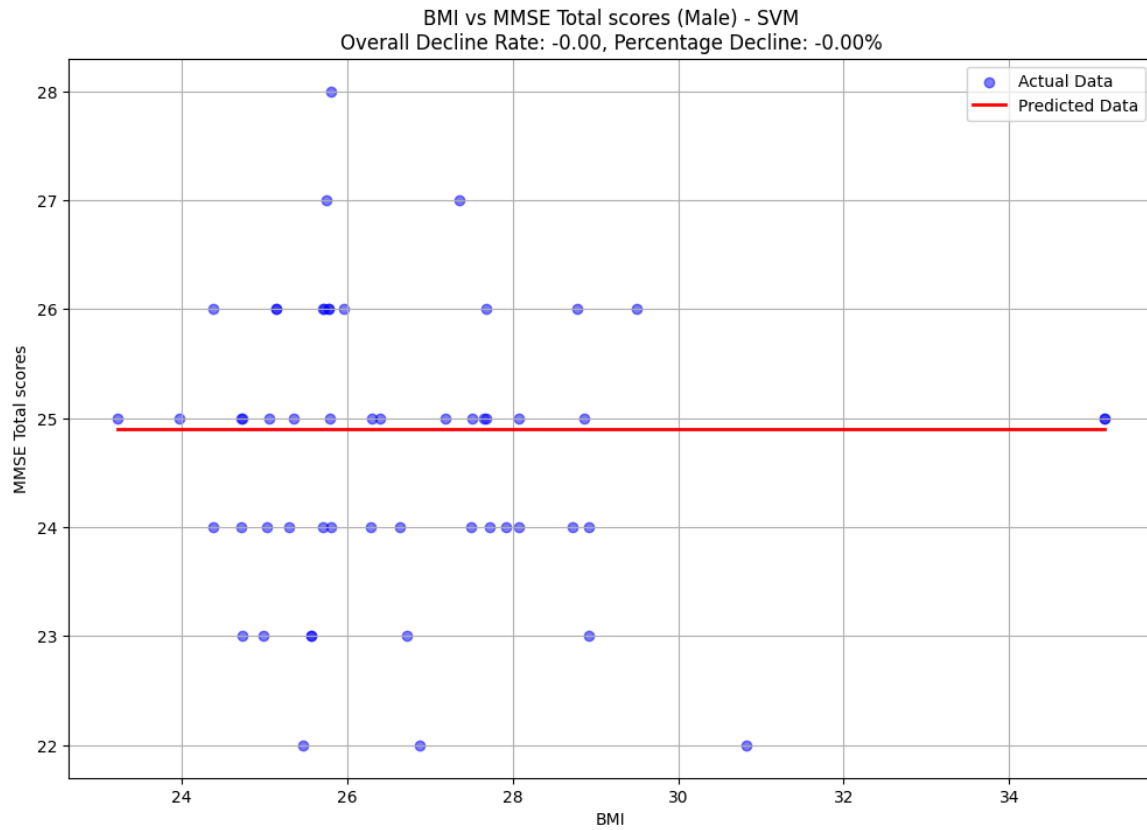
BMI vs MoCA (Male) - Linear Regression
Overall Decline Rate: -0.17, Percentage Decline: -0.73%





