HADASSAH MEDICAL CENTER

Multiple Sclerosis Treatment Effectiveness

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We examine the effectiveness of various Multiple Sclerosis (MS) treatments using several key metrics and patient characteristics, based on a dataset of 528 MS patients.

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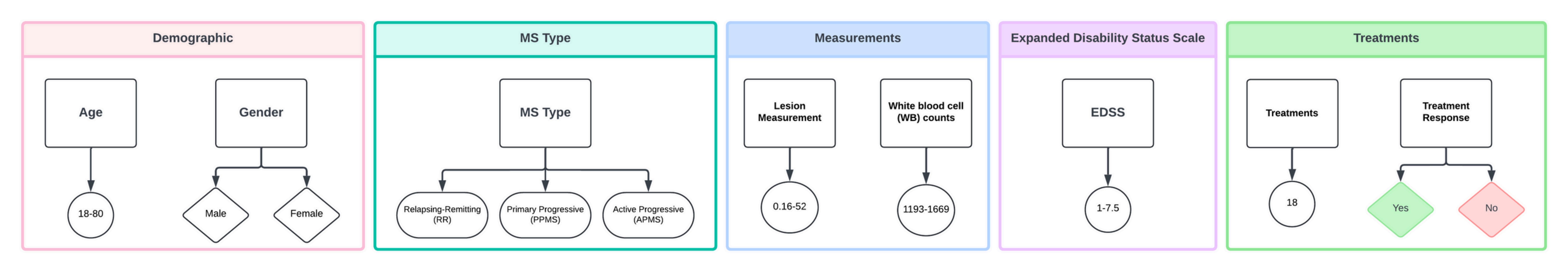
Dataset

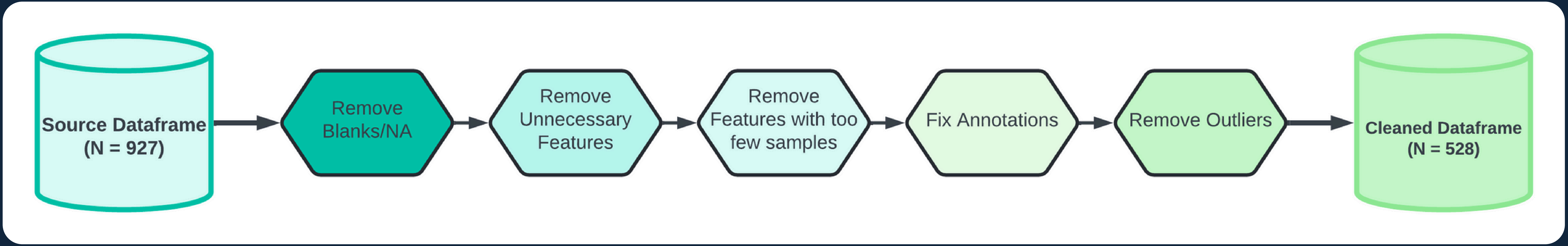
(Post-Cleaning)

The Dataset includes MS patients with various demographic and clinical characteristics.

This allows for analysis of treatment effectiveness across different patient profiles, MS types, and disability levels, providing valuable insights for personalized MS management strategies.

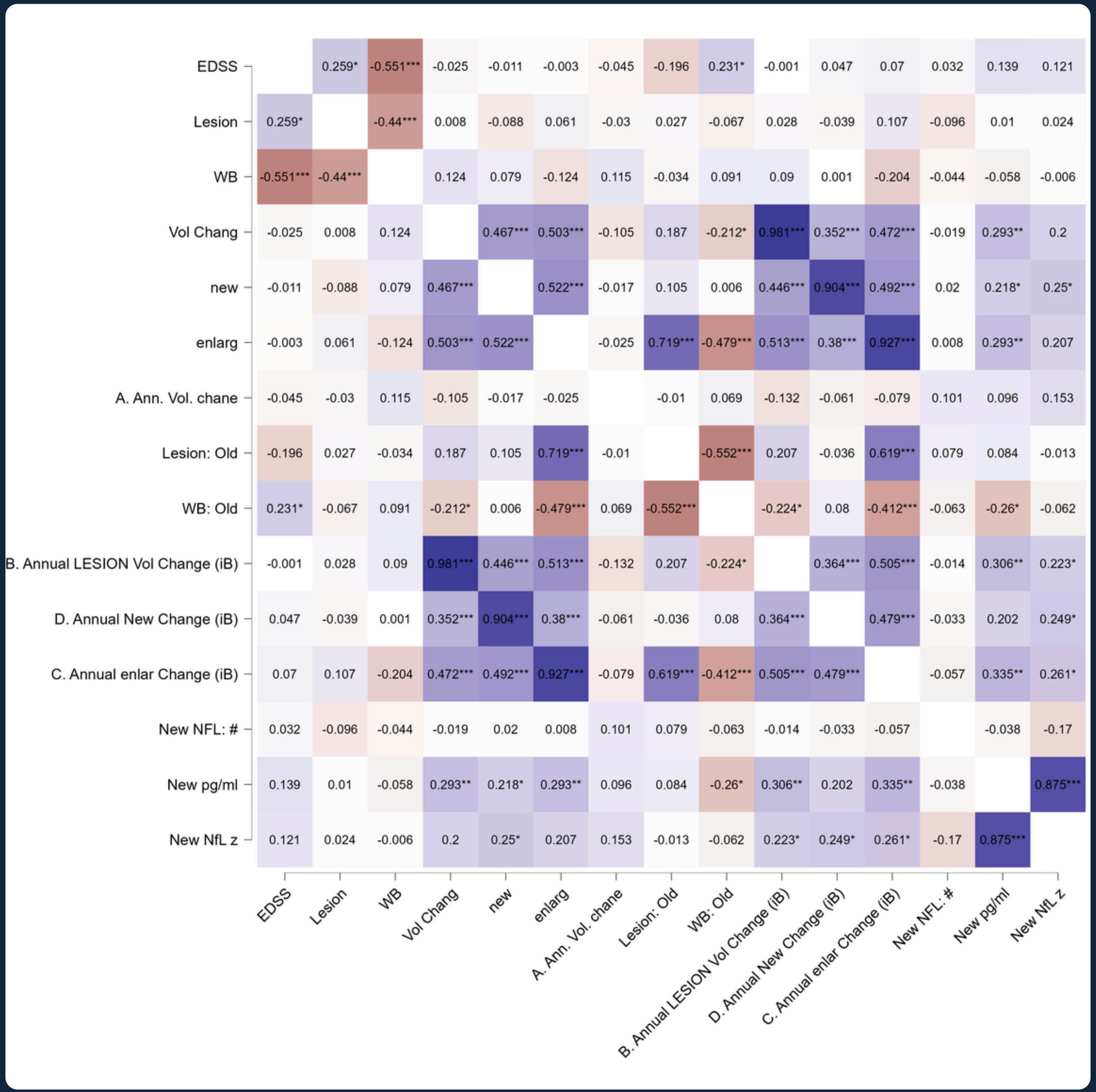


Data Cleaning



Data Cleaning

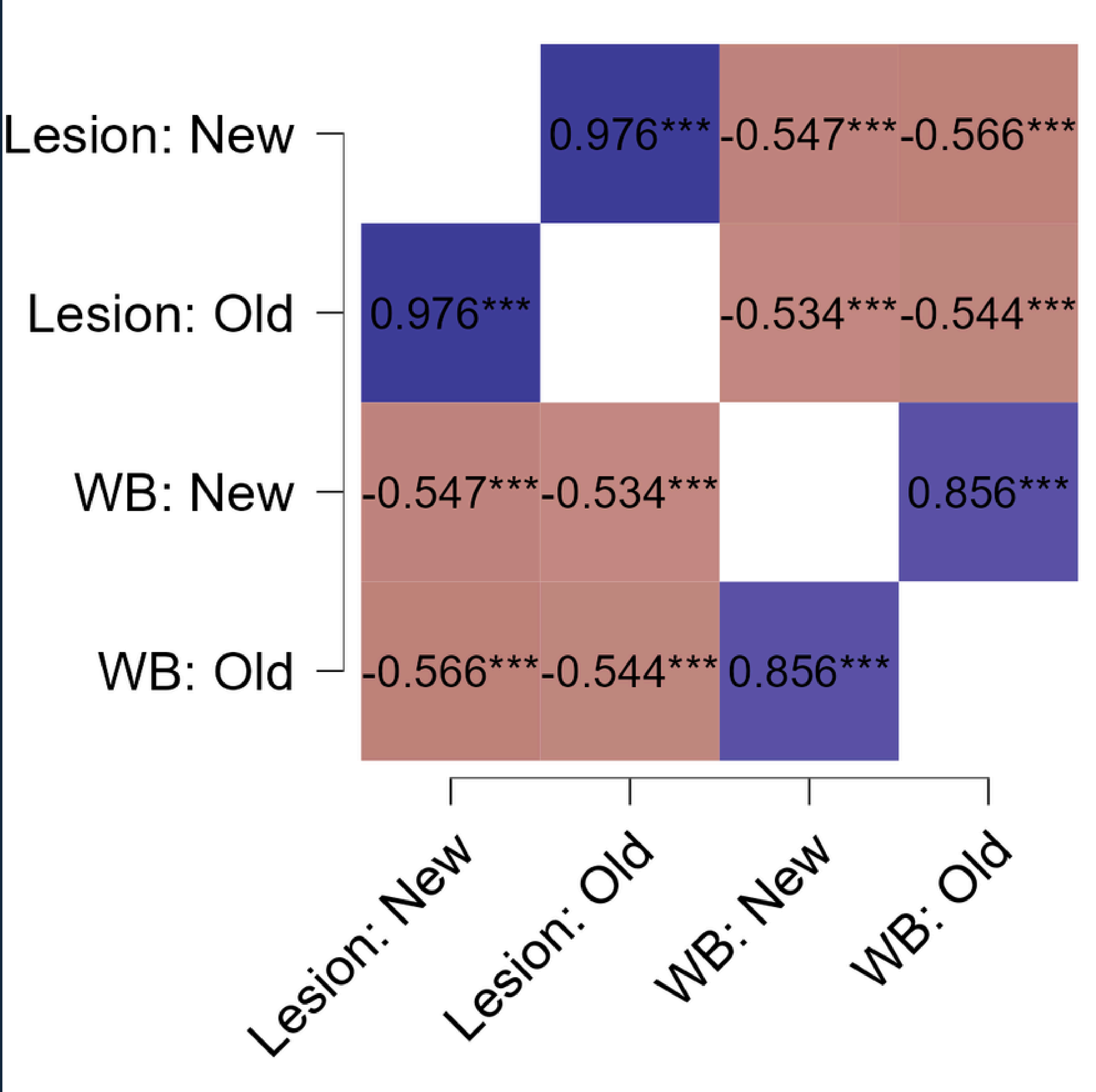
Spearman correlations



Removing features with high collinearity, or with too few samples (N<500)

