Supplementary Material

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# Supplementary Table 1: All features extracted from dose distributions or CT image data for each segment (PTV+2cm, total lung-GTV, ipsilateral lung - GTV)

|  |  |
| --- | --- |
| 1 | shape\_Elongation |
| 2 | shape\_Flatness |
| 3 | shape\_LeastAxisLength |
| 4 | shape\_MajorAxisLength |
| 5 | shape\_Maximum2DDiameterColumn |
| 6 | shape\_Maximum2DDiameterRow |
| 7 | shape\_Maximum2DDiameterSlice |
| 8 | shape\_Maximum3DDiameter |
| 9 | shape\_MeshVolume |
| 10 | shape\_MinorAxisLength |
| 11 | shape\_Sphericity |
| 12 | shape\_SurfaceArea |
| 13 | shape\_SurfaceVolumeRatio |
| 14 | shape\_VoxelVolume |
| 15 | firstorder\_Energy |
| 16 | firstorder\_Entropy |
| 17 | firstorder\_Minimum |
| 18 | firstorder\_10Percentile |
| 19 | firstorder\_90Percentile |
| 20 | firstorder\_Maximum |
| 21 | firstorder\_Mean |
| 22 | firstorder\_Median |
| 23 | firstorder\_InterquartileRange |
| 24 | firstorder\_Range |
| 25 | firstorder\_MeanAbsoluteDeviation |
| 26 | firstorder\_RootMeanSquared |
| 27 | firstorder\_Skewness |
| 28 | firstorder\_Kurtosis |
| 29 | firstorder\_Variance |
| 30 | firstorder\_Uniformity |
| 31 | glcm\_Autocorrelation |
| 32 | glcm\_JointAverage |
| 33 | glcm\_ClusterProminence |
| 34 | glcm\_ClusterShade |
| 35 | glcm\_ClusterTendency |
| 36 | glcm\_Contrast |
| 37 | glcm\_Correlation |
| 38 | glcm\_DifferenceAverage |
| 39 | glcm\_DifferenceEntropy |
| 40 | glcm\_DifferenceVariance |
| 41 | glcm\_JointEnergy |
| 42 | glcm\_JointEntropy |
| 43 | glcm\_Imc1 |
| 44 | glcm\_Imc2 |
| 45 | glcm\_Idm |
| 46 | glcm\_Idmn |
| 47 | glcm\_MCC |
| 48 | glcm\_Id |
| 49 | glcm\_Idn |
| 50 | glcm\_InverseVariance |
| 51 | glcm\_MaximumProbability |
| 52 | glcm\_SumEntropy |
| 53 | glcm\_SumSquares |
| 54 | glrlm\_GrayLevelNonUniformity |
| 55 | glrlm\_GrayLevelNonUniformityNormalized |
| 56 | glrlm\_GrayLevelVariance |
| 57 | glrlm\_HighGrayLevelRunEmphasis |
| 58 | glrlm\_LongRunEmphasis |
| 59 | glrlm\_LongRunHighGrayLevelEmphasis |
| 60 | glrlm\_LongRunLowGrayLevelEmphasis |
| 61 | glrlm\_LowGrayLevelRunEmphasis |
| 62 | glrlm\_RunEntropy |
| 63 | glrlm\_RunLengthNonUniformity |
| 64 | glrlm\_RunLengthNonUniformityNormalized |
| 65 | glrlm\_RunPercentage |
| 66 | glrlm\_RunVariance |
| 67 | glrlm\_ShortRunEmphasis |
| 68 | glrlm\_ShortRunHighGrayLevelEmphasis |
| 69 | glrlm\_ShortRunLowGrayLevelEmphasis |
| 70 | glszm\_GrayLevelNonUniformity |
| 71 | glszm\_GrayLevelNonUniformityNormalized |
| 72 | glszm\_GrayLevelVariance |
| 73 | glszm\_HighGrayLevelZoneEmphasis |
| 74 | glszm\_LargeAreaEmphasis |
| 75 | glszm\_LargeAreaHighGrayLevelEmphasis |
| 76 | glszm\_LargeAreaLowGrayLevelEmphasis |
| 77 | glszm\_LowGrayLevelZoneEmphasis |
| 78 | glszm\_SizeZoneNonUniformity |
| 79 | glszm\_SizeZoneNonUniformityNormalized |
| 80 | glszm\_SmallAreaEmphasis |
| 81 | glszm\_SmallAreaHighGrayLevelEmphasis |
| 82 | glszm\_SmallAreaLowGrayLevelEmphasis |
| 83 | glszm\_ZoneEntropy |
| 84 | glszm\_ZonePercentage |
| 85 | glszm\_ZoneVariance |
| 86 | ngtdm\_Busyness |
| 87 | ngtdm\_Coarseness |
| 88 | ngtdm\_Complexity |
| 89 | ngtdm\_Contrast |
| 90 | ngtdm\_Strength |
| 91 | gldm\_DependenceEntropy |
| 92 | gldm\_DependenceNonUniformity |
| 93 | gldm\_DependenceNonUniformityNormalized |
| 94 | gldm\_DependenceVariance |
| 95 | gldm\_GrayLevelNonUniformity |
| 96 | gldm\_GrayLevelVariance |
| 97 | gldm\_HighGrayLevelEmphasis |
| 98 | gldm\_LargeDependenceEmphasis |
| 99 | gldm\_LargeDependenceHighGrayLevelEmphasis |
| 100 | gldm\_LargeDependenceLowGrayLevelEmphasis |
| 101 | gldm\_LowGrayLevelEmphasis |
| 102 | gldm\_SmallDependenceEmphasis |
| 103 | gldm\_SmallDependenceHighGrayLevelEmphasis |
| 104 | gldm\_SmallDependenceLowGrayLevelEmphasis |

# Supplementary Table 2: all extracted features after feature reduction used in this study. Abbreviations used: planning target volume (PTV), total lung-GTV (TL), ipsilateral lung-GTV (IL)