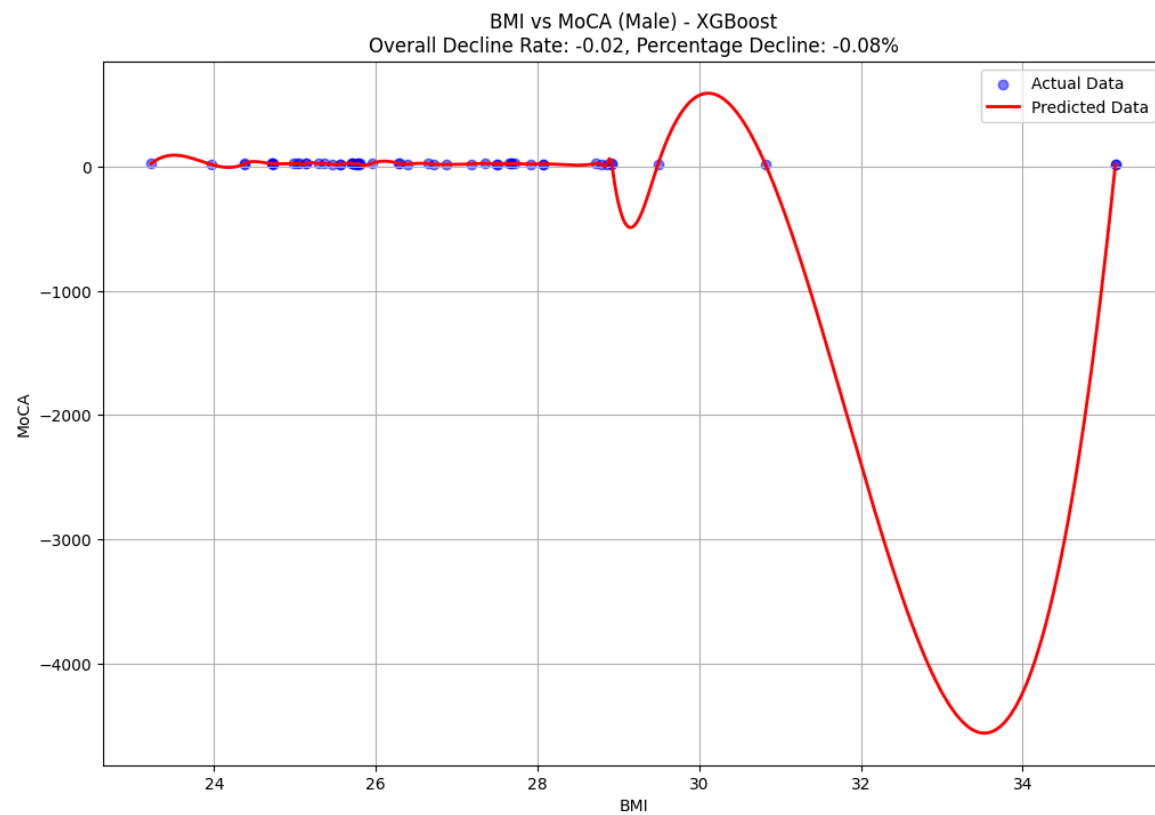
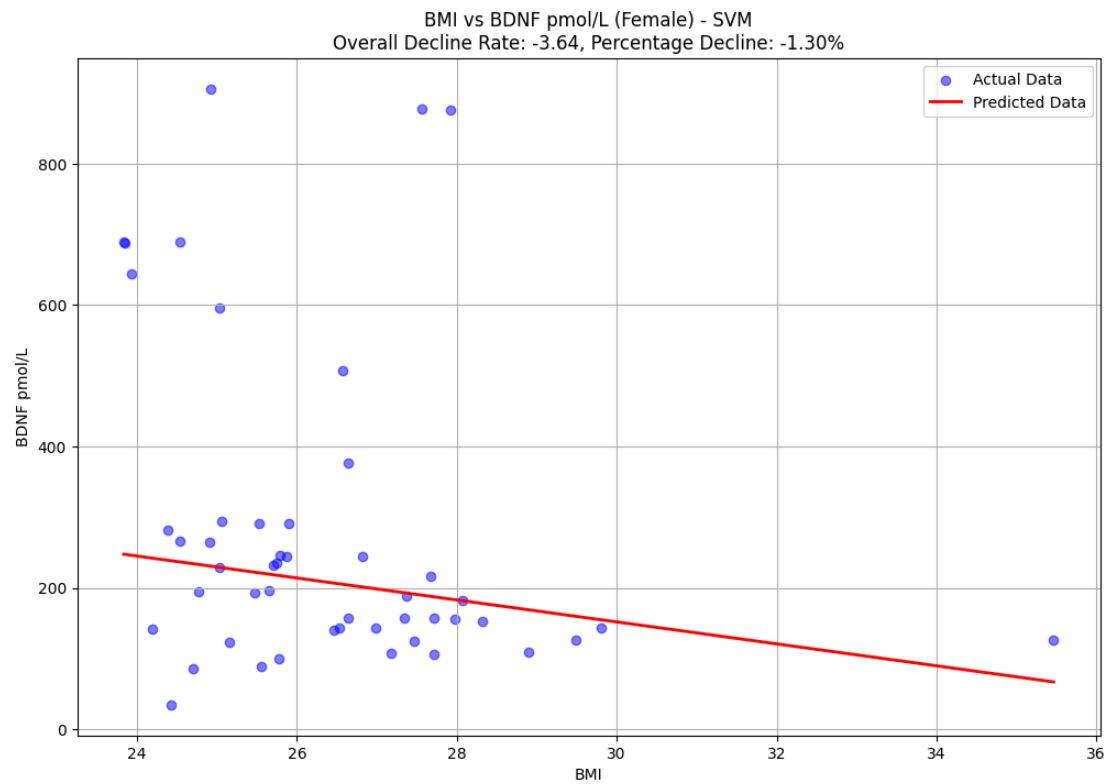