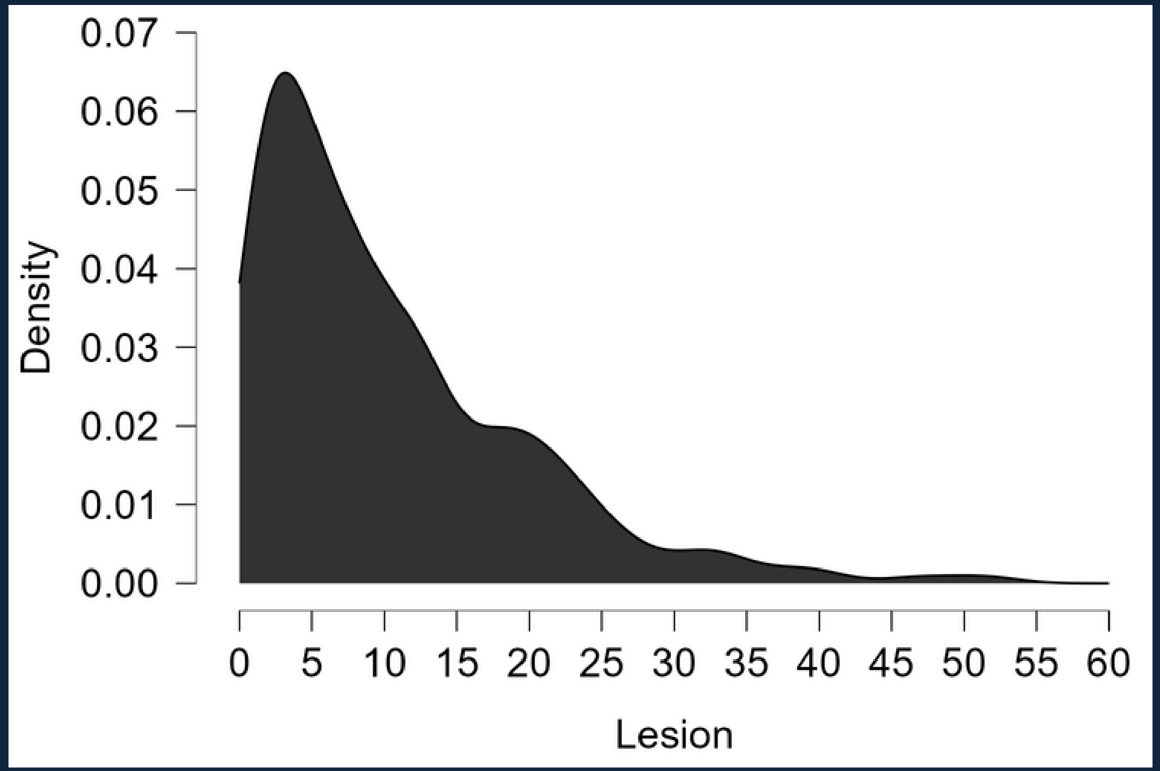
Data Cleaning

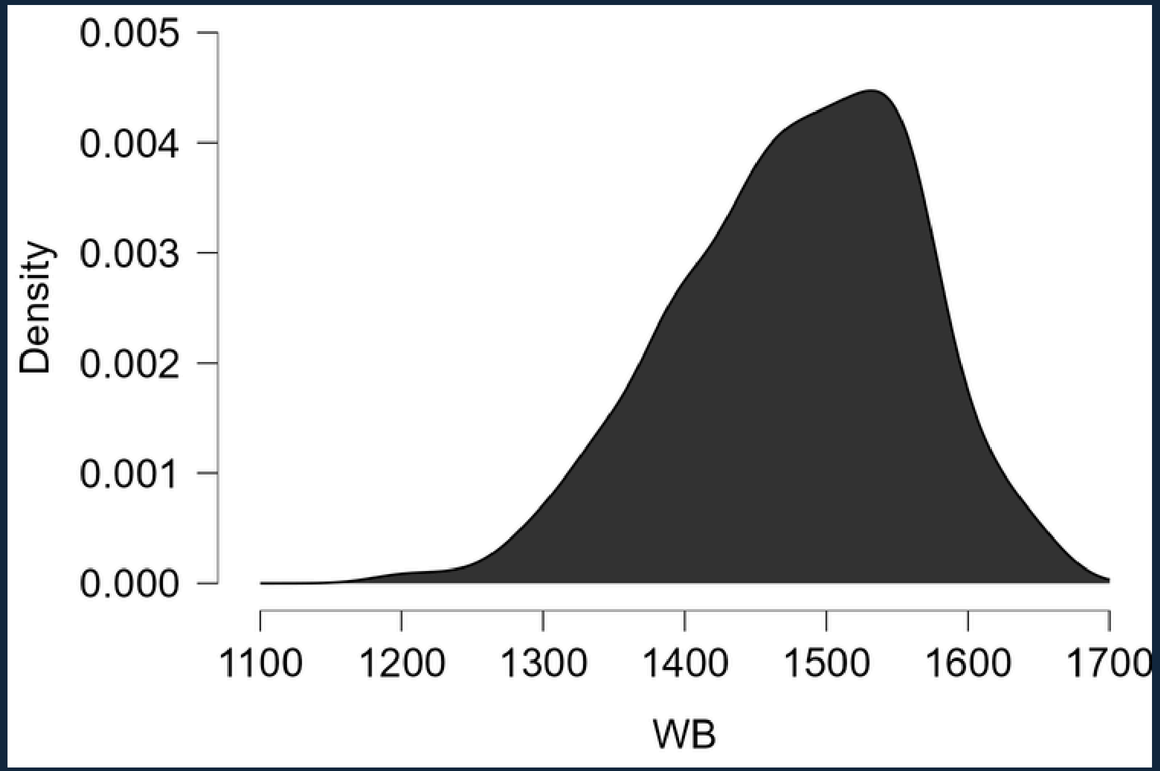
Spearman correlations

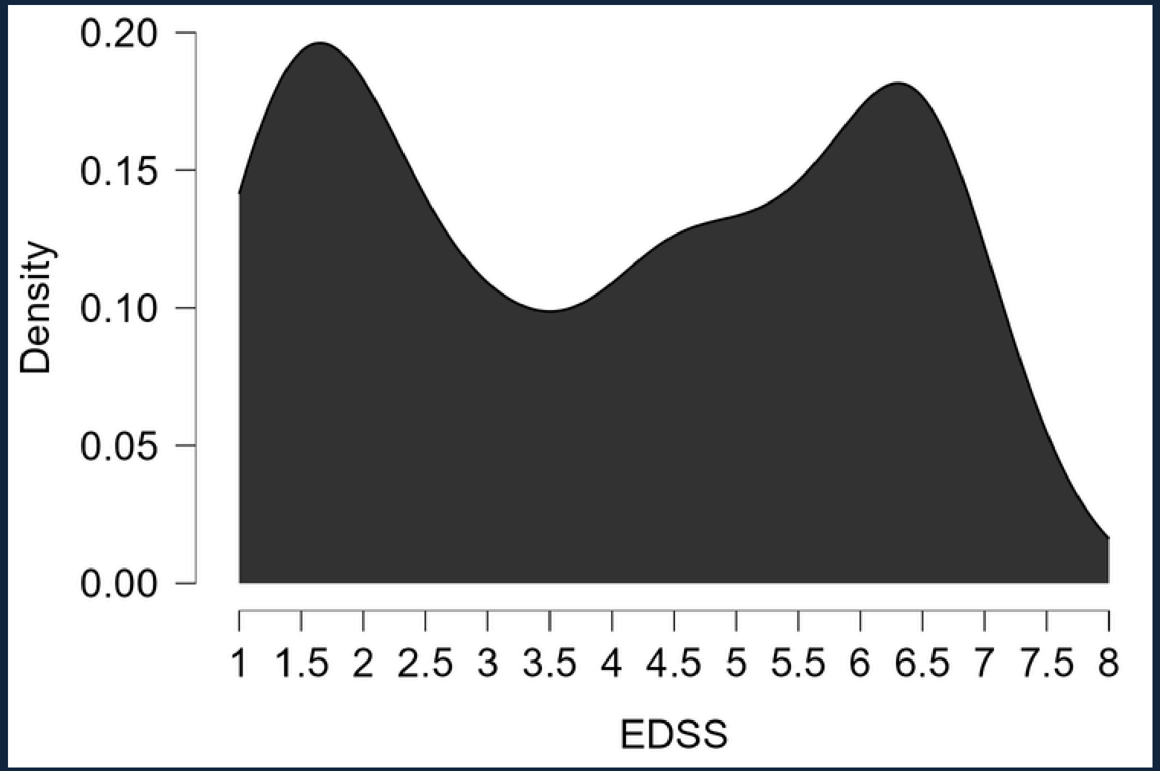


Due to high collinearity, we keep only the current/new measurements

Data Distributions



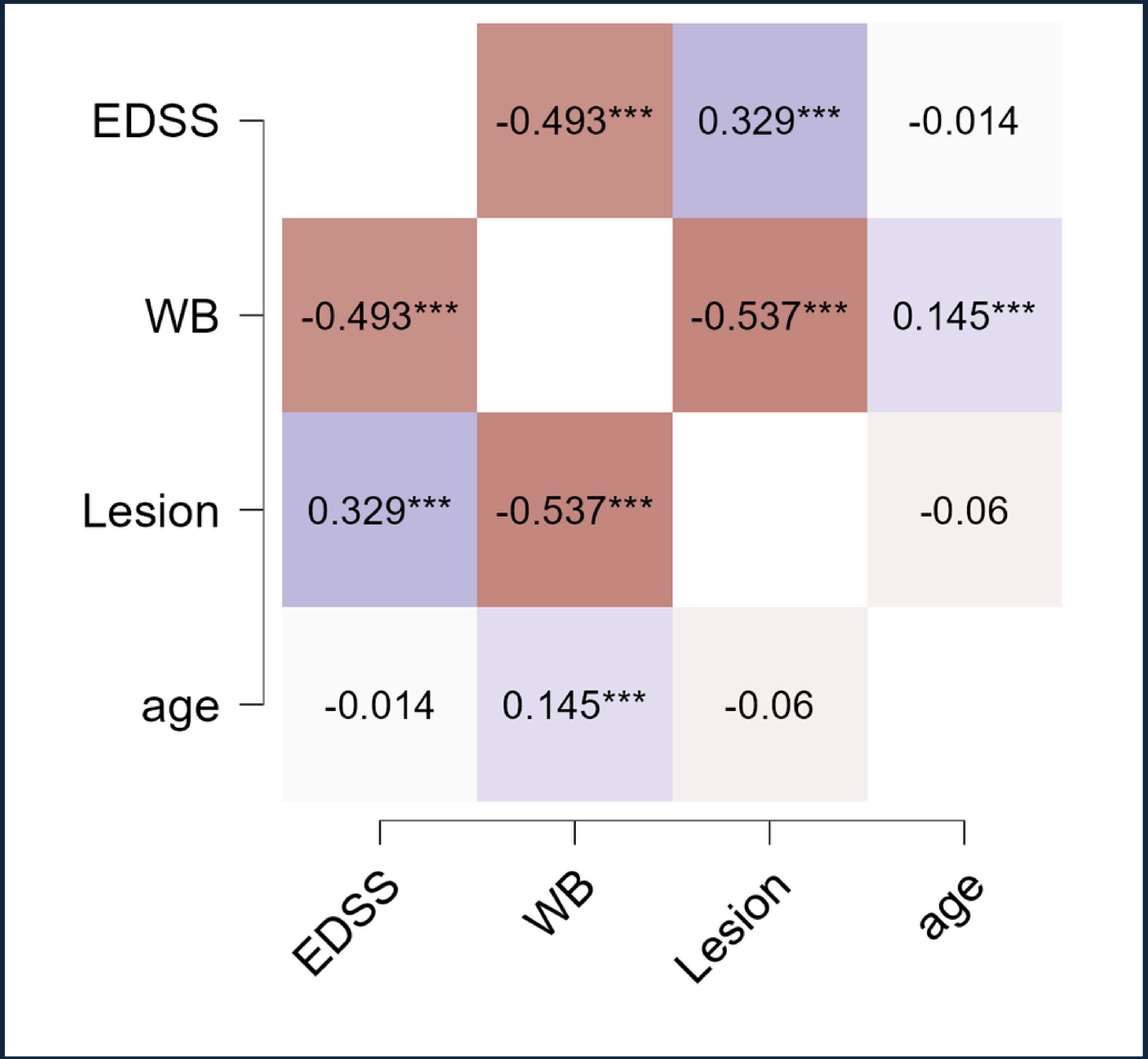