|  |  |  |
| --- | --- | --- |
| Features | EQD2 | Physical Dose |
| Clinics | Age | Age |
|  | Size | Size |
|  | Location | Location |
|  | Sex | Sex |
|  | KPI | KPI |
| Dosimetric Features | DVH\_V50 | DVH\_V50 |
| Dosimetric Features & Clinics | DVH\_V50 | DVH\_V50 |
|  | Age | Age |
|  | Size | Size |
|  | Location | Location |
|  | Sex | Sex |
|  | KPI | KPI |
| Dosiomics | PTV\_original\_glszm\_GrayLevelNonUniformity | TL\_original\_firstorder\_InterquartileRange |
|  | PTV\_original\_glrlm\_RunEntropy | PTV\_original\_gldm\_DependenceNonUniformityNormalized |
|  | IL\_original\_shape\_Sphericity | TL\_original\_shape\_Sphericity |
|  | TL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | IL\_original\_shape\_Sphericity |
|  | TL\_original\_shape\_Sphericity | IL\_original\_shape\_LeastAxisLength |
|  | IL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | PTV\_original\_firstorder\_Minimum |
|  | TL\_original\_shape\_SurfaceVolumeRatio | TL\_original\_shape\_Flatness |
|  | PTV\_original\_glszm\_GrayLevelNonUniformityNormalized | PTV\_original\_shape\_Elongation |
|  | IL\_original\_shape\_LeastAxisLength | TL\_original\_glrlm\_RunEntropy |
|  | IL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis | IL\_original\_shape\_Elongation |
|  | TL\_original\_shape\_Flatness | TL\_original\_shape\_Elongation |
|  | TL\_original\_firstorder\_InterquartileRange | PTV\_original\_gldm\_DependenceVariance |
|  | TL\_original\_firstorder\_Minimum | TL\_original\_firstorder\_Minimum |
|  | TL\_original\_shape\_Elongation | PTV\_original\_glszm\_ZoneEntropy |
|  | IL\_original\_glcm\_Imc1 | IL\_original\_glrlm\_RunEntropy |
|  | TL\_original\_glszm\_LowGrayLevelZoneEmphasis | TL\_original\_shape\_SurfaceVolumeRatio |
|  | IL\_original\_shape\_Elongation | IL\_original\_shape\_SurfaceVolumeRatio |
|  | PTV\_original\_glcm\_MCC | PTV\_original\_glszm\_SmallAreaLowGrayLevelEmphasis |
|  | IL\_original\_glszm\_GrayLevelNonUniformityNormalized | IL\_original\_glcm\_Idmn |
|  | TL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis |  |
|  | IL\_original\_glrlm\_RunEntropy |  |
| Radiomics | CT\_PTV\_original\_ngtdm\_Strength | CT\_PTV\_original\_ngtdm\_Strength |
|  | CT\_IL\_original\_shape\_Sphericity | CT\_IL\_original\_shape\_Sphericity |
|  | CT\_IL\_original\_glcm\_Idn | CT\_IL\_original\_glcm\_Idn |
|  | CT\_GL\_original\_shape\_Sphericity | CT\_GL\_original\_shape\_Sphericity |
|  | CT\_PTV\_original\_glcm\_ClusterProminence | CT\_PTV\_original\_glcm\_ClusterProminence |
|  | CT\_IL\_original\_ngtdm\_Contrast | CT\_IL\_original\_ngtdm\_Contrast |
|  | CT\_PTV\_original\_firstorder\_Energy | CT\_PTV\_original\_firstorder\_Energy |
|  | CT\_PTV\_original\_glrlm\_RunEntropy | CT\_IL\_original\_shape\_Elongation |
|  | CT\_PTV\_original\_ngtdm\_Complexity | CT\_PTV\_original\_ngtdm\_Complexity |
|  | CT\_IL\_original\_shape\_Elongation | CT\_PTV\_original\_glrlm\_RunEntropy |
|  | CT\_PTV\_original\_glcm\_ClusterShade | CT\_PTV\_original\_glcm\_ClusterShade |
|  | CT\_GL\_original\_glcm\_MCC | CT\_GL\_original\_glcm\_MCC |
|  | CT\_GL\_original\_ngtdm\_Contrast | CT\_GL\_original\_ngtdm\_Contrast |
|  | CT\_IL\_original\_glcm\_ClusterShade | CT\_IL\_original\_glcm\_ClusterShade |
|  | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis |
|  | CT\_IL\_original\_shape\_Flatness | CT\_IL\_original\_shape\_Flatness |
|  | CT\_IL\_original\_shape\_LeastAxisLength | CT\_IL\_original\_shape\_LeastAxisLength |
|  | CT\_GL\_original\_shape\_SurfaceVolumeRatio | CT\_GL\_original\_shape\_SurfaceVolumeRatio |
|  | CT\_PTV\_original\_glrlm\_GrayLevelVariance | CT\_PTV\_original\_glrlm\_GrayLevelVariance |
|  | CT\_PTV\_original\_glcm\_InverseVariance | CT\_PTV\_original\_glcm\_InverseVariance |
|  | CT\_GL\_original\_shape\_Elongation | CT\_IL\_original\_ngtdm\_Strength |
|  | CT\_IL\_original\_ngtdm\_Strength | CT\_GL\_original\_shape\_Elongation |
|  | CT\_GL\_original\_shape\_Flatness | CT\_GL\_original\_shape\_Flatness |
| Dosiomics+Radiomics | CT\_PTV\_original\_ngtdm\_Strength | CT\_PTV\_original\_ngtdm\_Strength |
|  | PTV\_original\_glszm\_GrayLevelNonUniformity | CT\_IL\_original\_glcm\_Idn |
|  | CT\_IL\_original\_glcm\_Idn | CT\_PTV\_original\_glcm\_ClusterProminence |
|  | CT\_PTV\_original\_glcm\_ClusterProminence | TL\_original\_firstorder\_InterquartileRange |
|  | TL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | CT\_IL\_original\_ngtdm\_Contrast |
|  | CT\_IL\_original\_ngtdm\_Contrast | PTV\_original\_gldm\_DependenceNonUniformityNormalized |
|  | PTV\_original\_glrlm\_RunEntropy | CT\_PTV\_original\_firstorder\_Energy |
|  | CT\_PTV\_original\_firstorder\_Energy | CT\_PTV\_original\_ngtdm\_Complexity |
|  | CT\_PTV\_original\_ngtdm\_Complexity | CT\_PTV\_original\_glrlm\_RunEntropy |
|  | IL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | CT\_GL\_original\_shape\_Sphericity |
|  | CT\_PTV\_original\_glrlm\_RunEntropy | PTV\_original\_firstorder\_Minimum |
|  | PTV\_original\_glszm\_GrayLevelNonUniformityNormalized | CT\_PTV\_original\_glcm\_ClusterShade |
|  | CT\_PTV\_original\_glcm\_ClusterShade | CT\_GL\_original\_glcm\_MCC |
|  | CT\_GL\_original\_glcm\_MCC | TL\_original\_glrlm\_RunEntropy |
|  | IL\_original\_shape\_Sphericity | IL\_original\_shape\_Sphericity |
|  | TL\_original\_glszm\_LowGrayLevelZoneEmphasis | CT\_GL\_original\_ngtdm\_Contrast |
|  | IL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis | PTV\_original\_shape\_Elongation |
|  | CT\_GL\_original\_ngtdm\_Contrast | CT\_IL\_original\_glcm\_ClusterShade |
|  | TL\_original\_firstorder\_InterquartileRange | CT\_IL\_original\_shape\_Sphericity |
|  | CT\_GL\_original\_shape\_Sphericity | CT\_PTV\_original\_glrlm\_GrayLevelVariance |
|  | CT\_PTV\_original\_glrlm\_GrayLevelVariance | CT\_PTV\_original\_glcm\_InverseVariance |
|  | CT\_IL\_original\_glcm\_ClusterShade | IL\_original\_shape\_LeastAxisLength |
|  | IL\_original\_glcm\_Imc1 | TL\_original\_firstorder\_Minimum |
|  | TL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis | IL\_original\_glrlm\_RunEntropy |
|  | CT\_PTV\_original\_glcm\_InverseVariance | PTV\_original\_glszm\_ZoneEntropy |
|  | TL\_original\_firstorder\_Minimum | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis |
|  | CT\_IL\_original\_shape\_Sphericity | CT\_IL\_original\_ngtdm\_Strength |
|  | IL\_original\_glszm\_GrayLevelNonUniformityNormalized | PTV\_original\_gldm\_DependenceVariance |
|  | IL\_original\_glrlm\_RunEntropy | CT\_IL\_original\_glszm\_GrayLevelNonUniformity |
|  | TL\_original\_firstorder\_Kurtosis | IL\_original\_glcm\_Idmn |
|  | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis | CT\_IL\_original\_firstorder\_Minimum |
|  | CT\_GL\_original\_shape\_SurfaceVolumeRatio | CT\_GL\_original\_shape\_SurfaceVolumeRatio |
|  | PTV\_original\_glszm\_ZoneEntropy | CT\_GL\_original\_shape\_Elongation |
|  | CT\_PTV\_original\_glszm\_LargeAreaLowGrayLevelEmphasis |  |