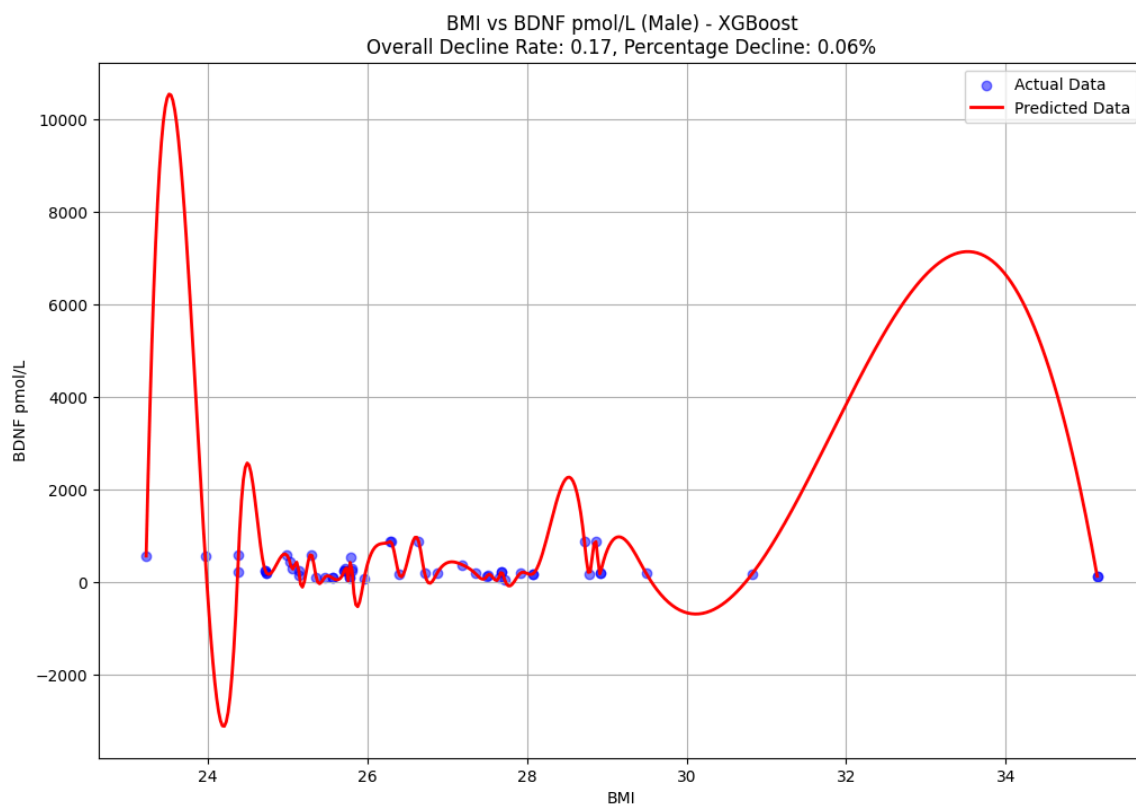
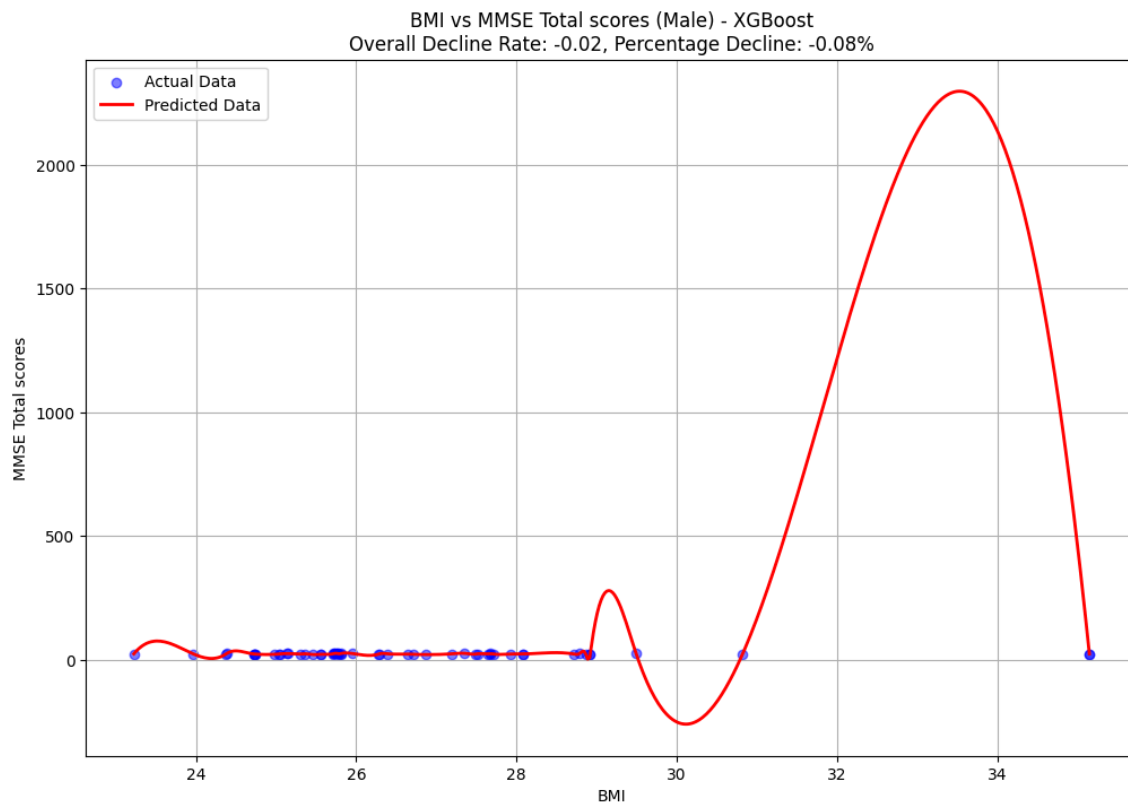