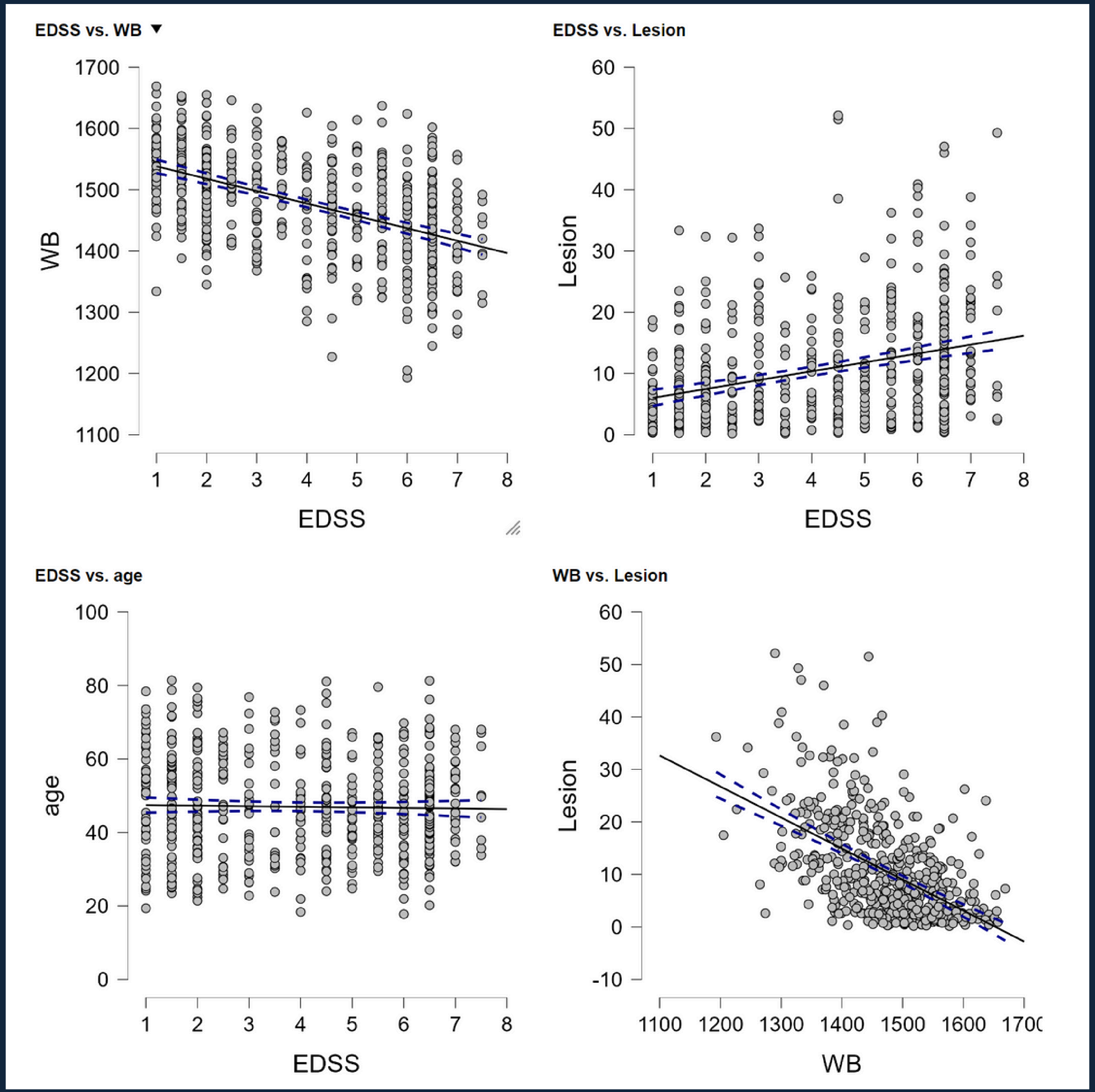


EDSS

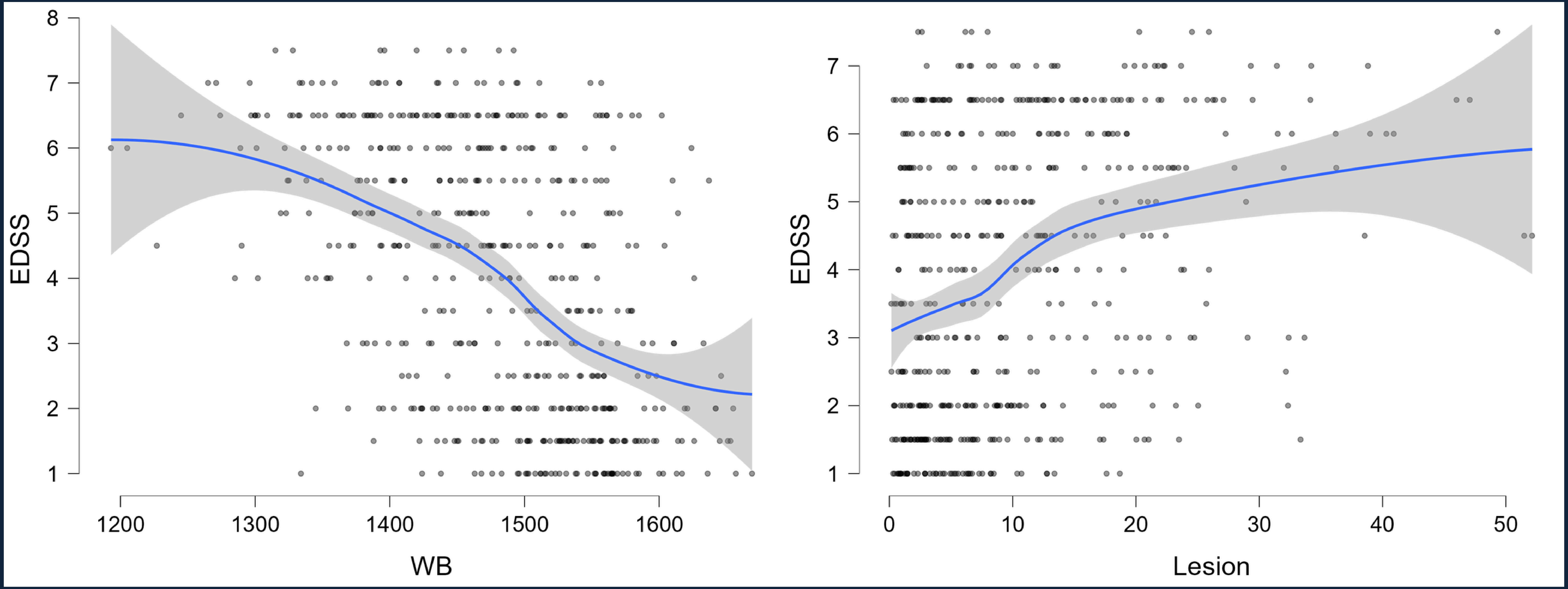
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
normal brain functioning
some disability
requires walking assistance/ aid
restricted to wheelchair
restricted to bed/ wheelchair
bedridden
death

