**Appendix 1.** Model diagnostics and goodness-of-fit tests

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test for normality** | Obs | W | V | z | Prob>z |  | |
| Shapiro-Wilk test | 887 | 0.63736 | 205.06 | 13.12 | 0.00000 | H0 of normality is strongly rejected | |
| Shapiro-Francia test | 887 | 0.64388 | 214.13 | 12.21 | 0.00001 | H0 of normality is strongly rejected | |
| **Within/Between provider variance of DUP** | | | |  |  |  | |
|  | Mean | SD | Min | Max | Obs |  | |
| Overall variance in DUP | 73.77 | 125.75 | 0 | 957 | N = 887 | | Within provider variation is much larger than between provider variation | |
| between provider variance in DUP |  | 38.02 | 5 | 169.53 | n = 31 | |
| within provider variance in DUP |  | 119.9394 | -95.76 | 926.88 | T-bar = 28.61 | |
| **Goodness-of-fit tests** |  |  |  |  |  |  | |
| Pregibon link test |  |  |  |  |  |  | |
| yhat | z = 6.52 | | Prob>z = 0.000 | | rejects the H0 that the model is misspecified at 1% significance level | | |
| yhat squared | z = -2.58 | | Prob>z = 0.010 | | fails to reject the log link function at 10% significance level | | |
| Hosmer-Lemeshow test | F(10, 887) = 0.73 | | Prob>F = 0.6963 | | fails to reject the specification of the mean function | | |
| RESET test | chi2(1) = 6.73 | | Prob>chi2 = 0.0095 | | fails to reject the misspecification of the model at 1% significance level | | |
| Park test |  |  |  |  |  |  | |
| Gaussian | chi2(1) = 374.83 | | Prob>chi2 = 0.0000 | | Park test confirms the Gamma distribution as the most appropriate | | |
| Poisson | chi2(1) = 81.07 | | Prob>chi2 = 0.0000 | |
| Gamma | chi2(1) = 1.83 | | Prob>chi2 = 0.1760 | |
| Inverse Gaussian | chi2(1) = 137.12 | | Prob>chi2 = 0.0000 | |
| Squared corr. btw. y and yhat | 0.1891 |  |  |  |  |  | |
| AIC | 8803.7 |  |  |  |  |  | |
| BIC | 8947.4 |  |  |  |  |  | |

**Appendix 2.** Derivation of the study sample from full sample

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Patients in financial year 2012/13 to 2014/15** | | | **n** | **%** |
| with recorded psychosis and treatment start | | | 1,441 |  |
| with valid psychosis and treatment start\* (referred to as full sample) | | | 1,368 | 94.93 |
|  | | |  |  |
|  | Out of the patients with valid psychosis and treatment start | | **n** | **%** |
|  | excluded due to missing LSOA | | 6 | 0.44 |
|  | excluded due to missing HoNOS score | | 97 | 7.09 |
|  | excluded due to date of HoNOS more than 30 days after treatment start | | 356 | 26.02 |
|  | excluded due to fewer than 3 patients per provider | | 22 | 1.61 |
|  |  | |  |  |
|  | **Final study sample** | | **887** | **64.84** |
|  |  | Among the patients within the study sample | **n** | **%** |
|  |  | Number of emergent dates used as psychosis start | 696 | 78.47 |
|  |  | Number of manifest dates used as psychosis start | 191 | 21.53 |
|  |  | Number of prescription dates used as treatment start | 784 | 88.39 |
|  |  | Number of treatment dates used as treatment start | 103 | 11.61 |
|  |  | Number of emergent dates that are equal to manifest dates | 192 | 21.65 |
|  |  | Number of prescription dates that are equal to treatment date | 466 | 52.54 |
|  |  | Mean difference between manifest date and emergent date in days | 14.0 |  |
|  |  | Mean difference between prescription date and treatment date in days | 0.3 |  |
| Note: \* Observations were dropped if treatment start happened before the psychosis start | | | | |