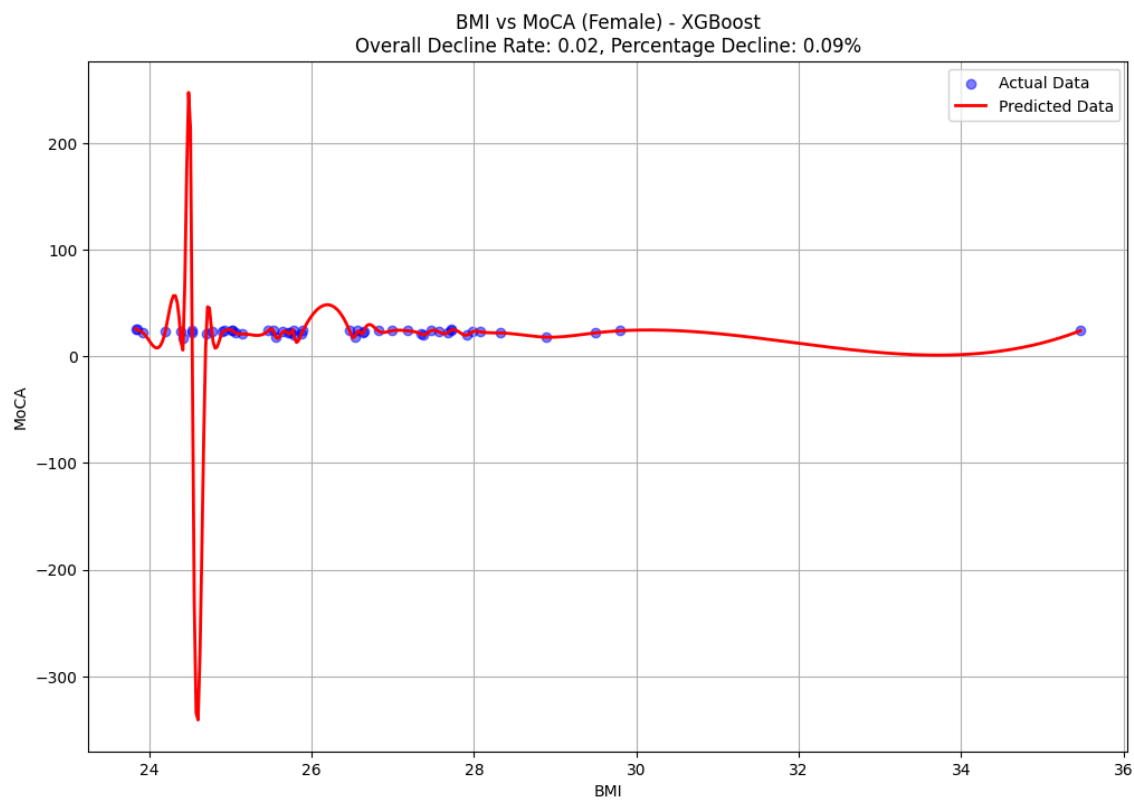
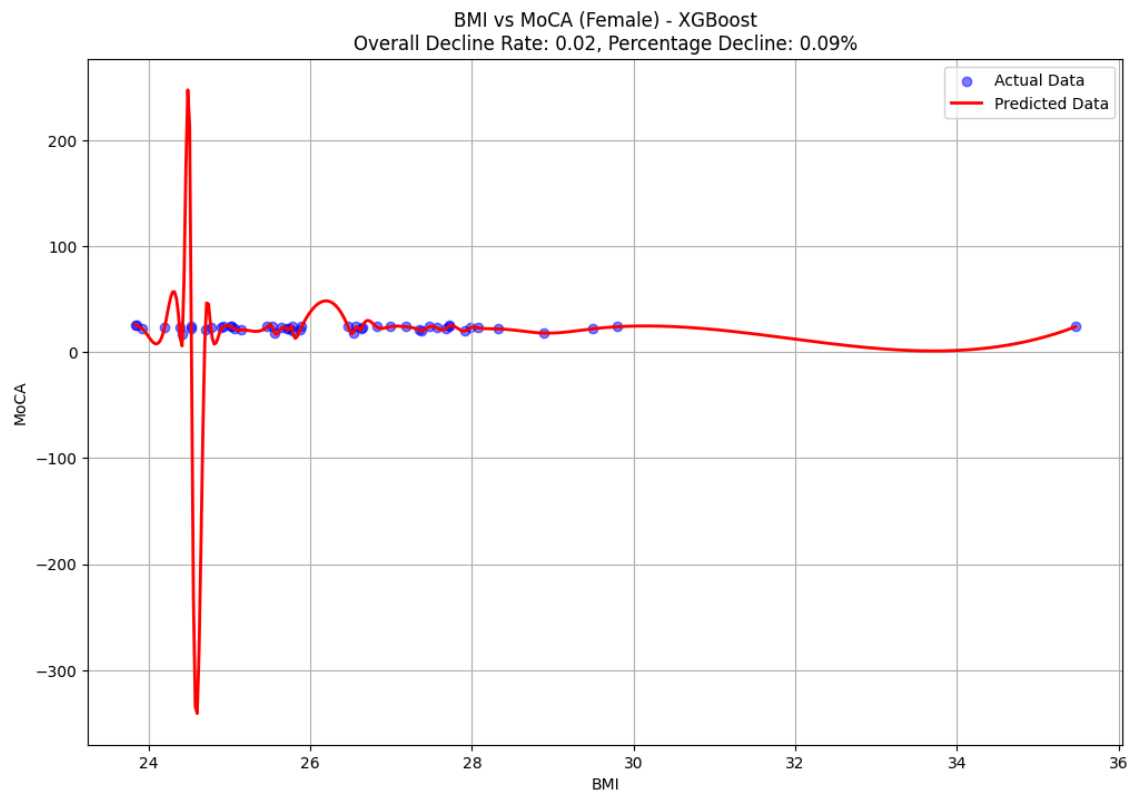