EDSS - Correlations

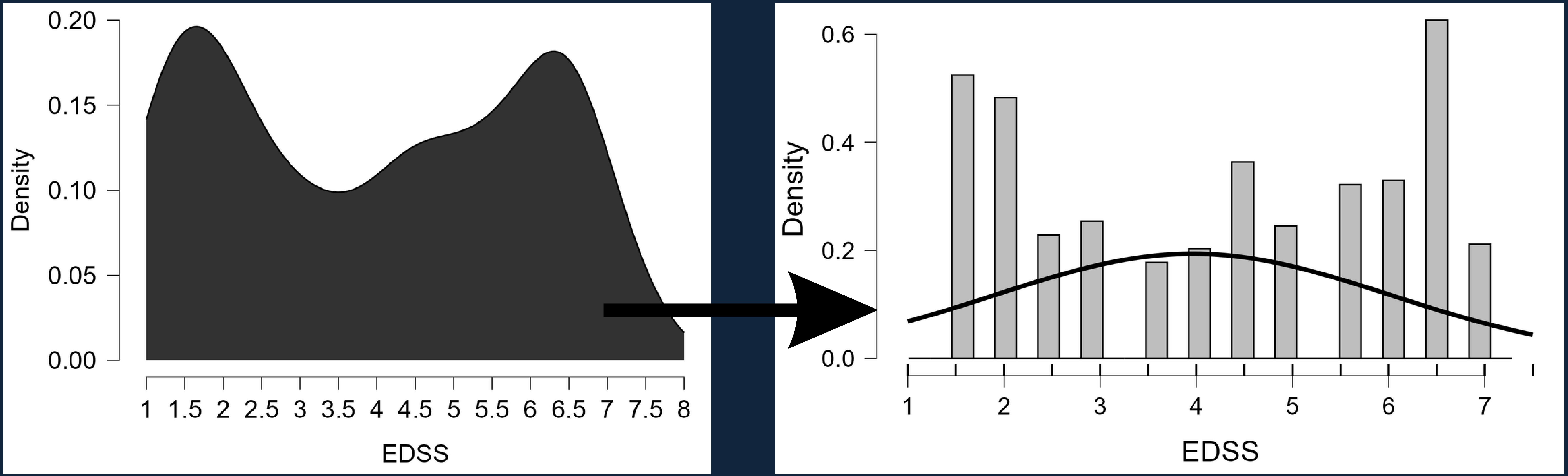




EDSS - Scatterplots



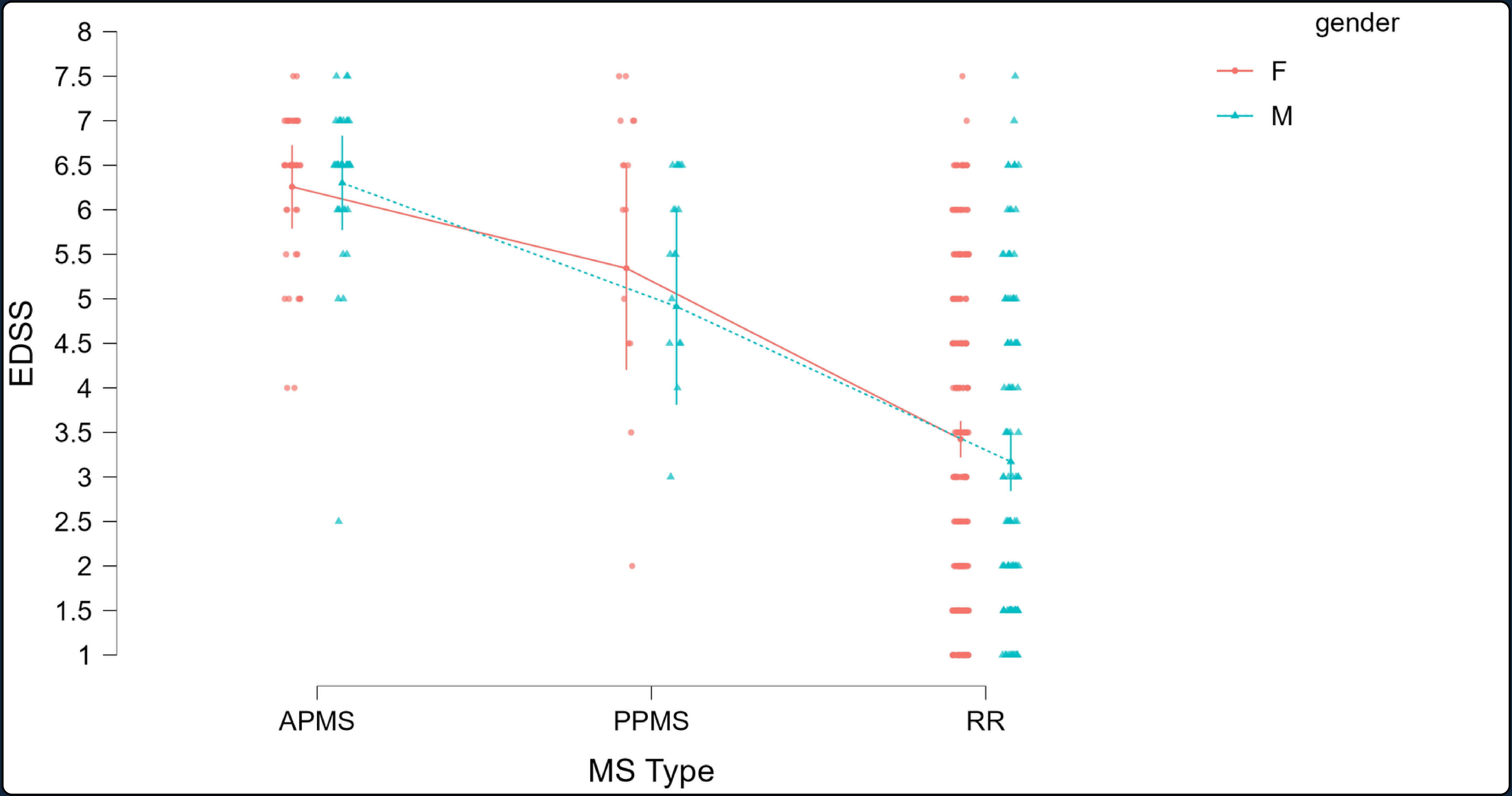
EDSS



EDSS is not normally distributed.

Predicting EDSS by MS Type and Gender

Generalized Linear Mixed Model (CI=95%)

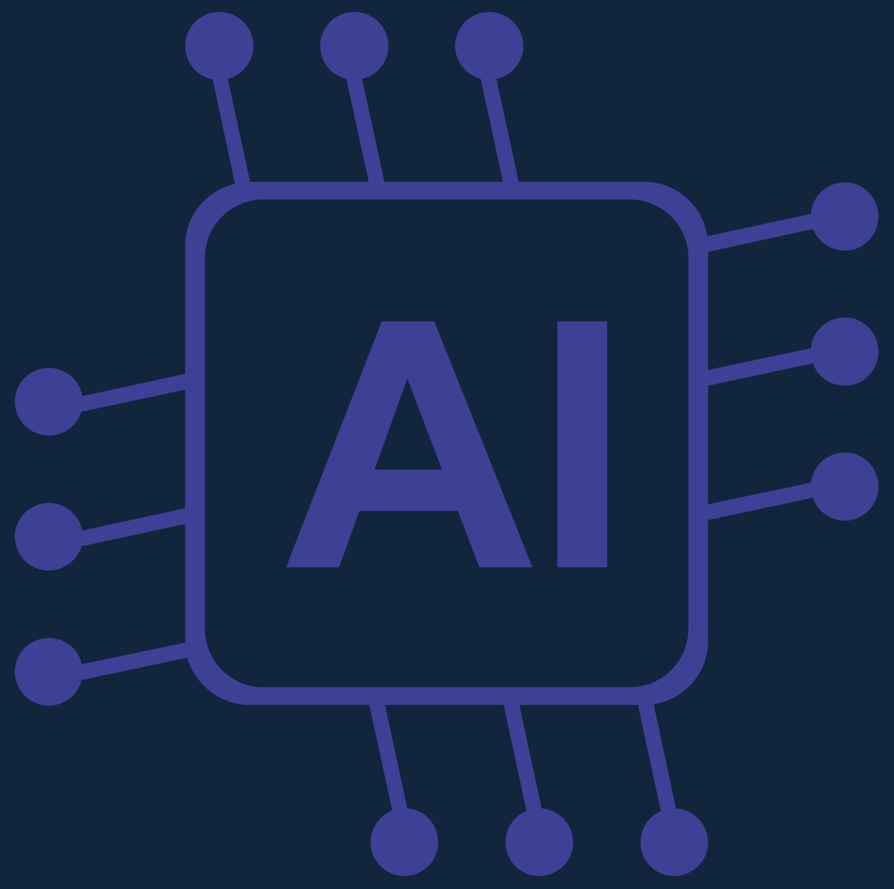


Using Machine Learning to Predict EDSS

A **Decision Tree Regressor** is ideal for predicting EDSS with limited features:

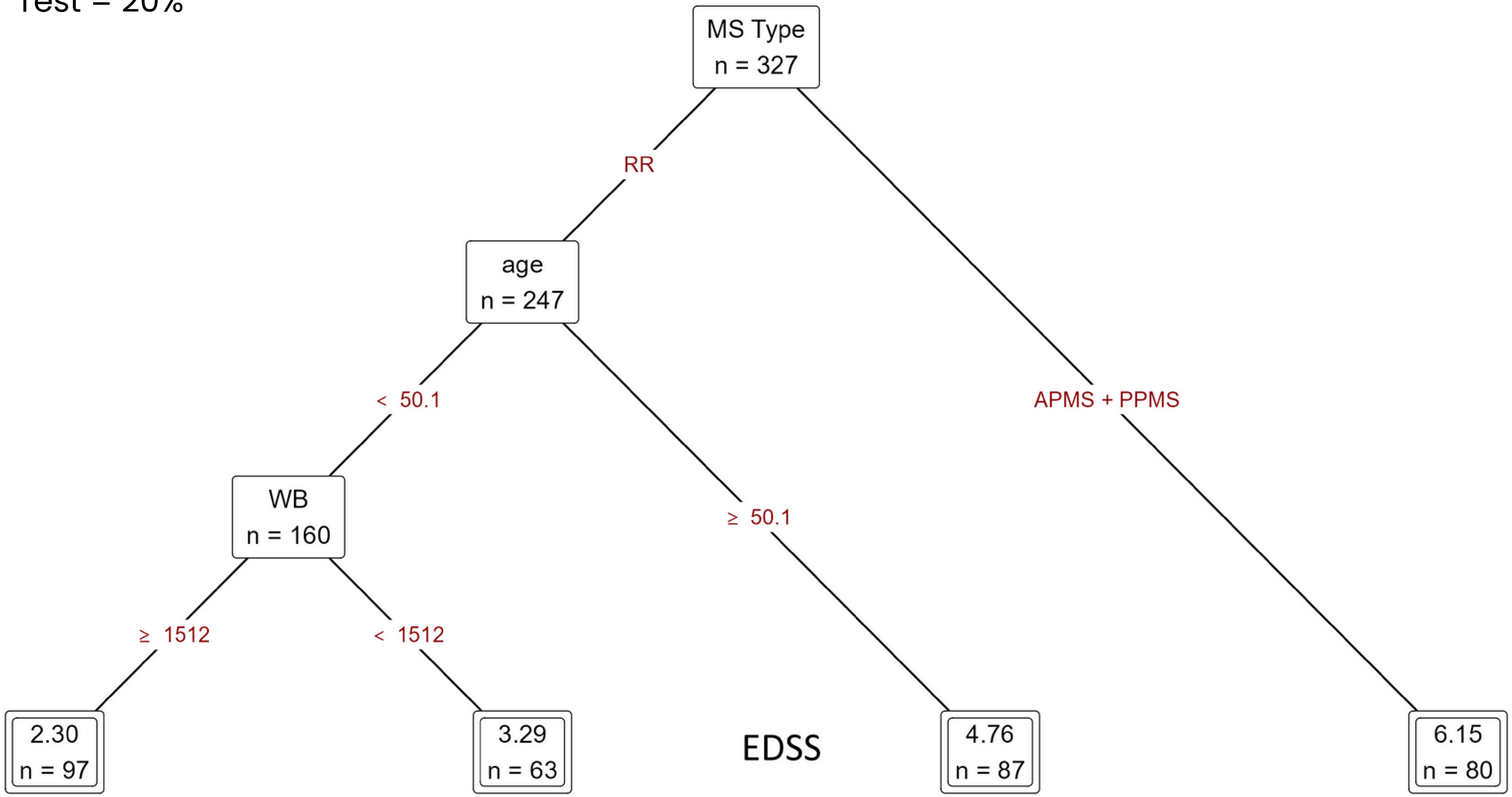
- Highly interpretable
- Non-Parametric
- Provides clear feature importance rankings
- Less likely to overfit on small datasets
- Aligns with clinical decision-making processes
- Computationally efficient