| RadiomicsDVHClinics | CT\_PTV\_original\_ngtdm\_Strength | CT\_PTV\_original\_ngtdm\_Strength |
|  | CT\_IL\_original\_shape\_Sphericity | CT\_IL\_original\_shape\_Sphericity |
|  | CT\_IL\_original\_glcm\_Idn | CT\_IL\_original\_glcm\_Idn |
|  | CT\_GL\_original\_shape\_Sphericity | CT\_GL\_original\_shape\_Sphericity |
|  | CT\_PTV\_original\_glcm\_ClusterProminence | CT\_PTV\_original\_glcm\_ClusterProminence |
|  | CT\_IL\_original\_ngtdm\_Contrast | CT\_IL\_original\_ngtdm\_Contrast |
|  | CT\_PTV\_original\_firstorder\_Energy | CT\_PTV\_original\_firstorder\_Energy |
|  | CT\_PTV\_original\_glrlm\_RunEntropy | CT\_IL\_original\_shape\_Elongation |
|  | CT\_PTV\_original\_ngtdm\_Complexity | CT\_PTV\_original\_ngtdm\_Complexity |
|  | CT\_IL\_original\_shape\_Elongation | CT\_PTV\_original\_glrlm\_RunEntropy |
|  | CT\_PTV\_original\_glcm\_ClusterShade | CT\_PTV\_original\_glcm\_ClusterShade |
|  | CT\_GL\_original\_glcm\_MCC | CT\_GL\_original\_glcm\_MCC |
|  | CT\_GL\_original\_ngtdm\_Contrast | CT\_GL\_original\_ngtdm\_Contrast |
|  | CT\_IL\_original\_glcm\_ClusterShade | CT\_IL\_original\_glcm\_ClusterShade |
|  | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis |
|  | CT\_IL\_original\_shape\_Flatness | CT\_IL\_original\_shape\_Flatness |
|  | CT\_IL\_original\_shape\_LeastAxisLength | CT\_IL\_original\_shape\_LeastAxisLength |
|  | CT\_GL\_original\_shape\_SurfaceVolumeRatio | CT\_GL\_original\_shape\_SurfaceVolumeRatio |
|  | CT\_PTV\_original\_glrlm\_GrayLevelVariance | CT\_PTV\_original\_glrlm\_GrayLevelVariance |
|  | CT\_PTV\_original\_glcm\_InverseVariance | CT\_PTV\_original\_glcm\_InverseVariance |
|  | CT\_GL\_original\_shape\_Elongation | CT\_IL\_original\_ngtdm\_Strength |
|  | CT\_IL\_original\_ngtdm\_Strength | CT\_GL\_original\_shape\_Elongation |
|  | CT\_GL\_original\_shape\_Flatness | CT\_GL\_original\_shape\_Flatness |
|  | DVH\_V50 | DVH\_V50 |
|  | Age | Age |
|  | Size | Size |
|  | Location | Location |
|  | Sex | Sex |
|  | KPI | KPI |
| DosiomicsDVHClinics | PTV\_original\_glszm\_GrayLevelNonUniformity | TL\_original\_firstorder\_InterquartileRange |
|  | PTV\_original\_glrlm\_RunEntropy | PTV\_original\_gldm\_DependenceNonUniformityNormalized |
|  | IL\_original\_shape\_Sphericity | TL\_original\_shape\_Sphericity |
|  | TL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | IL\_original\_shape\_Sphericity |
|  | TL\_original\_shape\_Sphericity | IL\_original\_shape\_LeastAxisLength |
|  | IL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | PTV\_original\_firstorder\_Minimum |
|  | TL\_original\_shape\_SurfaceVolumeRatio | TL\_original\_shape\_Flatness |
|  | PTV\_original\_glszm\_GrayLevelNonUniformityNormalized | PTV\_original\_shape\_Elongation |
|  | IL\_original\_shape\_LeastAxisLength | TL\_original\_glrlm\_RunEntropy |
|  | IL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis | IL\_original\_shape\_Elongation |
|  | TL\_original\_shape\_Flatness | TL\_original\_shape\_Elongation |
|  | TL\_original\_firstorder\_InterquartileRange | PTV\_original\_gldm\_DependenceVariance |
|  | TL\_original\_firstorder\_Minimum | TL\_original\_firstorder\_Minimum |
|  | TL\_original\_shape\_Elongation | PTV\_original\_glszm\_ZoneEntropy |
|  | IL\_original\_glcm\_Imc1 | IL\_original\_glrlm\_RunEntropy |
|  | TL\_original\_glszm\_LowGrayLevelZoneEmphasis | TL\_original\_shape\_SurfaceVolumeRatio |
|  | IL\_original\_shape\_Elongation | IL\_original\_shape\_SurfaceVolumeRatio |
|  | PTV\_original\_glcm\_MCC | PTV\_original\_glszm\_SmallAreaLowGrayLevelEmphasis |
|  | IL\_original\_glszm\_GrayLevelNonUniformityNormalized | IL\_original\_glcm\_Idmn |
|  | TL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis | DVH\_V50 |
|  | IL\_original\_glrlm\_RunEntropy | Age |
|  | DVH\_V50 | Size |
|  | Age | Location |
|  | Size | Sex |
|  | Location | KPI |
|  | Sex |  |
|  | KPI |  |
| DosiomicsRadiomicsDVHClinics | CT\_PTV\_original\_ngtdm\_Strength | CT\_PTV\_original\_ngtdm\_Strength |
|  | PTV\_original\_glszm\_GrayLevelNonUniformity | CT\_IL\_original\_glcm\_Idn |
|  | CT\_IL\_original\_glcm\_Idn | CT\_PTV\_original\_glcm\_ClusterProminence |
|  | CT\_PTV\_original\_glcm\_ClusterProminence | TL\_original\_firstorder\_InterquartileRange |
|  | TL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | CT\_IL\_original\_ngtdm\_Contrast |
|  | CT\_IL\_original\_ngtdm\_Contrast | PTV\_original\_gldm\_DependenceNonUniformityNormalized |
|  | PTV\_original\_glrlm\_RunEntropy | CT\_PTV\_original\_firstorder\_Energy |
|  | CT\_PTV\_original\_firstorder\_Energy | CT\_PTV\_original\_ngtdm\_Complexity |
|  | CT\_PTV\_original\_ngtdm\_Complexity | CT\_PTV\_original\_glrlm\_RunEntropy |
|  | IL\_original\_glszm\_SmallAreaLowGrayLevelEmphasis | CT\_GL\_original\_shape\_Sphericity |
|  | CT\_PTV\_original\_glrlm\_RunEntropy | PTV\_original\_firstorder\_Minimum |
|  | PTV\_original\_glszm\_GrayLevelNonUniformityNormalized | CT\_PTV\_original\_glcm\_ClusterShade |
|  | CT\_PTV\_original\_glcm\_ClusterShade | CT\_GL\_original\_glcm\_MCC |
|  | CT\_GL\_original\_glcm\_MCC | TL\_original\_glrlm\_RunEntropy |
|  | IL\_original\_shape\_Sphericity | IL\_original\_shape\_Sphericity |
|  | TL\_original\_glszm\_LowGrayLevelZoneEmphasis | CT\_GL\_original\_ngtdm\_Contrast |
|  | IL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis | PTV\_original\_shape\_Elongation |
|  | CT\_GL\_original\_ngtdm\_Contrast | CT\_IL\_original\_glcm\_ClusterShade |
|  | TL\_original\_firstorder\_InterquartileRange | CT\_IL\_original\_shape\_Sphericity |
|  | CT\_GL\_original\_shape\_Sphericity | CT\_PTV\_original\_glrlm\_GrayLevelVariance |
|  | CT\_PTV\_original\_glrlm\_GrayLevelVariance | CT\_PTV\_original\_glcm\_InverseVariance |
|  | CT\_IL\_original\_glcm\_ClusterShade | IL\_original\_shape\_LeastAxisLength |
|  | IL\_original\_glcm\_Imc1 | TL\_original\_firstorder\_Minimum |
|  | TL\_original\_glrlm\_ShortRunLowGrayLevelEmphasis | IL\_original\_glrlm\_RunEntropy |
|  | CT\_PTV\_original\_glcm\_InverseVariance | PTV\_original\_glszm\_ZoneEntropy |
|  | TL\_original\_firstorder\_Minimum | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis |
|  | CT\_IL\_original\_shape\_Sphericity | CT\_IL\_original\_ngtdm\_Strength |
|  | IL\_original\_glszm\_GrayLevelNonUniformityNormalized | PTV\_original\_gldm\_DependenceVariance |
|  | IL\_original\_glrlm\_RunEntropy | CT\_IL\_original\_glszm\_GrayLevelNonUniformity |
|  | TL\_original\_firstorder\_Kurtosis | IL\_original\_glcm\_Idmn |
|  | CT\_GL\_original\_glszm\_LargeAreaHighGrayLevelEmphasis | CT\_IL\_original\_firstorder\_Minimum |
|  | CT\_GL\_original\_shape\_SurfaceVolumeRatio | CT\_GL\_original\_shape\_SurfaceVolumeRatio |
|  | PTV\_original\_glszm\_ZoneEntropy | CT\_GL\_original\_shape\_Elongation |
|  | CT\_PTV\_original\_glszm\_LargeAreaLowGrayLevelEmphasis | DVH\_V50 |
|  | DVH\_V50 | Age |
|  | Age | Size |
|  | Size | Location |
|  | Location | Sex |
|  | Sex | KPI |
|  | KPI |  |