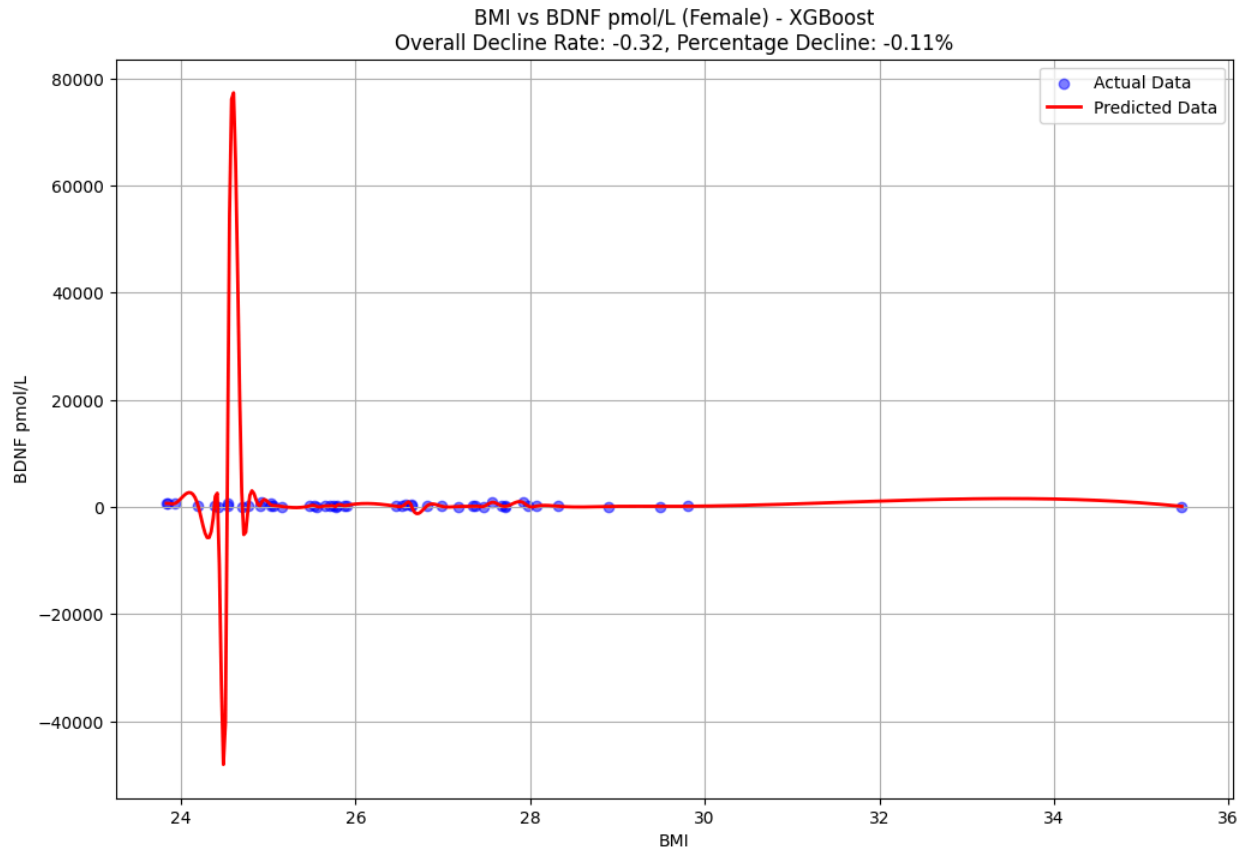
A scatter plot showing the relationship between BMI (x-axis) and MoCA (y-axis). The x-axis ranges from 24 to 36, and the y-axis ranges from 18 to 26. Blue dots represent 'Actual Data' points, and a red line represents the 'Predicted Data' (linear regression). The data points are scattered around the regression line, which shows a positive correlation.