This simplicity and transparency make it a good starting point for modeling EDSS in Multiple Sclerosis patients, balancing predictive power with clinical usefulness.



EDSS Prediction (CI=100%)

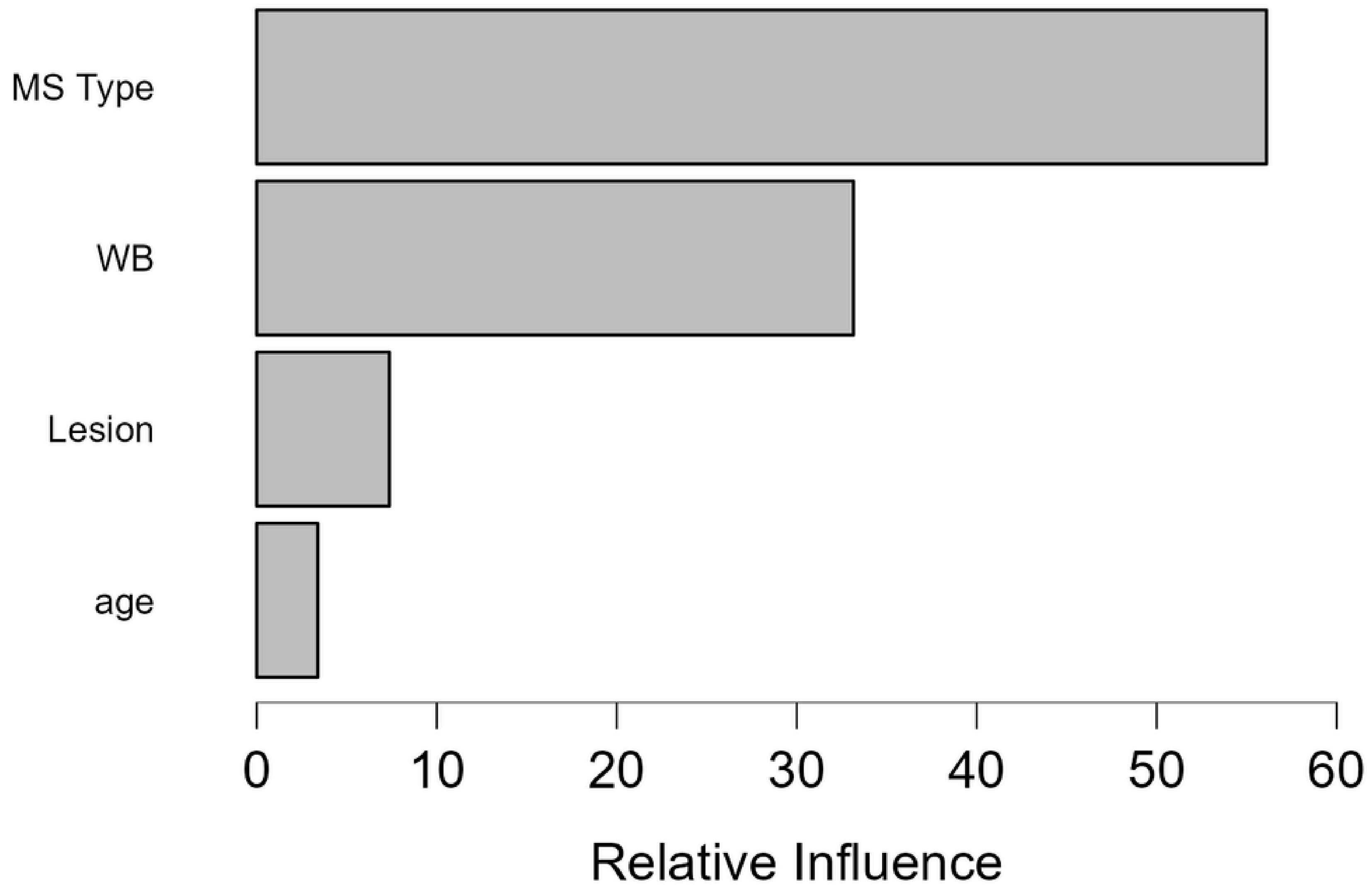
Train = 80%
Test = 20%



Model Evaluation

Model Performance Metrics

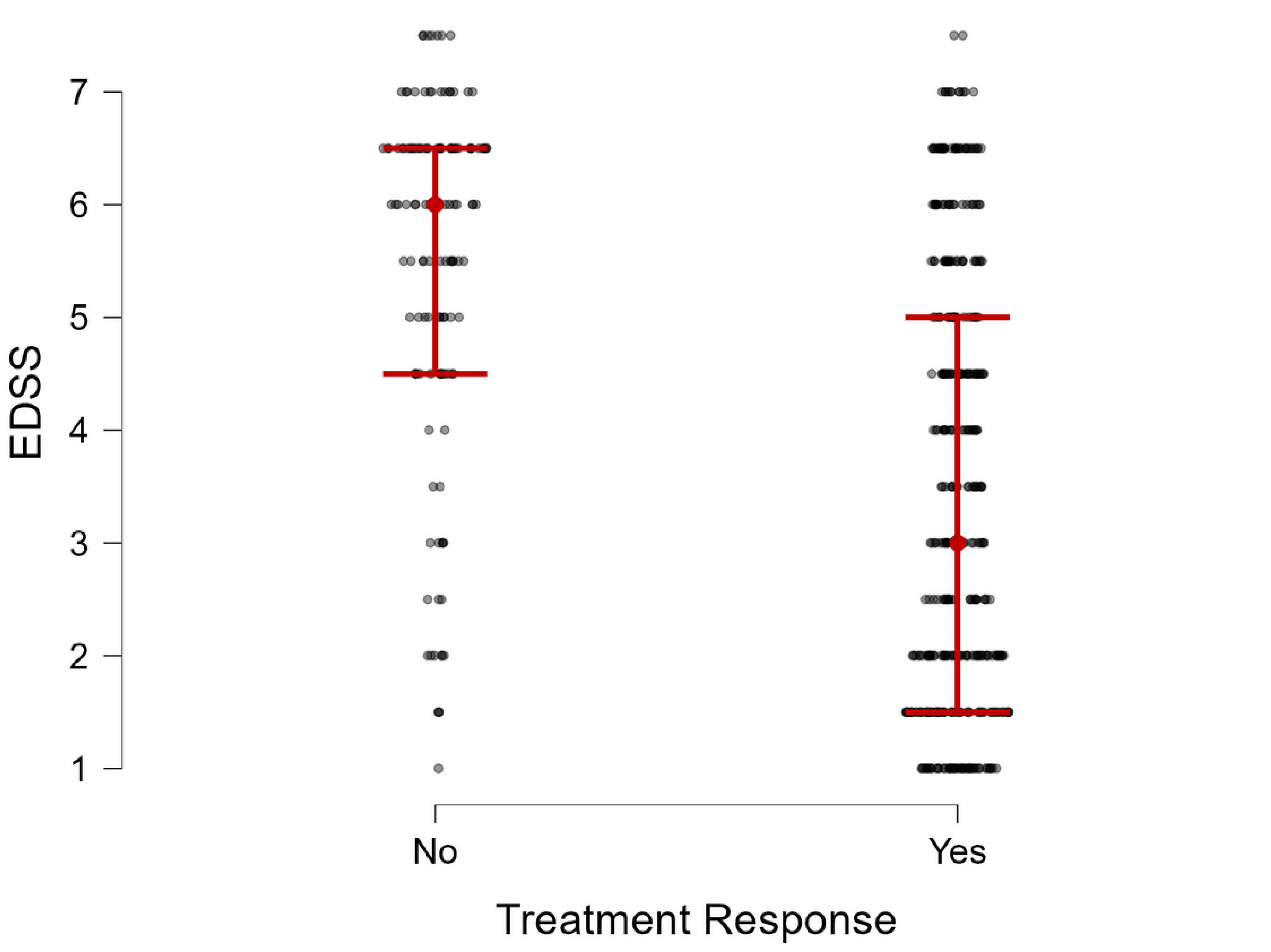
	Value
MSE	1.985
RMSE	1.409
MAE / MAD	1.133
MAPE	45.35%
R^2	0.581