**Appendix 3.** Comparison of covariates between full sample and study sample

|  |  |  |
| --- | --- | --- |
|  | **Study sample** n = 887 | **Full sample** n = 1,368 |
| Duration of untreated psychosis (DUP) |  |  |
| DUP ≤ 2 weeks (%) | 44.3 | 45.8 |
| DUP > 2 and ≤ 6 weeks (%) | 18.8 | 19.4 |
| DUP > 6 and ≤ 12 weeks (%) | 13.4 | 12.9 |
| DUP > 12 weeks (%) | 23.5 | 21.9 |
| Socioeconomic deprivation |  |  |
| Least deprived quintile (%) | 16.4 | 16.3 |
| 2nd least deprived quintile (%) | 16.0 | 16.0 |
| 3rd least deprived quintile (%) | 20.3 | 20.6 |
| 4th least deprived quintile (%) | 21.5 | 21.4 |
| Most deprived quintile (%) | 25.8 | 25.7 |
| Hallucinations and delusions (HoNOS item 6) |  |  |
| No problems with hallucinations and delusions (%) | 17.1 | 22.4 |
| Minor problems with hallucinations and delusions (%) | 7.0 | 8.4 |
| Mild problems with hallucinations and delusions (%) | 20.3 | 20.9 |
| Moderately problems with hallucinations and delusions (%) | 36.8 | 32.8 |
| Severe problems with hallucinations and delusions (%) | 18.8 | 15.7 |
| Previous mental health related service use |  |  |
| Zero service contacts | 70.4 | 74.0 |
| 1-10 service contacts | 22.3 | 19.7 |
| Zero outpatient episodes | 94.7 | 94.6 |
| 1-3 outpatient episodes | 4.5 | 4.5 |
| Zero ward stays | 93.8 | 95.3 |
| 1-3 ward stays | 5.4 | 4.2 |
| Number of physical comorbidities, mean (SD) | 0.014 (0.12) | 0.010 (0.11) |
| Number of mental comorbidities, mean (SD) | 0.016 (0.16) | 0.012 (0.13) |
| Financial year |  |  |
| 2012/13 (%) | 33.2 | 40.2 |
| 2013/14 (%) | 40.0 | 36.6 |
| 2014/15 (%) | 26.8 | 23.3 |
| Note: DUP = Duration of untreated psychosis. Full sample includes all patients with a valid psychosis start date and a valid prescription start date in the financial year 2012/13 - 2014/15. The study sample is based on the full sample and excludes observations with missing LSOA, missing HoNOS score (or HoNOS more than 30 days after treatment start), and providers where fewer than 3 patients were treated. | | |

**Appendix 4.** Distribution of study sample across regions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Region\*** |  | **Full sample** | |  | **Study sample** | |
| East Midlands |  | 29 | 2.1% |  | 17 | 1.9% |
| East of England |  | 82 | 6.0% |  | 52 | 5.9% |
| London |  | 139 | 10.2% |  | 99 | 11.2% |
| North East |  | 3 | 0.2% |  | 3 | 0.3% |
| North West |  | 248 | 18.1% |  | 163 | 18.4% |
| South East |  | 357 | 26.1% |  | 228 | 25.7% |
| South West |  | 213 | 15.6% |  | 119 | 13.4% |
| West Midlands |  | 218 | 15.9% |  | 158 | 17.8% |
| Yorkshire and The Humber |  | 7 | 0.5% |  | 4 | 0.5% |
| No information on region |  | 72 | 5.3% |  | 44 | 5.0% |
| **Total** |  | 1,368 | 100.0% |  | 887 | 100.0% |
| Note: \* Regions as defined by the Office for National Statistics. | | | |  |  |  |