A scatter plot showing the relationship between BMI (X-axis) and MMSE Total scores (Y-axis). The X-axis ranges from 24 to 36, and the Y-axis ranges from 20 to 28. Blue dots represent 'Actual Data' points, which are scattered across the plot. A solid red line represents the 'Predicted Data' or linear regression line, showing a negative correlation between BMI and MMSE Total scores. The legend in the top right corner identifies the blue dots as 'Actual Data' and the red line as 'Predicted Data'.









Detailed Analysis

1. BMI vs MoCA

- **Overall (Linear Regression):** The MoCA scores decline by 0.09 units for each unit increase in BMI, representing a 0.40% decrease in the average MoCA score.
- **Overall (SVM):** The MoCA scores decline by 0.02 units for each unit increase in BMI, representing a 0.09% decrease in the average MoCA score.
- **Overall (XGBoost):** The MoCA scores increase by 0.01 units for each unit increase in BMI, representing a 0.04% increase in the average MoCA score.

By Gender:

- **Male (Linear Regression):** The MoCA scores decline by 0.17 units for each unit increase in BMI, representing a 0.73% decrease in the average MoCA score.
- **Female (Linear Regression):** The MoCA scores show almost no change with BMI, indicating a negligible impact.
- **Male (SVM):** The MoCA scores remain unchanged with BMI, indicating no relationship.
- **Female (SVM):** The MoCA scores increase by 0.01 units for each unit increase in BMI, representing a 0.06% increase in the average MoCA score.

- **Male (XGBoost):** The MoCA scores decline by 0.02 units for each unit increase in BMI, representing a 0.08% decrease in the average MoCA score.
- **Female (XGBoost):** The MoCA scores increase by 0.02 units for each unit increase in BMI, representing a 0.09% increase in the average MoCA score.

2. BMI vs MMSE Total Scores

- **Overall (Linear Regression):** The MMSE scores decline by 0.04 units for each unit increase in BMI, representing a 0.17% decrease in the average MMSE score.
- **Overall (SVM):** The MMSE scores show no change with BMI.
- **Overall (XGBoost):** The MMSE scores decline by 0.01 units for each unit increase in BMI, representing a 0.04% decrease in the average MMSE score.

By Gender:

- **Male (Linear Regression):** The MMSE scores decline by 0.03 units for each unit increase in BMI, representing a 0.11% decrease in the average MMSE score.
- **Female (Linear Regression):** The MMSE scores decline by 0.08 units for each unit increase in BMI, representing a 0.35% decrease in the average MMSE score.
- **Male (SVM):** The MMSE scores remain unchanged with BMI.
- **Female (SVM):** The MMSE scores decline by 0.02 units for each unit increase in BMI, representing a 0.09% decrease in the average MMSE score.
- **Male (XGBoost):** The MMSE scores decline by 0.02 units for each unit increase in BMI, representing a 0.08% decrease in the average MMSE score.
- **Female (XGBoost):** The MMSE scores decline by 0.02 units for each unit increase in BMI, representing a 0.09% decrease in the average MMSE score.

3. BMI vs BDNF pmol/L

- **Overall (Linear Regression):** The BDNF levels decline by 21.83 pmol/L for each unit increase in BMI, representing a 7.59% decrease in the average BDNF level.
- **Overall (SVM):** The BDNF levels decline by 1.21 pmol/L for each unit increase in BMI, representing a 0.42% decrease in the average BDNF level.
- **Overall (XGBoost):** The BDNF levels decline by 0.18 pmol/L for each unit increase in BMI, representing a 0.06% decrease in the average BDNF level.

By Gender:

- **Male (Linear Regression):** The BDNF levels decline by 16.44 pmol/L for each unit increase in BMI, representing a 5.59% decrease in the average BDNF level.
- **Female (Linear Regression):** The BDNF levels decline by 30.55 pmol/L for each unit increase in BMI, representing a 10.88% decrease in the average BDNF level.
- **Male (SVM):** The BDNF levels increase slightly by 0.02 pmol/L for each unit increase in BMI, representing a 0.01% increase in the average BDNF level.
- **Female (SVM):** The BDNF levels decline by 3.64 pmol/L for each unit increase in BMI, representing a 1.30% decrease in the average BDNF level.