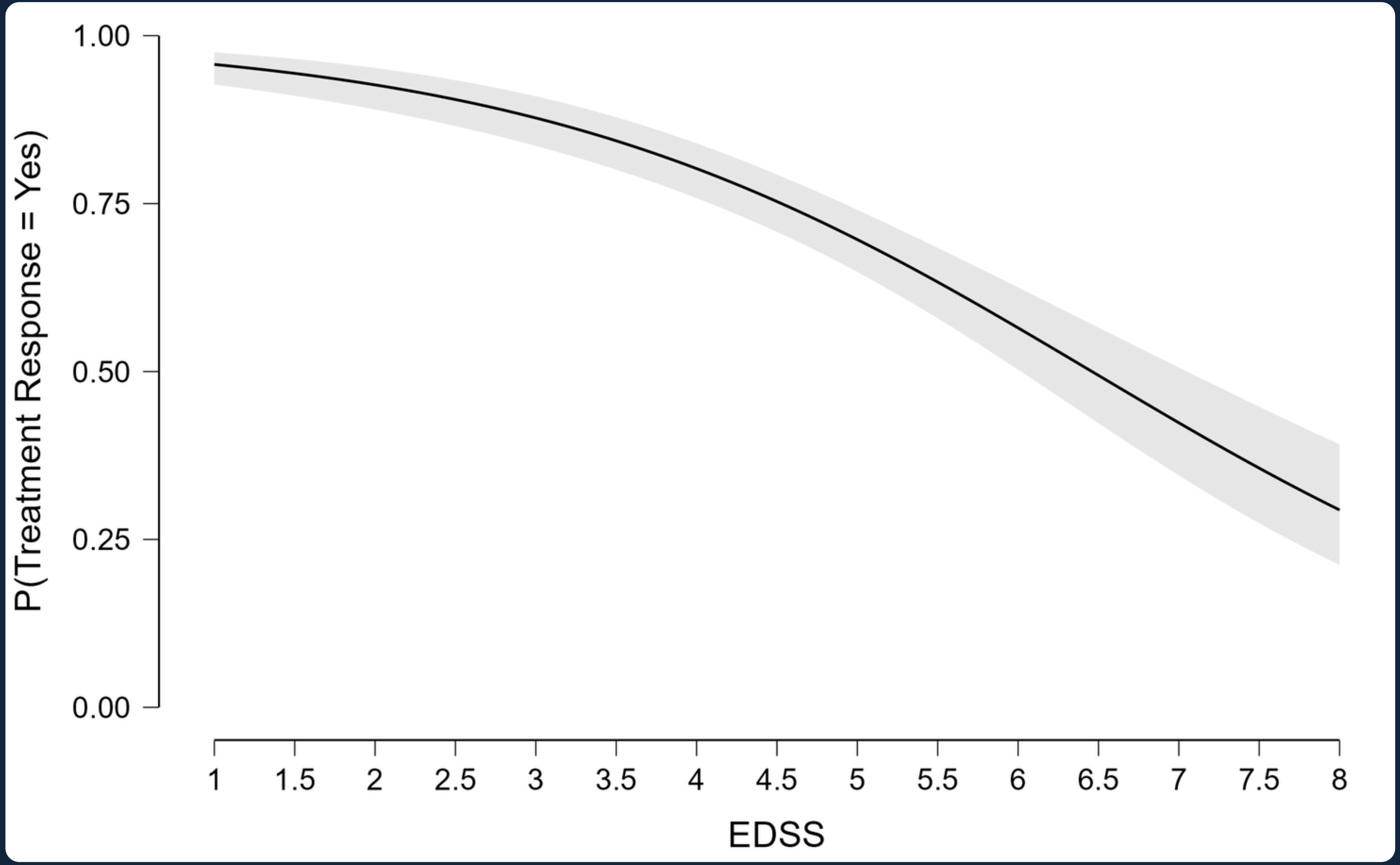
Model predictions error is around ±1.4 (RMSE)

EDSS and Response to Treatments

Mann-Whitney : p<0.001

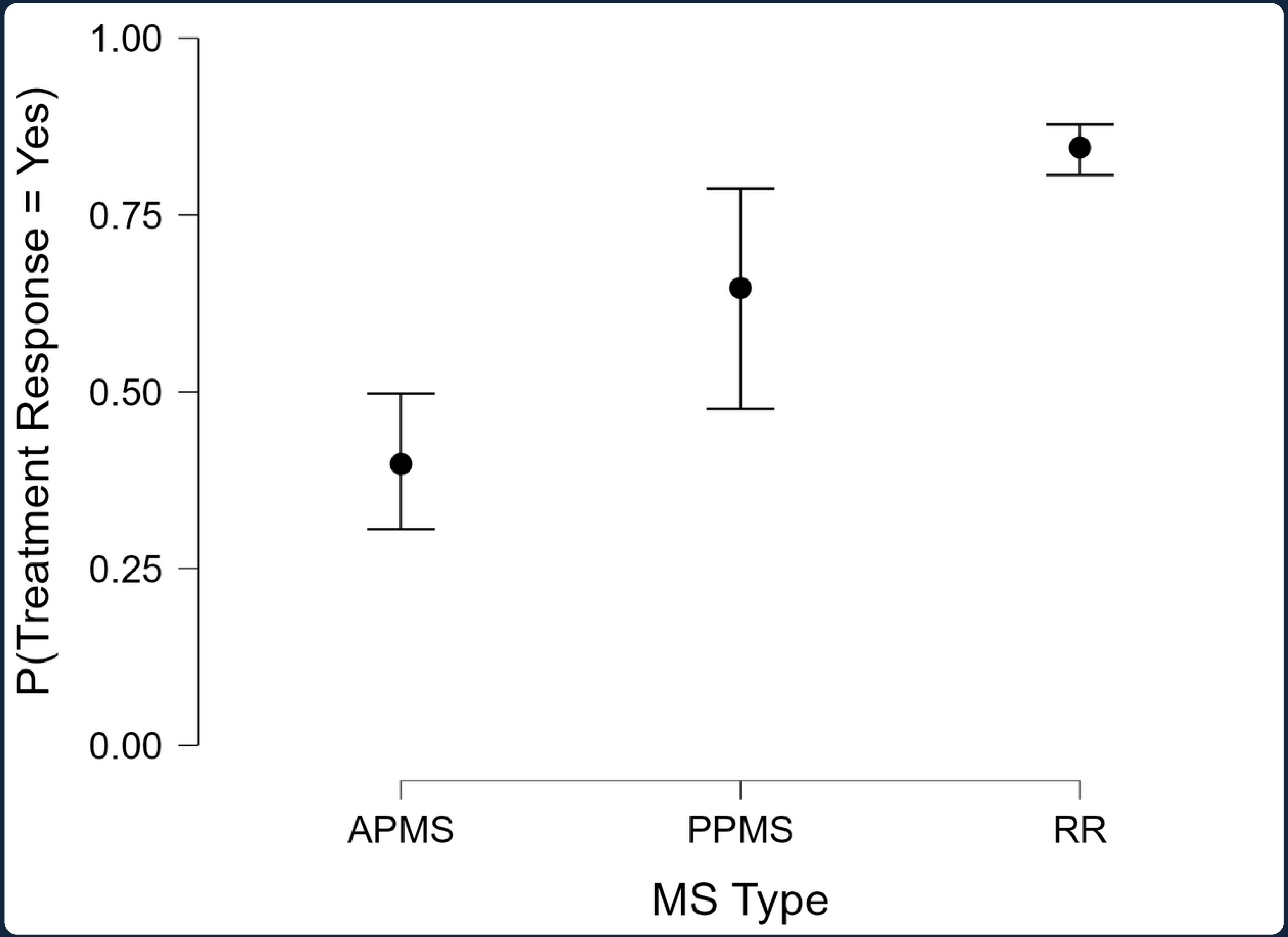


Logistic Regression (CI=95%)



Response to Treatments by MS Type

Logistic Regression (CI=95%)



Using Machine Learning to Predict Effective Treatments

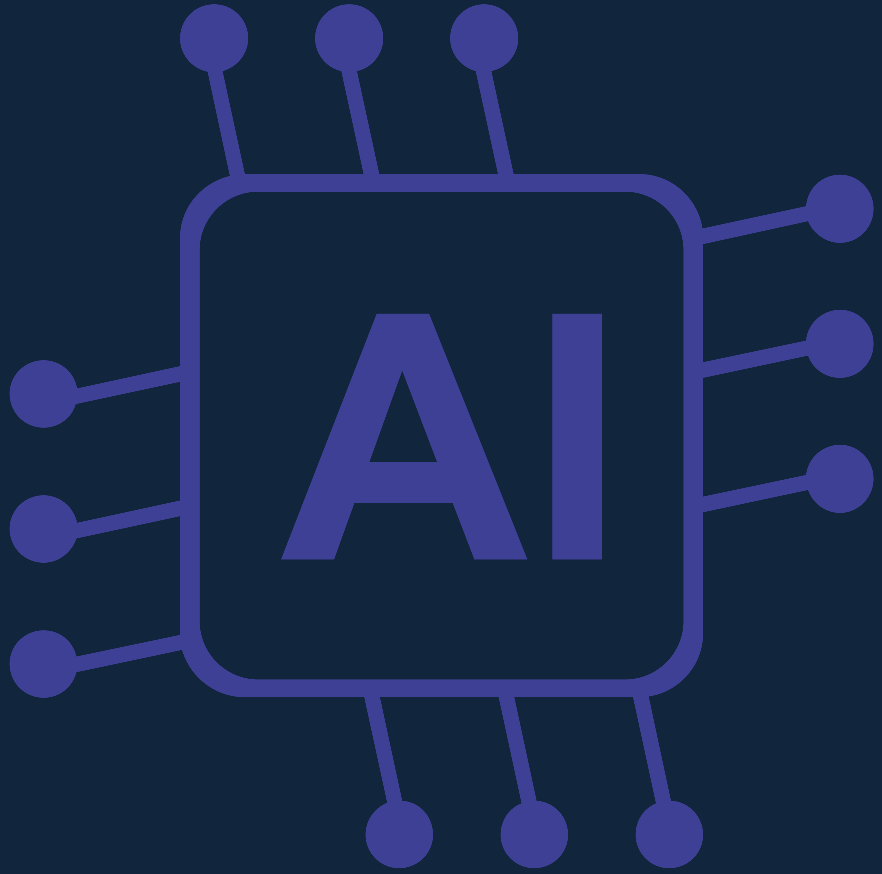
We aimed to identify the best treatment combinations for patients using machine learning models.