**Appendix 5.** Sensitivity analysis: GLM results for different DUP start and end point definitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **GLM log-gamma regression** dependent variable: DUP in days | (1) **Study sample** | | (2) **Completed observations** | | (3) **Valid treatment date only** | |
|
| Socioeconomic status  (reference category: Least deprived quintile) |  |  |  |  |  |  |
| 2nd least deprived quintile | 0.3347\*\*\* | | 0.2143\*\*\* | | 0.4116\*\*\* | |
| 3rd least deprived quintile | 0.4135\*\*\* | | 0.3509\*\* | | 0.4757\*\*\* | |
| 4th least deprived quintile | 0.6091\*\*\* | | 0.5170\*\*\* | | 0.6981\*\*\* | |
| Most deprived quintile | 0.1862\* | | -0.0385 | | 0.2449 | |
| Severity of hallucinations and delusions (reference category: No problems) |  |  |  |  |  |  |
| Minor problems | -0.3864\*\*\* | | -0.1888 | | -0.2172\*\*\* | |
| Mild problems | -0.0746 | | 0.1318 | | -0.0208 | |
| Moderately problems | -0.1547 | | -0.0088 | | -0.1323 | |
| Severe problems | -0.3456\*\*\* | | -0.2477 | | -0.2951 | |
| Previous mental health service use(reference category: Zero service contacts) |  |  |  |  |  |  |
| 1-10 Service contacts | -0.5151\*\* | | -0.5663\*\* | | -0.5928\*\* | |
| >10 Service contacts | -0.9178\*\*\* | | -0.9899\* | | -0.6876 | |
| Employment status  (reference category: Employed) |  |  |  | |  | |
| Unemployment | 0.6368\*\* | | 0.6152\* | | 0.6277\*\*\* | |
| Student | 0.4865\*\* | | 0.4346\*\*\* | | 0.5982\*\*\* | |
| Provider fixed effects | no | | no | | no | |
| Year fixed effects | yes | | yes | | yes | |
| Covariates | yes | | yes | | yes | |
| Number of patients | 887 | | 658 | | 758 | |
| Proportion of total sample | 100.00% | | 74.18% | | 85.46% | |
| Note: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Dependent variable is duration of untreated psychosis in days (DUP). Model (1) includes the full study sample but without controlling for provider fixed effects. Model (2) includes only observations for which the emergent date and the prescription date have been used to calculate DUP. Model (3) includes only observations from the study sample which have a treatment date recorded. Only significant covariates are shown - all models include all covariates used in the study sample model and year fixed effects. No provider fixed effects were used due to the small sample sizes. Cluster robust standard errors were applied for 3 financial year clusters. | | | | | | |

**Appendix 6.** Sensitivity analysis: GLM results using treatment date as end point of DUP

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GLM log-gamma regression** dependent variable: DUP in days | **End point = prescription date** | |  | **End point = treatment date** | |
| (1)No provider fixed effects | (2) With provider fixed effects |  | (3)No provider fixed effects | (4) With provider fixed effects |
| Socioeconomic status  (reference category: Least deprived quintile) |  |  |  |  |  |
| 2nd least deprived quintile | 0.3347\*\*\* | 0.4593\*\*\* |  | 0.4133\*\* | 0.3523\*\*\* |
| 3rd least deprived quintile | 0.4135\*\*\* | 0.3305\*\*\* |  | 0.5024\*\*\* | 0.3082\*\* |
| 4th least deprived quintile | 0.6091\*\*\* | 0.4103\* |  | 0.6304\*\*\* | 0.3900\*\* |
| Most deprived quintile | 0.1862\* | -0.0121 |  | 0.2268 | -0.0247 |
| Severity of hallucinations and delusions (reference category: No problems) |  |  |  |  |  |
| minor problems | -0.3864\*\*\* | -0.1469 |  | -0.3412\*\*\* | -0.0786 |
| mild problems | -0.0746 | 0.0107 |  | -0.1999\* | -0.1524 |
| moderately problems | -0.1547 | -0.1691 |  | -0.2057\*\*\* | -0.2303 |
| severe problems | -0.3456\*\*\* | -0.2711\* |  | -0.3323\*\* | -0.2140 |
| Previous mental health service use(reference category: Zero service contacts) |  |  |  |  |  |
| 1-10 service contacts | -0.5151\*\* | -0.5258\*\* |  | -0.4955\*\*\* | -0.4712\* |
| >10 service contacts | -0.9178\*\*\* | -0.9294\*\* |  | -0.7733 | -0.9207\*\* |
| 1-3 outpatient episodes | -0.8812\*\* | -0.7132 |  | -0.4581\*\* | -0.4190 |
| > 3 outpatient episodes | -0.7764\* | -0.2109 |  | 1.1236\*\* | 1.4244 |
| 1-3 ward stays | -0.6740 | -0.7257 |  | -0.7770\*\*\* | -0.6796\* |
| > 3 ward stays | -0.7545 | -1.4165\*\* |  | -5.0645\*\*\* | -4.7246\*\* |
| Marital status (reference category: Single) |  |  |  |  |  |
| Married/Civil partner | -0.0574 | -0.0596 |  | 0.1640\*\*\* | 0.0063 |
| Divorced/Separated | -0.1148 | -0.0123 |  | 0.2440 | 0.2144 |
| Employment status  (reference category: Employed) |  |  |  |  |  |
| Unemployment | 0.6368\*\* | 0.5715\*\*\* |  | 0.5245\*\*\* | 0.5400\*\*\* |
| Student | 0.4865\*\* | 0.4563\* |  | 0.4577\* | 0.4583\* |
| Provider fixed effects | no | yes |  | no | yes |
| Year fixed effects | yes | yes |  | yes | yes |
| Covariates | yes | yes |  | yes | yes |
| Number of patients | 887 | 887 |  | 784 | 784 |
| Note: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Dependent variable is duration of untreated psychosis in days (DUP). Model (1) and (2) use the prescription date as end point of DUP whereas Model (3) and (4) use the treatment date. Model (1) and (3) do not apply provider fixed effects whereas Model (2) and (4) do. Displayed are only significant covariates. All models include all covariates of the full model and year fixed effects. Cluster robust standard errors were applied for financial years in Model (1) and (3) and for provider clusters in Model (2) and (4). | | | | | |