- **Male (XGBoost):** The BDNF levels increase by 0.17 pmol/L for each unit increase in BMI, representing a 0.06% increase in the average BDNF level.
- **Female (XGBoost):** The BDNF levels decline by 0.32 pmol/L for each unit increase in BMI, representing a 0.11% decrease in the average BDNF level.

Conclusion

The analysis highlights the varying impact of BMI on cognitive and biomarker measures, with differences observed across different models and between genders. The findings suggest a more pronounced decline in cognitive scores and BDNF levels with increasing BMI in males compared to females. These insights can inform future research and interventions aimed at mitigating the impact of BMI on cognitive health and biomarkers.

OR

The analysis revealed notable differences in the relationship between BMI and cognitive/biomarker measures (MoCA, MMSE, BDNF) across different models (Linear Regression, SVM, XGBoost) and genders. Here are the key conclusions:

BMI vs MoCA:

Overall:

- Linear Regression showed a slight decline in MoCA scores with increasing BMI.
- SVM indicated a minimal decline.
- XGBoost showed a slight increase.

By Gender:

- Males exhibited a greater decline in MoCA scores with increasing BMI using Linear Regression and XGBoost, whereas SVM showed no change.
- Females had negligible changes in MoCA scores with BMI across all models, with slight increases in SVM and XGBoost.

BMI vs MMSE Total Scores:

Overall:

Linear Regression and XGBoost indicated a minor decline in MMSE scores with increasing BMI. SVM showed no change.

By Gender:

Both males and females showed declines in MMSE scores with increasing BMI across all models, with females exhibiting a more pronounced decline in Linear Regression.

BMI vs BDNF pmol/L:

Overall:

Linear Regression showed a significant decline in BDNF levels with increasing BMI.

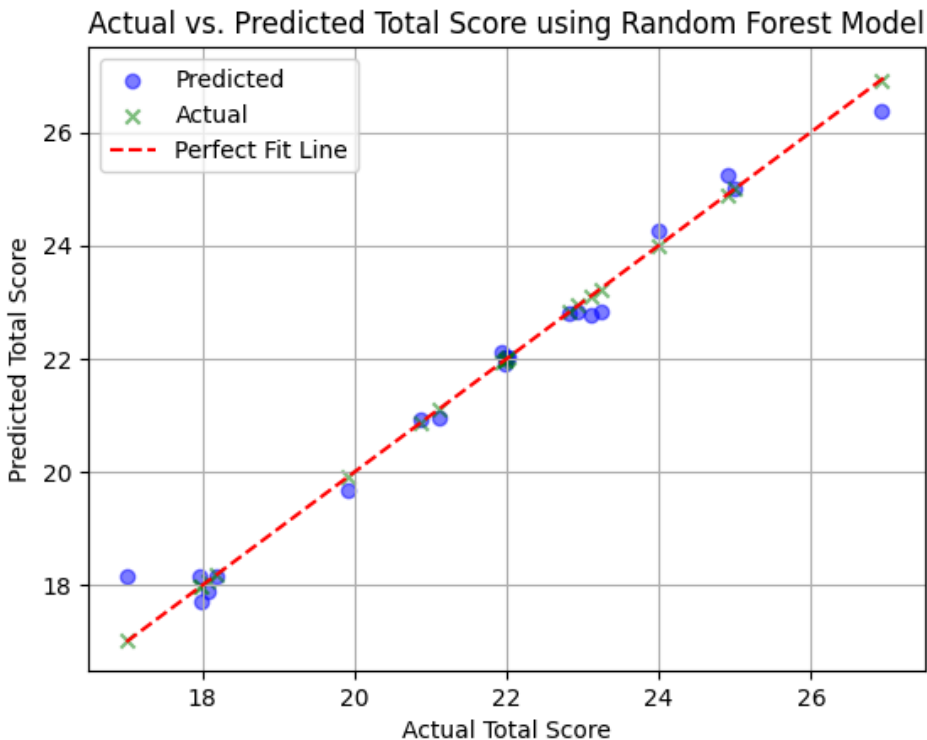
SVM and XGBoost showed lesser declines.