# Supplementary Table 3: Hyperparameter tuning grid for machine learning models

|  |  |  |
| --- | --- | --- |
|  | **Hyperparameter** | **Search space  (by increment)** |
| **Elastic Net Regression** | Lambda | 0 – 1, by 0.02 |
| Alpha | 0 – 1, by 0.05 |
| **Random Forest** | Number of trees (ntree) | 501 – 2001, by 500 |
| Features per node (Mtry) | 1 – 6, by 1 |
| **LogitBoost** | Iteration Number | 1 – 100, by 2 |
| **Support Vector Machine** | C | 0.00001 – 0.01. by 0.005, 0.01 – 0.1, by 0.05,  0.1 – 1, by 0.2,  1 – 10, by 2 |
| Sigma | 0.1 – 1, by 0.1,  1 –50, by 5,  60 – 450, by 70 |

# 4 Calibration Curves of the nine best performing models

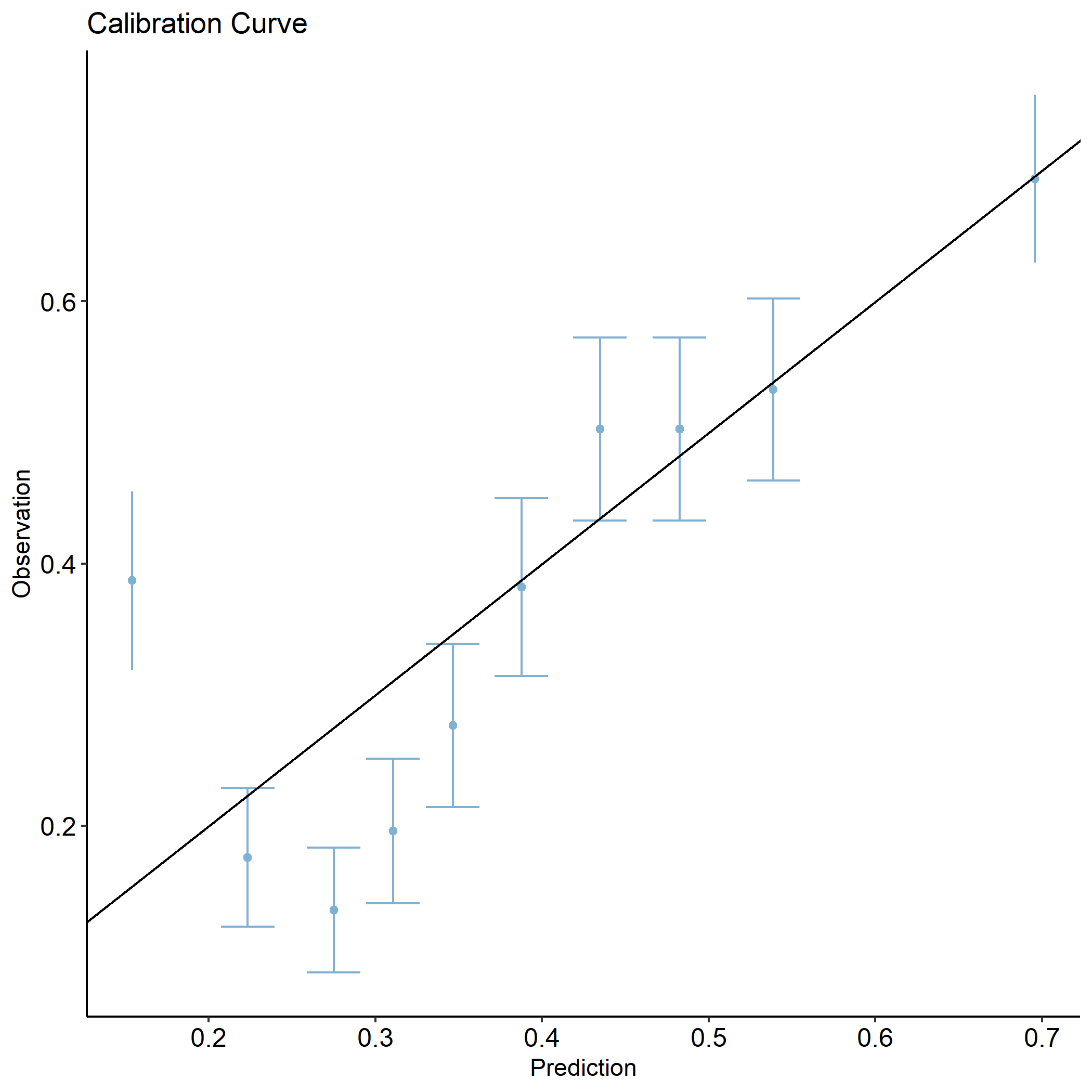


Figure 1: Calibration Curve for Radiomics model.

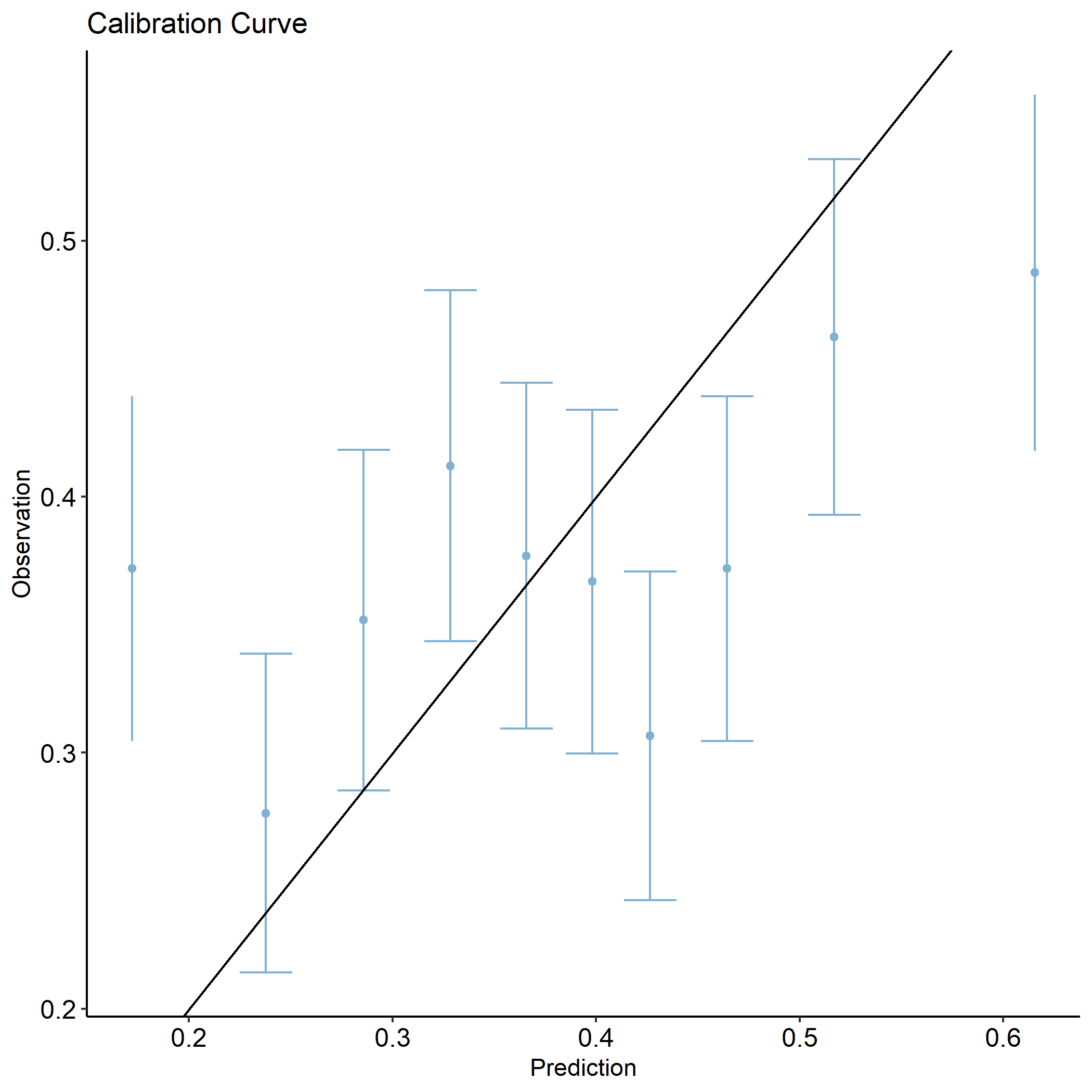


Figure 2: Calibration Curve for Dosiomics model for physical dose.