**Appendix 7.** Sensitivity analysis: GLM results after restricting age and restricting DUP

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **GLM log-gamma regression** dependent variable: DUP in days | (1) **14-35 yrs old** | (2) **DUP > 0** | (3) **DUP < 2 yrs** | (4) **DUP < 1.5 yrs** |
| Socioeconomic status  (reference category: Least deprived quintile) |  |  |  |  |
| 2nd least deprived quintile | 0.5426\*\*\* | 0.3579\*\* | 0.4799\*\*\* | 0.2711 |
| 3rd least deprived quintile | 0.4424\*\*\* | 0.4717\*\*\* | 0.2983\*\* | 0.2744\*\* |
| 4th least deprived quintile | 0.5653\*\*\* | 0.5227\*\*\* | 0.4124\* | 0.4222\* |
| Most deprived quintile | 0.1670 | 0.0841 | 0.0112 | 0.0422 |
| Severity of hallucinations and delusions  (reference category: No problems) |  |  |  |  |
| Minor problems | -0.2671 | -0.1038 | -0.1160 | 0.0182 |
| Mild problems | -0.0284 | 0.1373 | 0.0208 | 0.0923 |
| Moderately problems | -0.3131 | -0.0687 | -0.1500 | -0.0681 |
| Severe problems | -0.5140\*\*\* | -0.0933 | -0.2776\* | -0.2132 |
| Previous mental health service use (reference category: Zero service contacts) |  |  |  |  |
| 1-10 Service contacts | -0.5452\*\* | -0.2231 | -0.5408\*\*\* | -0.5286\*\*\* |
| >10 Service contacts | -0.8479\*\* | -0.1902 | -0.9096\*\* | -1.1272\*\*\* |
| Employment status (reference category: Employed) |  |  |  |  |
| Unemployment | 0.5455\*\*\* | 0.4391\*\* | 0.5511\*\*\* | 0.5137\*\*\* |
| Student | 0.4691\* | 0.3596\* | 0.4512\* | 0.5061\* |
| Provider fixed effects | yes | yes | yes | yes |
| Year fixed effects | yes | yes | yes | yes |
| Covariates | yes | yes | yes | yes |
| Number of patients | 805 | 775 | 883 | 874 |
| Proportion of total sample | 90.76% | 87.37% | 99.55% | 98.53% |
| Note: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Dependent variable is duration of untreated psychosis in days (DUP). Model (1) includes only 14 to 35 year old patients. Model (2) includes only observations with a DUP greater than zero. Model (3) includes only observations with a DUP shorter than 2 years. Model (4) includes only observations with a DUP shorter than 1.5 years. Displayed are only significant covariates. All models include all covariates of the full model, year and provider effects. Cluster robust standard errors were applied. | | | | |