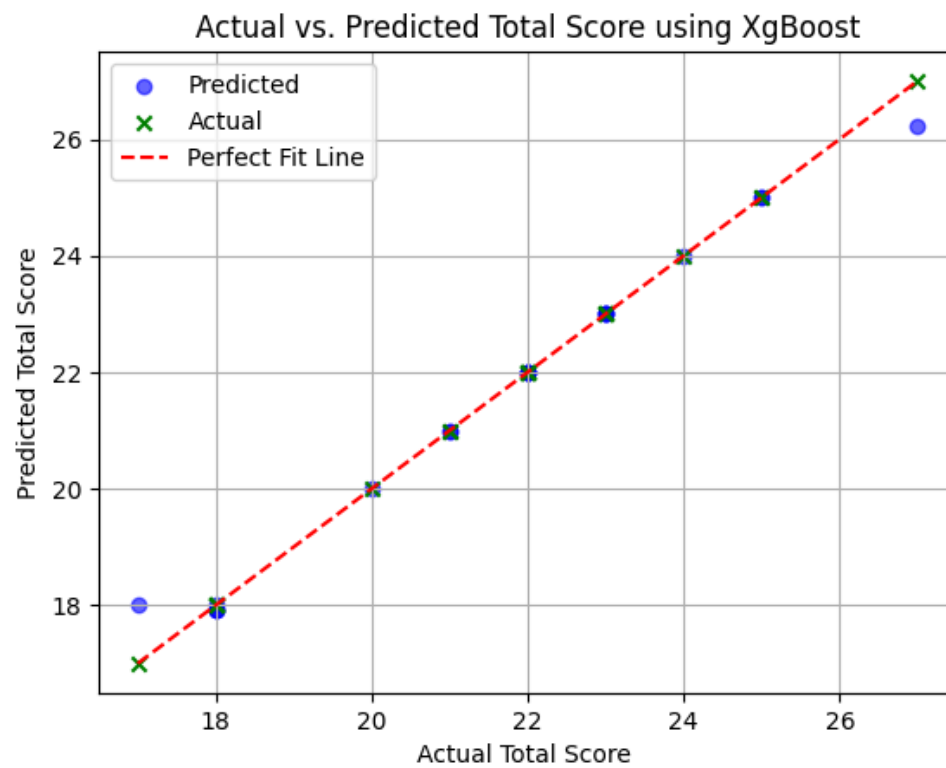
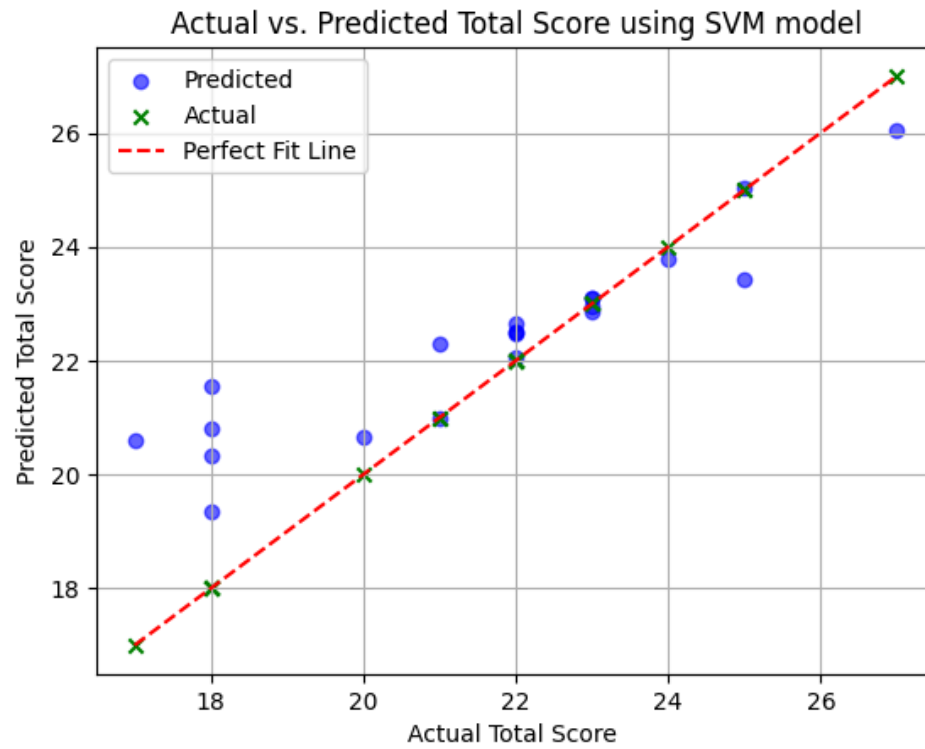
By Gender:

- Males exhibited a decline in BDNF levels with increasing BMI in Linear Regression, whereas SVM showed a slight increase and XGBoost showed a moderate increase.
- Females showed a more substantial decline in BDNF levels with increasing BMI across all models, with the largest decline observed in Linear Regression.

In summary, the relationship between BMI and cognitive/biomarker measures varies across different models and genders. Males generally show a more consistent decline in cognitive scores and BDNF levels with increasing BMI, while females show a more substantial decline in BDNF levels but minimal changes in cognitive scores. These findings underscore the importance of considering gender differences in assessing the impact of BMI on cognitive health and biomarkers.

Now Go through the different model's accuracy





Conclusion

- ALL models work well.
- XgBoost has an accuracy of 98.85% and Random Forest has an accuracy of 98.83%

- linear regression shows an accuracy of 100% which indicates an overfitting problem. To resolve this I have used cross-validations and Regularization techniques like Ridge and Lasso then achieve an accuracy of 99.6%
- SVM performs average on the given dataset by showing the accuracy of 67%.