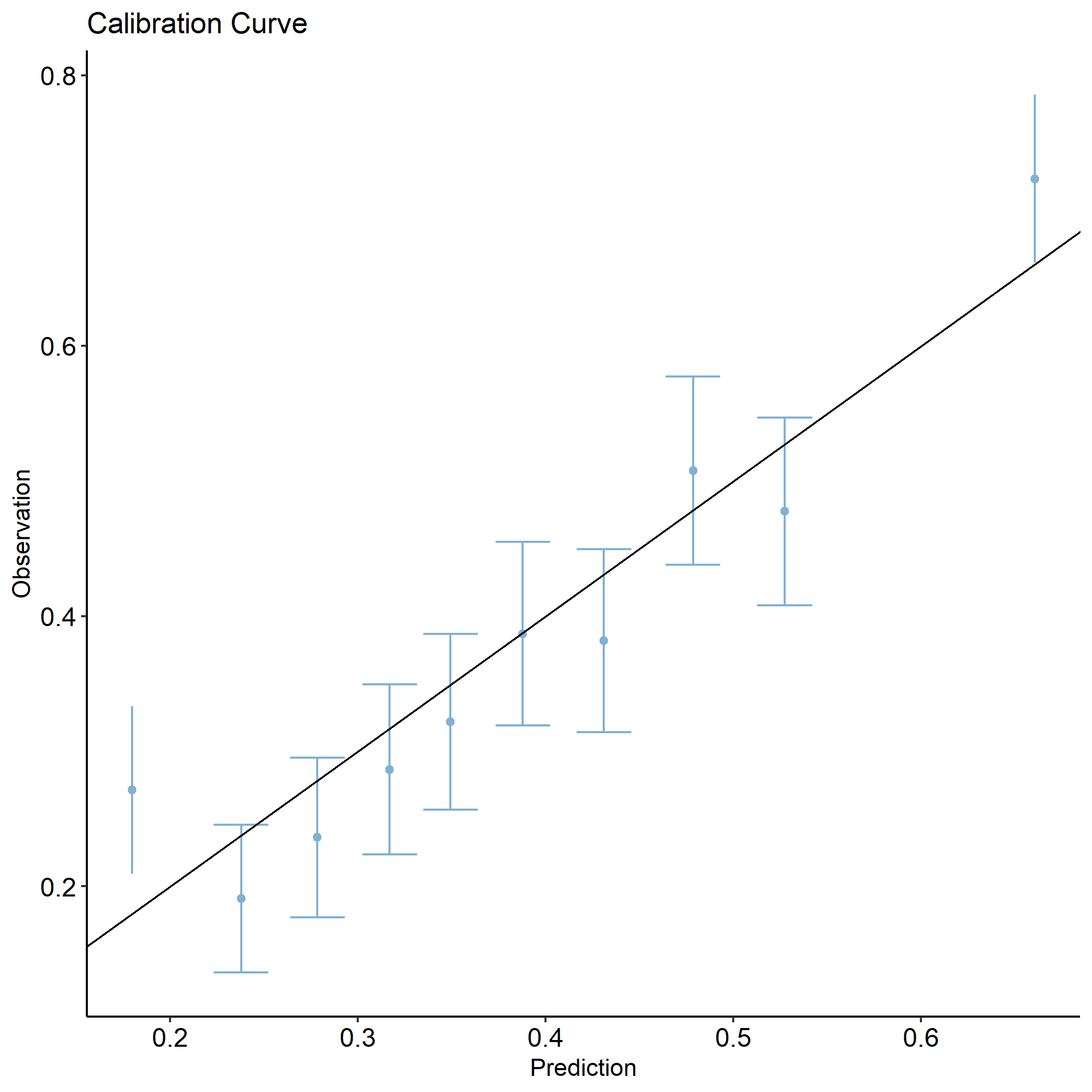


Figure 3: Calibration model for combined Dosiomics and Radiomics model for physical dose.

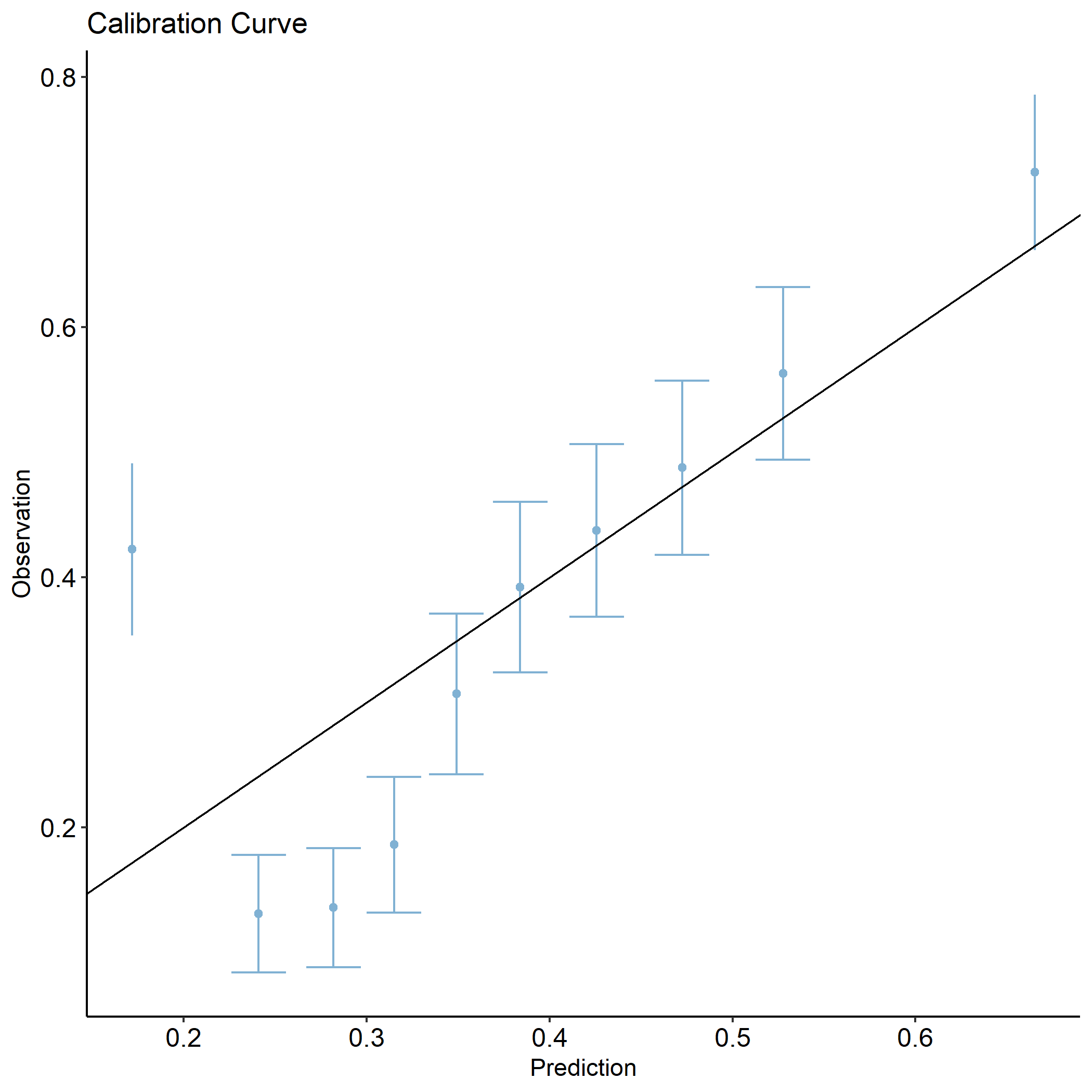


Figure 4: Calibration model for combined Radiomics+DVH+Clinics model for physical dose.