**Appendix 8.** Sensitivity analysis: GLM results for different measures of socioeconomic status (SES)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GLM log-gamma regression** dependent variable: DUP in days |  | (1) S**mall-area IMD and  patient-level SES** | | |  | (2) S**mall-area IMD only** | | |  | | (3) **Patient-level SES only** | | | | | |
|  |  | Coef. | Robust Std.Err. | marg. eff. dy/dx |  | Coef. | Robust Std.Err. | marg. eff. dy/dx |  | | Coef. | | Robust Std.Err. | | marg. eff. dy/dx | | |
| Socioeconomic status (reference category: Least deprived quintile) | | | | | | | | | | | | | | | | | | |
| 2nd least deprived quintile |  | 0.4593\*\*\* | (0.1305) | 35.50 |  | 0.4780\*\*\* | (0.1314) | 34.69 | |  | |  | |  | |  | | | |
| 3rd least deprived quintile |  | 0.3305\*\*\* | (0.0990) | 23.86 |  | 0.3952\*\* | (0.1223) | 27.44 | |  | |  | |  | |  | | | |
| 4th least deprived quintile |  | 0.4103\* | (0.1834) | 30.89 |  | 0.4712\*\* | (0.1667)) | 34.07 | |  | |  | |  | |  | | | |
| Most deprived quintile |  | -0.0121 | (0.1547) | -0.73 |  | 0.1077 | (0.1408) | 6.44 | |  | |  | |  | |  | | | |
| Marital status (reference category: Single) |  |  |  |  |  |  |  |  | |  | |  | |  | |  | | | |
| Married/Civil partner |  | -0.0596 | (0.1360) | -4.32 |  |  |  |  | |  | | -0.0457 | | (0.1230) | | -3.32 | | | |
| Divorced/Separated |  | -0.0123 | (0.3142) | -0.92 |  |  |  |  | |  | | 0.0545 | | (0.3790) | | 4.16 | | | |
| Accommodation (reference category: Mainstream housing) | | | | | | | | | | | | | | | | | | | |
| Homeless |  | 0.0106 | (0.2166) | 0.82 |  |  |  |  | |  | | -0.0321 | | (0.2098) | | -2.46 | | | |
| Institutionalised |  | 0.0767 | (0.2474) | 6.14 |  |  |  |  | |  | | 0.0488 | | (0.2262) | | 3.89 | | | |
| Other Accommodation |  | -1.0811\*\*\* | (0.2229) | -50.89 |  |  |  |  | |  | | -0.9557\*\*\* | | (0.2403) | | -47.96 | | | |
| Not known |  | -0.0575 | (0.2026) | -4.27 |  |  |  |  | |  | | 0.0262 | | (0.2122) | | 2.07 | | | |
| Employment (reference category: Employed) |  |  |  |  |  |  |  |  | |  | |  | |  | |  | | | |
| Unemployed |  | 0.5715\*\*\* | (0.1473) | 39.98 |  |  |  |  | |  | | 0.5130\*\* | | (0.1734) | | 36.03 | | | |
| Student |  | 0.4563\* | (0.2025) | 29.98 |  |  |  |  | |  | | 0.4024\* | | (0.2023) | | 26.63 | | | |
| Long-term disabled |  | 0.2700 | (0.2441) | 16.07 |  |  |  |  | |  | | 0.1816 | | (0.2468) | | 10.70 | | | |
| Other employment |  | 0.1926 | (0.4149) | 11.01 |  |  |  |  | |  | | 0.1335 | | (0.4686) | | 7.68 | | | |
| Not known |  | 0.7213\*\* | (0.2441) | 52.14 |  |  |  |  | |  | | 0.6310\*\*\* | | (0.1785) | | 47.28 | | | |
| Provider fixed effects |  | yes | | |  | yes | | | |  | | yes | | | | | | |
| Year fixed effects |  | yes | | |  | yes | | | |  | | yes | | | | | | |
| Covariates |  | yes | | |  | yes | | | |  | | yes | | | | | | |
| Note: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Dependent variable is duration of untreated psychosis in days (DUP). Model (1) includes small-area level measures of socioeconomic status (SES) measured as Index of Multiple Deprivation (IMD) quintiles and the patient-level SES measures: marital, accommodation, and employment status. Model (2) includes the small-area SES measure only. Model (3) includes the patient-level SES measures only. All models include year and provider fixed effects. Marginal effects are average marginal effects in days. For factor levels, they present the discrete change from reference category. Cluster robust standard errors were applied for 31 provider clusters. | | | | | | | | | | | | | | | | | | |