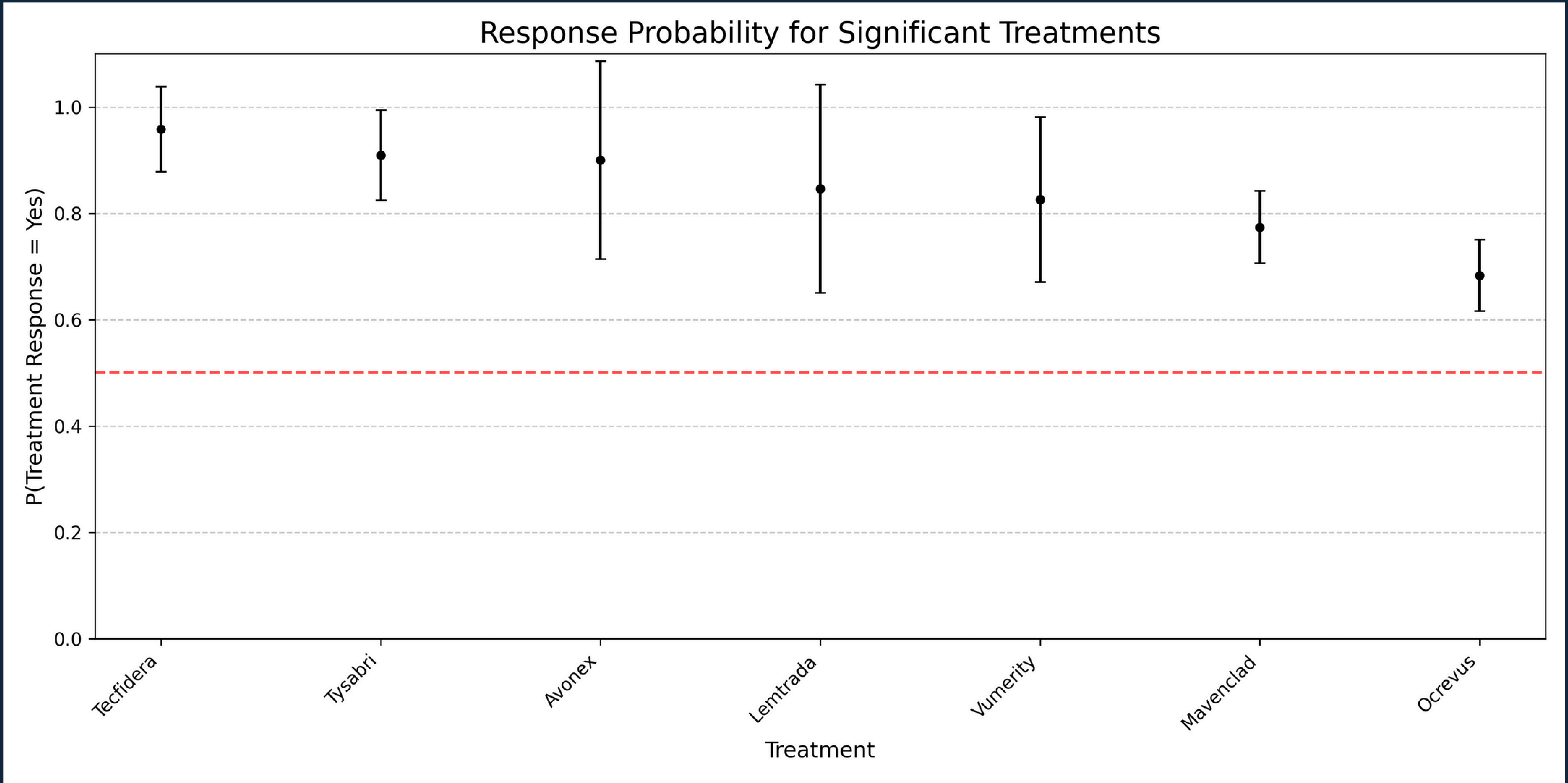
The Decision Tree classifier model was the best, with F1 score of 0.72 due to the task low complexity, which help to identify significant treatment combinations with high interpretability.

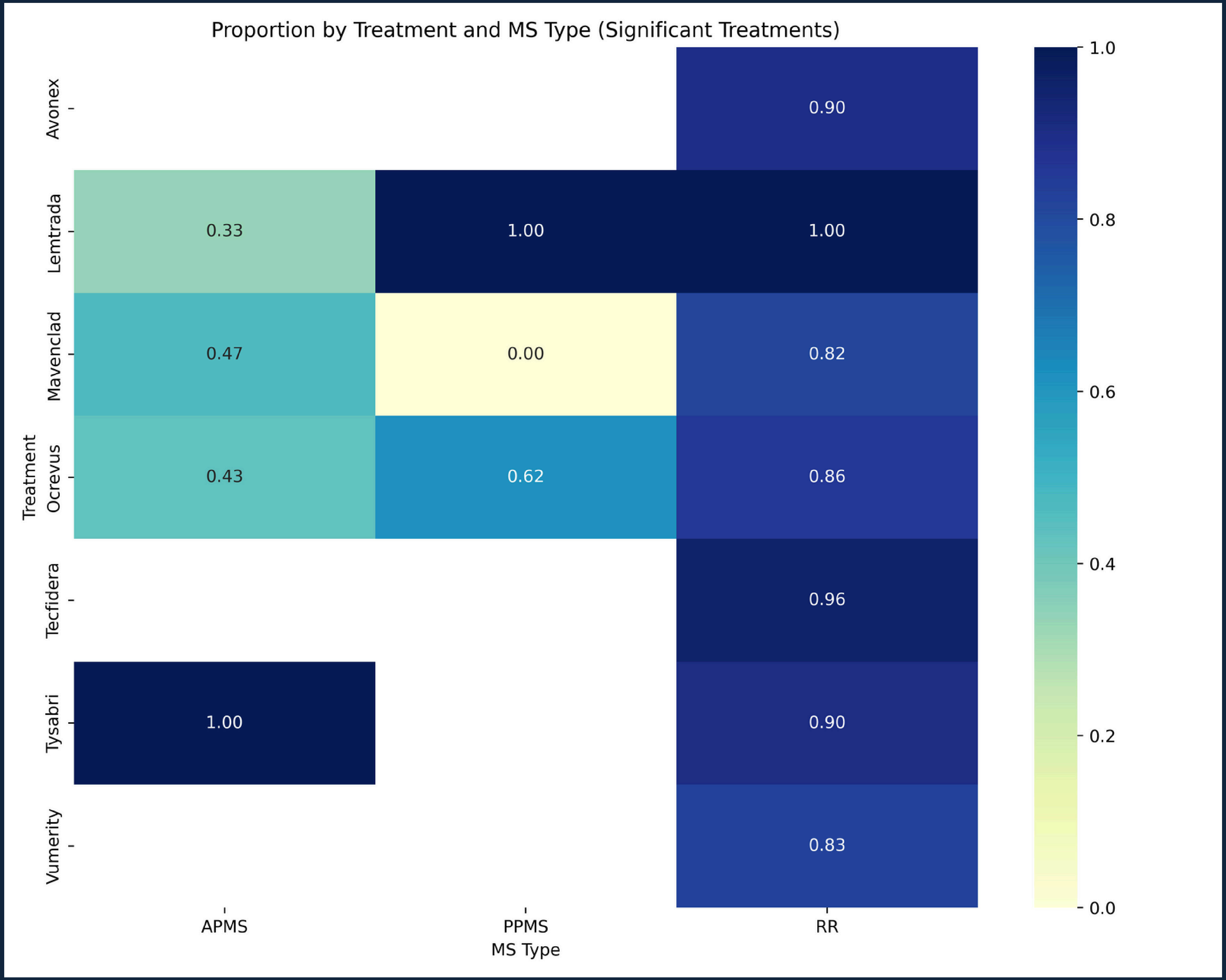
Models Tested:

1. Decision Tree
2. Gradient Boosting
3. Random Forest
4. Support Vector Machine
5. K-Nearest Neighbors

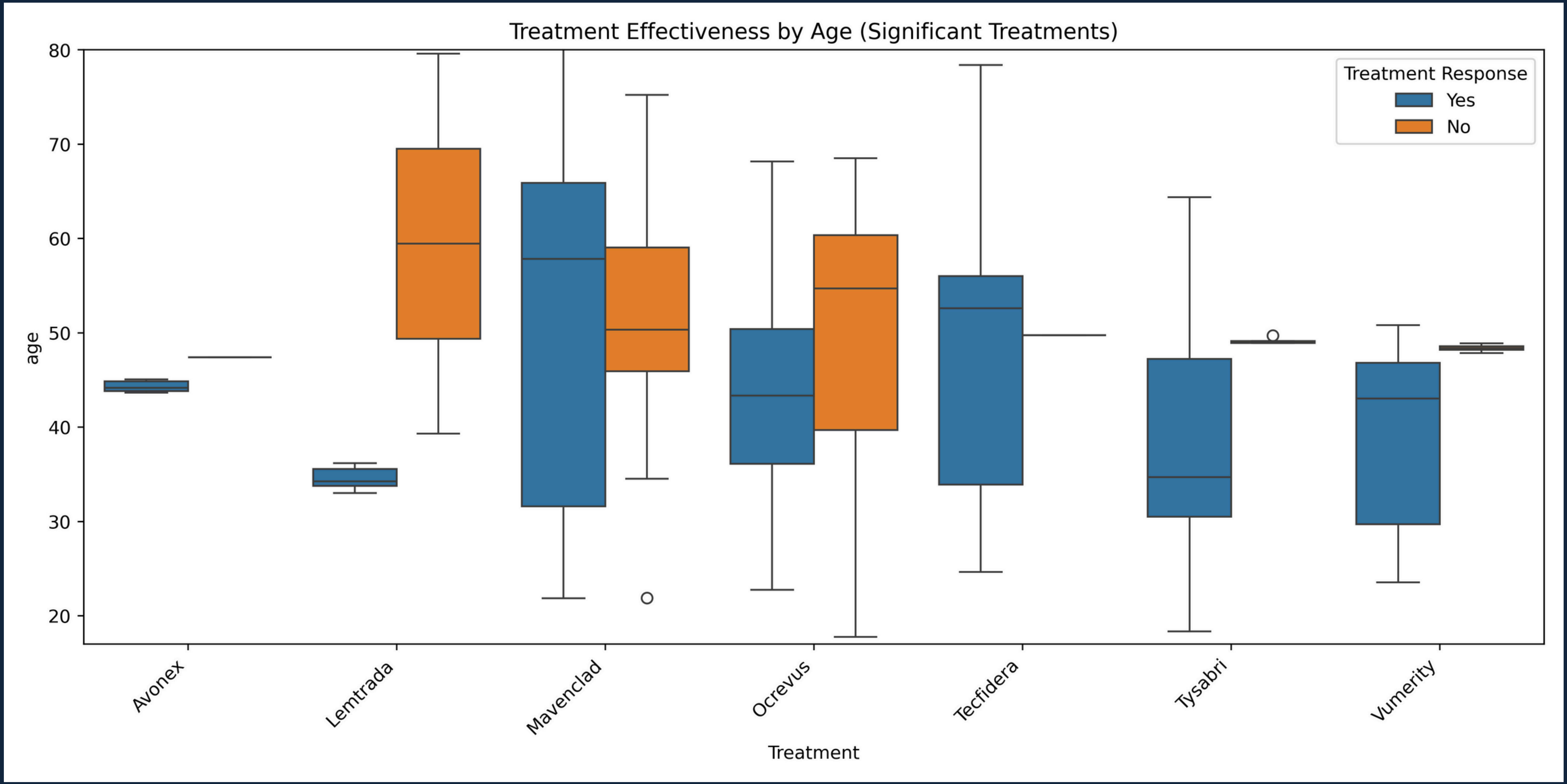
- Due to small sample size for some treatments our predictions reliability is limited.