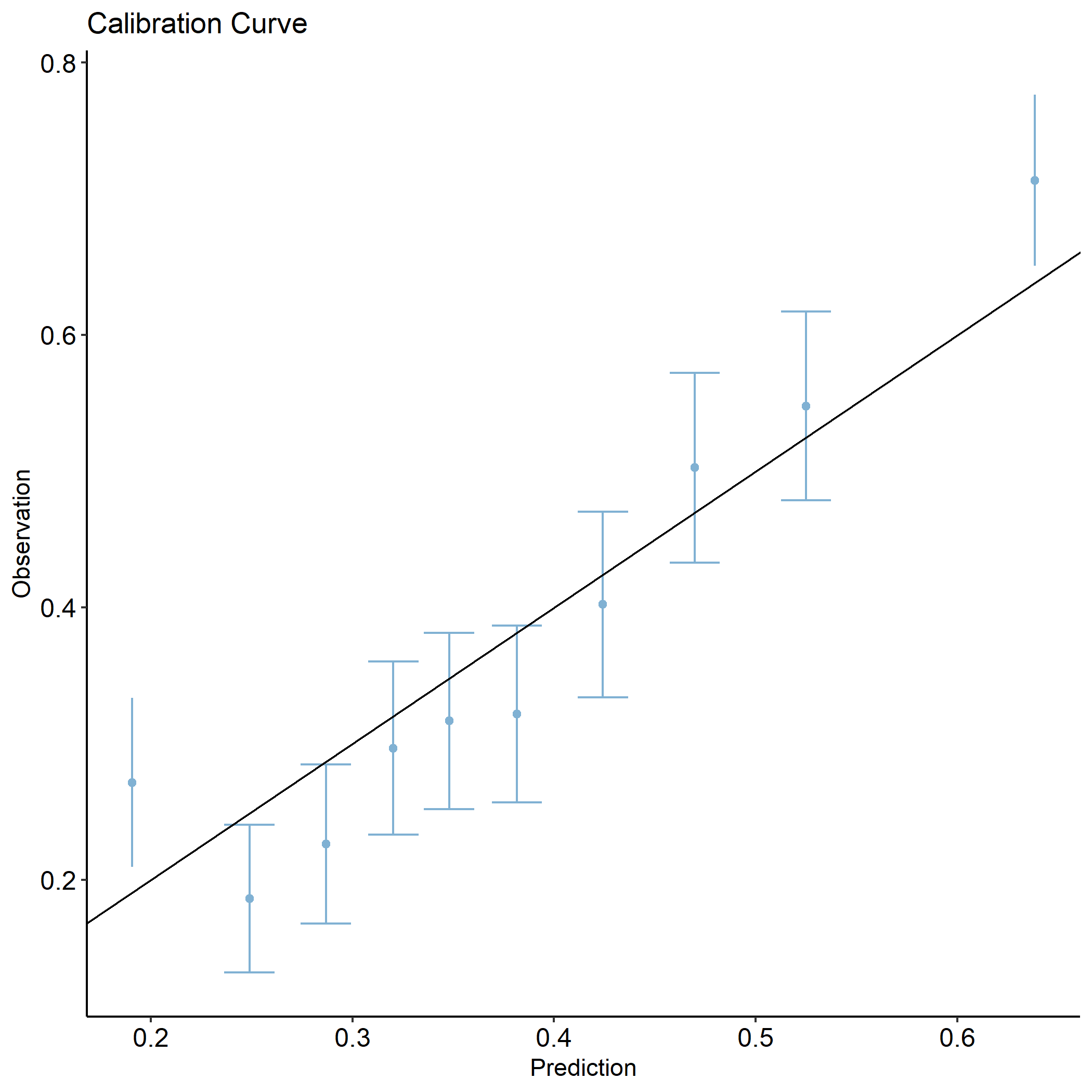


Figure 5: Calibration Curve for all models combined (ALL) for physical dose.

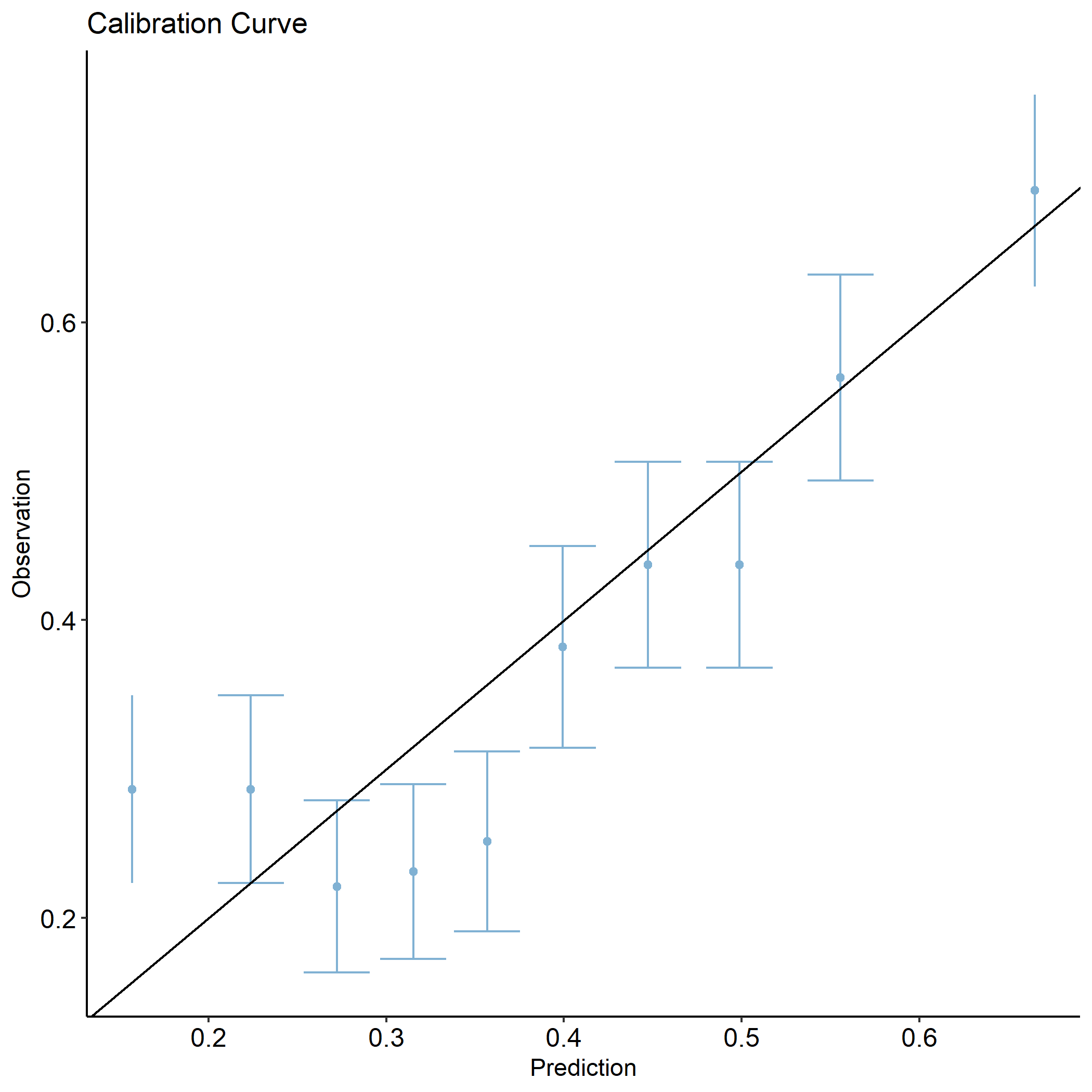


Figure 6: Calibration curve for Dosiomics model for EQD2.