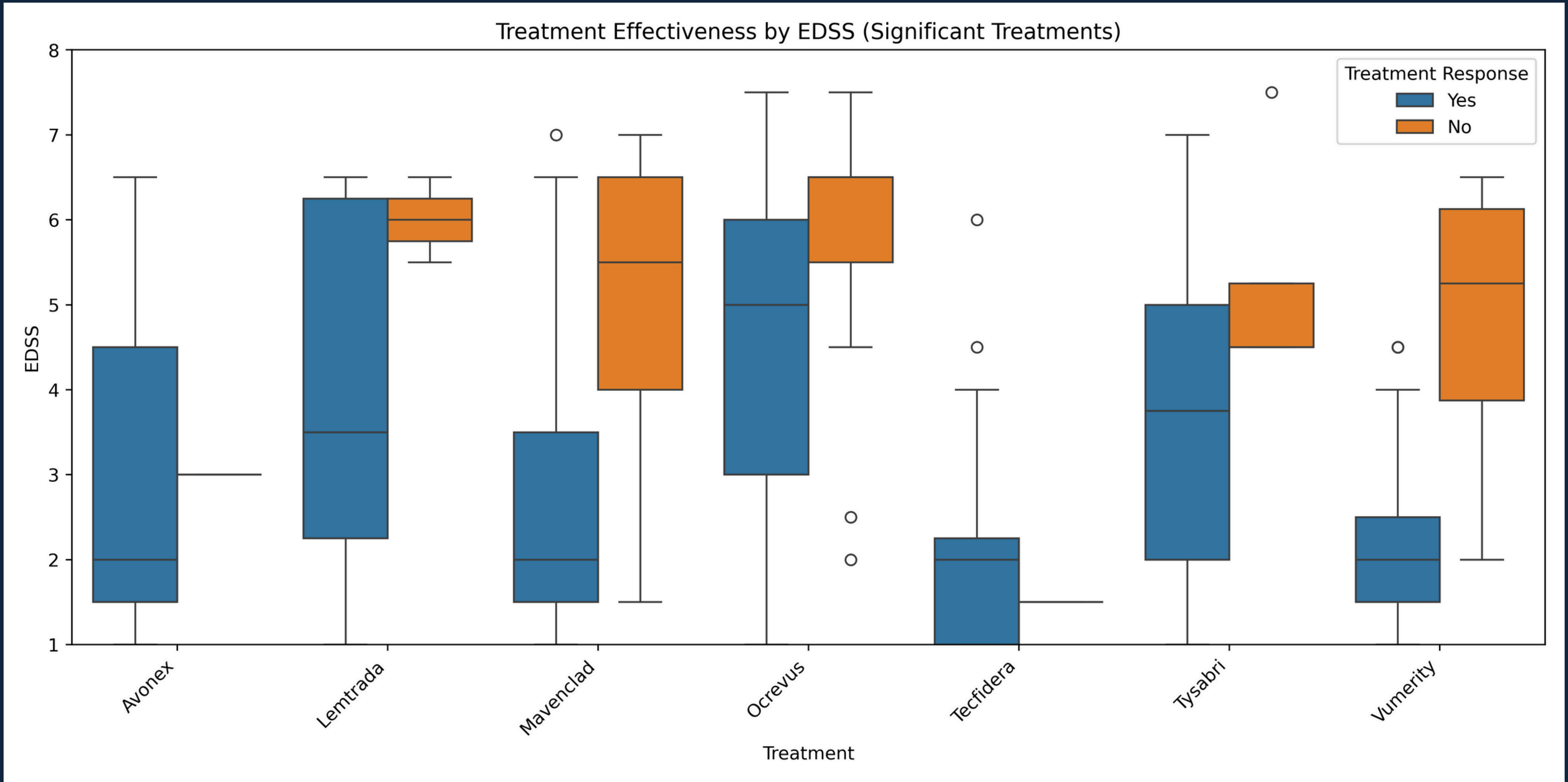



Response Probability for Significant Treatments
P(Treatment Response = Yes)
1.0
0.8
0.6
0.4
0.2
0.0
Tecfidera
Tysabri
Avonex
Lemtrada
Vumerity
Mavenclad
Ocrevus
Treatment

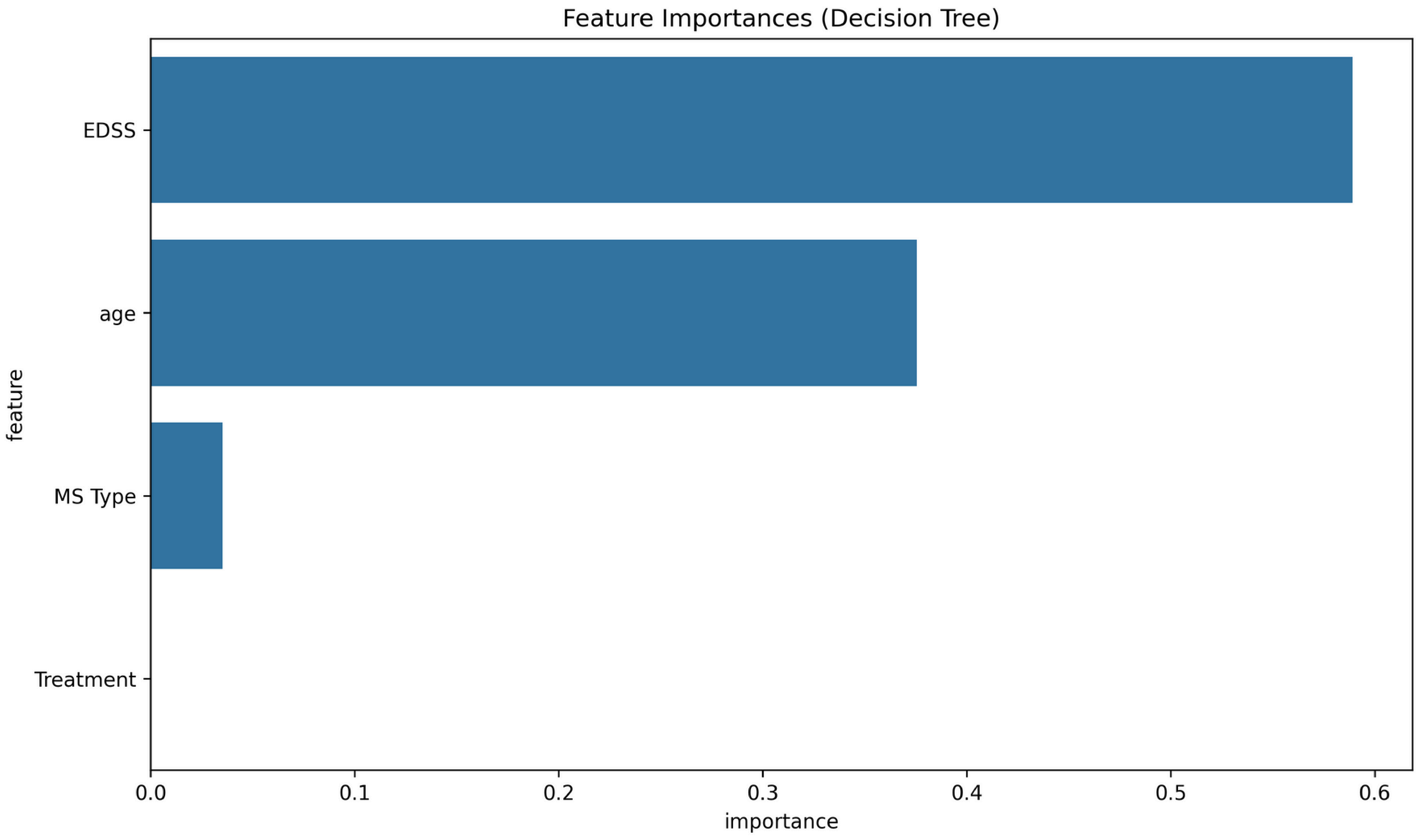


Proportion by Treatment and MS Type (Significant Treatments)
Avonex
Lemtrada
Mavenclad
Ocrevus
Tecfidera
Tysabri
Vumerity
Treatment
0.90
0.33
1.00
1.00
0.47
0.00
0.82
0.43
0.62
0.86
0.96
1.00
0.90
0.83
APMS
PPMS
RR
MS Type
1.0
0.8
0.6
0.4
0.2
0.0


Treatment Effectiveness by Age (Significant Treatments)
Treatment Response
Yes
No
age
80
70
60
50
40
30
20
Avonex
Lemtrada
Mavenclad
Ocrevus
Tecfidera
Tysabri
Vumerity
Treatment



Treatment Effectiveness by EDSS (Significant Treatments)
EDSS
Treatment
Treatment Response
Yes
No
Avonex
Lemtrada
Mavenclad
Ocrevus
Tecfidera
Tysabri
Vumerity
1
2
3
4
5
6
7
8



Feature Importances (Decision Tree)
EDSS
age
MS Type
Treatment
feature
0.0
0.1
0.2
0.3
0.4
0.5
0.6
importance

Best Treatment Effectivness Combinations

Treatment	Patients	MS-Type	Proportion	Age	EDSS	p-value
Avonex	10	RR	90.00%	43.8 to 45.4	1.6 to 4.5	0.0215
Lemtrada	13	RR	84.62%	30.8 to 45.9	3.0 to 5.5	0.0225
Mavenclad	146	RR	77.40%	50.2 to 55.6	3.0 to 3.7	<0.001
Ocrevus	186	RR	68.28%	44.1 to 47.6	4.8 to 5.3	<0.001
Tecfidera	24	RR	95.83%	40.6 to 52.7	1.5 to 2.6	<0.001
Tysabri	44	RR	90.91%	36.0 to 43.2	3.0 to 4.1	<0.001
Vumerity	23	RR	82.61%	37.1 to 45.0	2.0 to 3.4	0.0026

Model Evaluation

Cross-validation with 6 folds

```
Decision Tree Classification Report:
              precision    recall  f1-score   support

          No       0.41      0.31      0.35       104
         Yes       0.80      0.87      0.83       342

    accuracy                           0.74       446
   macro avg       0.61      0.59      0.59       446
weighted avg       0.71      0.74      0.72       446
```

- Poor results for predicting No Response to Treatments due to small sample size.