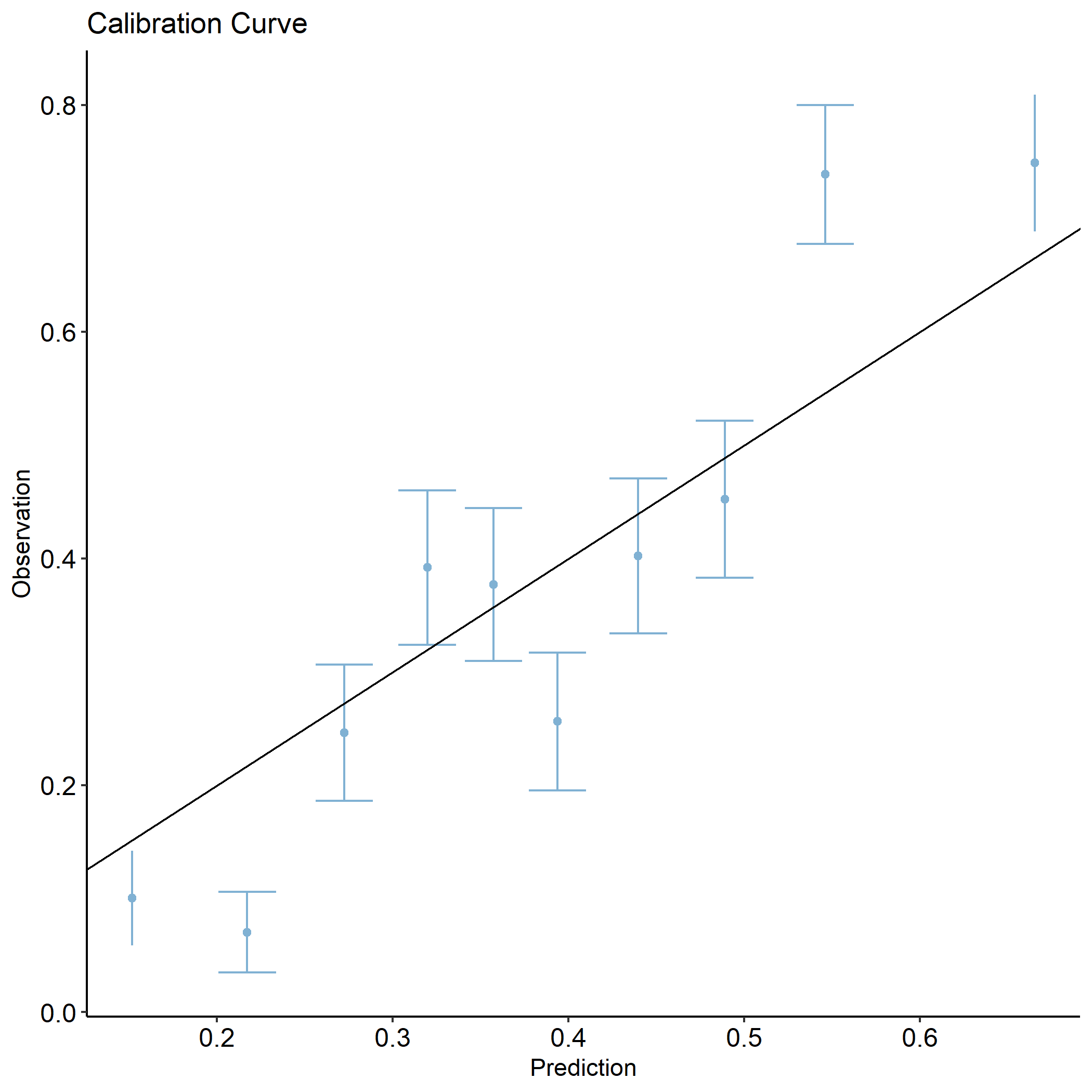


Figure 7: Calibration model for combined Dosiomics and Radiomics model for EQD2.

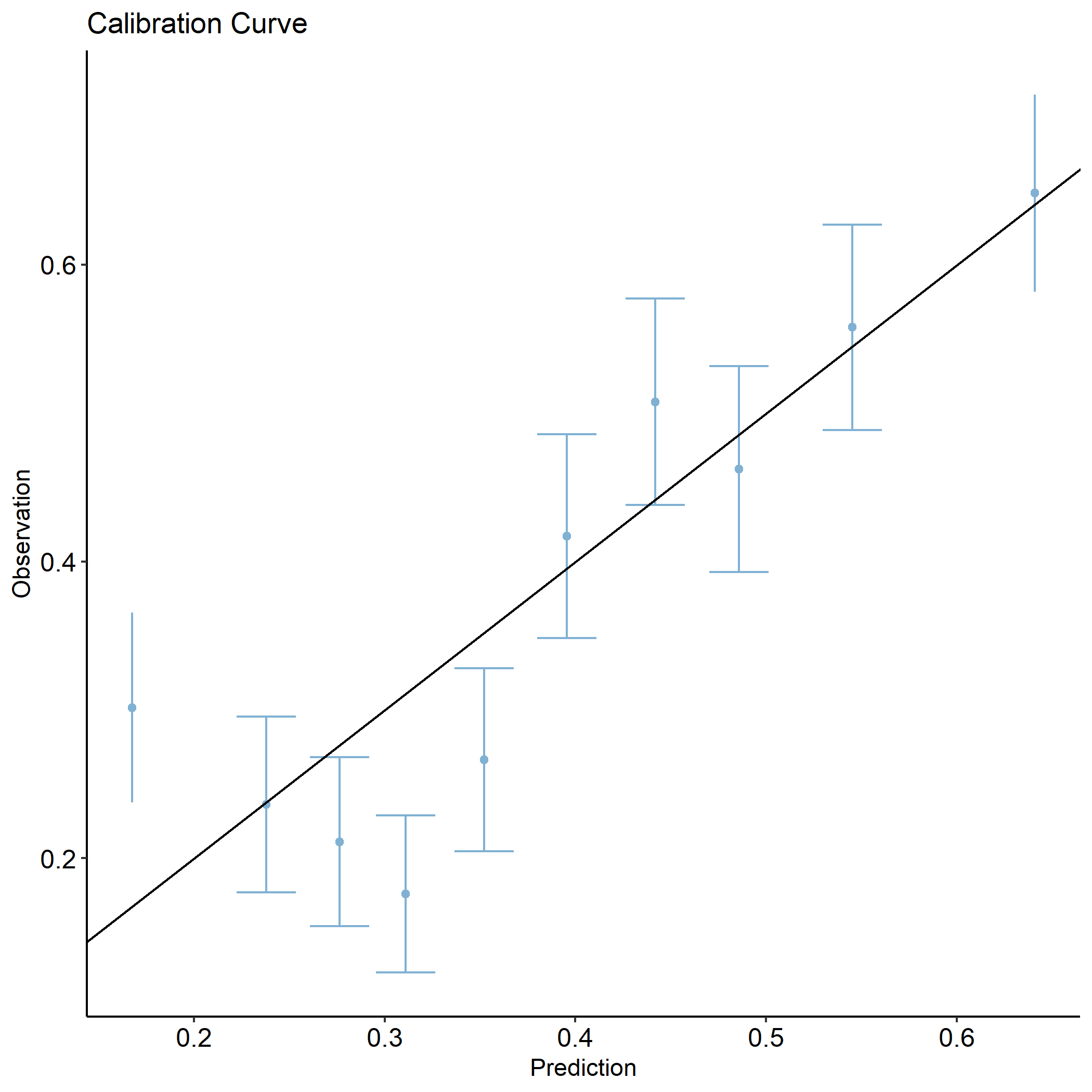


Figure 8: Calibration curve for Dosiomics+DVH+Clinics for EQD2.

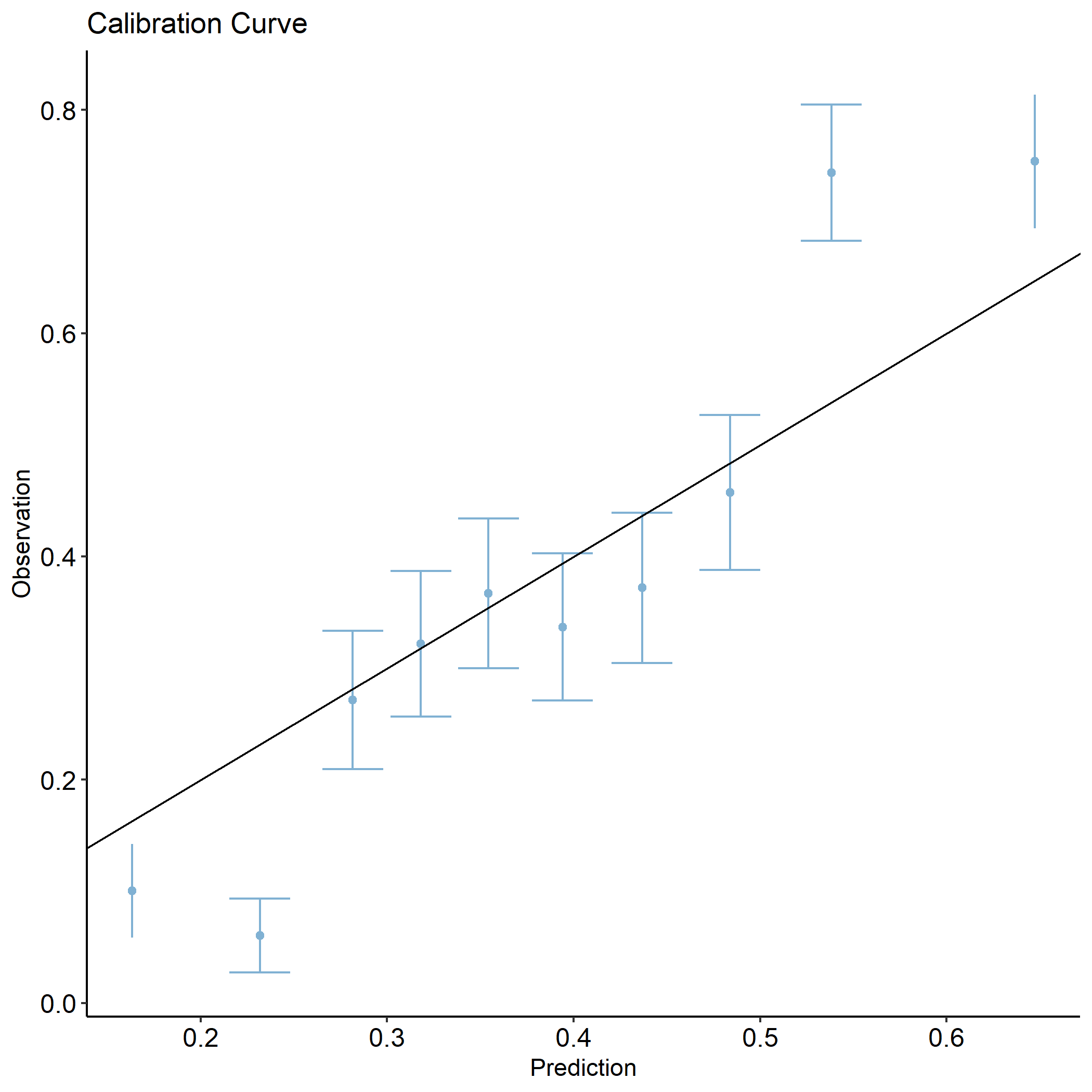


Figure 9: Calibration curve for all models combined (ALL) for EQD2.

# 5 Supplementary Table 4: Tripod Checklist: Prediction Model Development and Validation

|  |  |  |  |  |  |
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| **Section/Topic** | **Item** |  | **Checklist Item** | **Page** | **Reported on section** |
| **Title and abstract** | | | | |  |
| Title | 1 | D;V | Identify the study as developing and/or validating a multivariable prediction model, the target population, and the outcome to be predicted. | 1 | Title |
| Abstract | 2 | D;V | Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions. | 2 | Abstract |
| **Introduction** | | | | |  |
| Background and objectives | 3a | D;V | * Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models. | 3 | Introduction |
| 3b | D;V | * Specify the objectives, including whether the study describes the development or validation of the model or both. | 3, last paragraph | Introduction |
| **Methods** | | | | |  |
| Source of data | 4a | D;V | * Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable. | 3-5, Section 2.1  Section 2.2 | Methods. 2.1 Patient clinical Factors  2.2 Volumetric CT and Dose Data |
| 4b | D;V | * Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up. | 3-4, Section 2.1 | Methods. Patient clinical Factors |
| Participants | 5a | D;V | * Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres. | 3-4, Section 2.1 | Methods. Patient clinical Factors |
| 5b | D;V | * Describe eligibility criteria for participants. | 3-4, Section 2.1 | Methods. Patient clinical Factors |
| 5c | D;V | * Give details of treatments received, if relevant. | 3-5, Section 2.1 | Methods. Patient clinical Factors |
| Outcome | 6a | D;V | * Clearly define the outcome that is predicted by the prediction model, including how and when assessed. |  |  |
| 6b | D;V | * Report any actions to blind assessment of the outcome to be predicted. | - | - |
| Predictors | 7a | D;V | * Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured. | 6-7  Section 2.3 / 2.4 | Methods 2.3 Feature Processing  2.4 Machine Learning Model |
| 7b | D;V | * Report any actions to blind assessment of predictors for the outcome and other predictors. | - | - |
| Sample size | 8 | D;V | * Explain how the study size was arrived at. | - | - |
| Missing data | 9 | D;V | * Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method. | - | - |
| Statistical analysis methods | 10a | D | * Describe how predictors were handled in the analyses. | 7  Section 2.4 | 2.4 Machine Learning Model |
| 10b | D | * Specify type of model, all model-building procedures (including any predictor selection), and method for internal validation. | 6-7   * Section 2.3 / 2.4 | Methods 2.3 Feature Processing   * 2.4 Machine Learning Model |
| 10c | V | * For validation, describe how the predictions were calculated. | 7   * Section 2.4 | * 2.4 Machine Learning Model |
| 10d | D;V | * Specify all measures used to assess model performance and, if relevant, to compare multiple models. | 7  Section 2.4 | 2.4 Machine Learning Model |
| 10e | V | * Describe any model updating (e.g., recalibration) arising from the validation, if done. | 7  Section 2.4 | 2.4 Machine Learning Model |
| Risk groups | 11 | D;V | Provide details on how risk groups were created, if done. |  | - |
| Development vs. validation | 12 | V | For validation, identify any differences from the development data in setting, eligibility criteria, outcome, and predictors. | - | - |
| **Results** | | | | |  |
| Participants | 13a | D;V | * Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful. | 2.4 Machine Learning Model | Methods. Patient clinical Factors |
| 13b | D;V | * Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome. | 2.4 Machine Learning Model | Methods. Patient clinical Factors |
| 13c | V | * For validation, show a comparison with the development data of the distribution of important variables (demographics, predictors and outcome). | * - | * - |
| Model development | 14a | D | * Specify the number of participants and outcome events in each analysis. | * 8-9 | * Table 2 |
| 14b | D | * If done, report the unadjusted association between each candidate predictor and outcome. |  |  |
| Model specification | 15a | D | * Present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point). |  |  |
| 15b | D | * Explain how to the use the prediction model. |  |  |
| Model performance | 16 | D;V | * Report performance measures (with CIs) for the prediction model. | 8-10 | Results  3.1 Classifiers  3.3 Machine Learning PTP Prediction |
| Model-updating | 17 | V | If done, report the results from any model updating (i.e., model specification, model performance). |  |  |
| **Discussion** | | | | |  |
| Limitations | 18 | D;V | Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data). | 11 | Discussion, paragraph 6 & 7 |
| Interpretation | 19a | V | * For validation, discuss the results with reference to performance in the development data, and any other validation data. | * 10-11 | * Discussion, paragraphs 2,3,4 & 5 |
| 19b | D;V | * Give an overall interpretation of the results, considering objectives, limitations, results from similar studies, and other relevant evidence. | 11 | Conclusions |
| Implications | 20 | D;V | Discuss the potential clinical use of the model and implications for future research. |  |  |
| **Other information** | | | | |  |
| Supplementary information | 21 | D;V | Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets. | 12 | 9 Data Availability Statement |
| Funding | 22 | D;V | Give the source of funding and the role of the funders for the present study. | 12 | 8 Funding |

# 6 Supplementary Data 6: AUC values for all Classifiers and all models with and without shape features

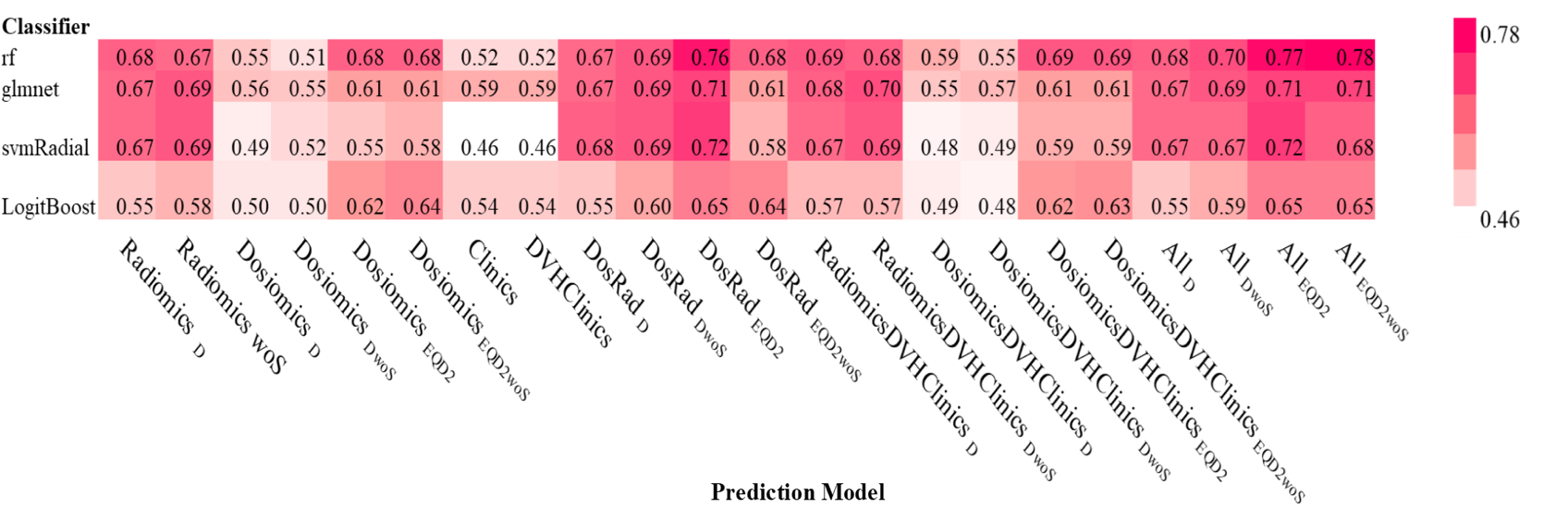


Figure 10: AUC values for all classifiers and models for physical dose (D) and 2-Gy-equivalent dose (EQD2). For individual models, shape features were excluded from the simulation.