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Socioeconomic inequalities in duration of untreated psychosis: Evidence from administrative data in England

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Background. Duration of untreated psychosis (DUP) is an important measure of access to care as it predicts prognosis and treatment outcomes. Little is known about potential socioeconomic inequalities in DUP. The aim of this study was to investigate inequalities in DUP associated with socioeconomic deprivation in a national cohort in England.

Method. We analysed a cohort of 887 patients with a first-episode in psychosis using the administrative Mental Health Services Dataset in England. We used a Generalised Linear Model to account for non-linearity in DUP and looked at inequalities across the whole distribution of DUP using quantile regression.

Results. The median DUP was 22 days (mean = 74 days) with considerable variations between and within the 31 hospital providers. We found evidence of significant inequalities regarding the level of socioeconomic deprivation. Patients living in the second, third, and fourth deprived neighbourhood quintiles faced a 36, 24, and 31 day longer DUP than patients from the least deprived neighbourhoods. Inequalities were more prevalent in higher quantiles of the DUP distribution. Unemployment prolonged DUP by 40 days. Having been in contact with mental health care services prior to the psychosis start significantly reduced the DUP by up to 53 days.

Conclusions. Socioeconomic deprivation is an important factor in explaining inequalities in DUP. Policies to improve equitable access to care should particularly focus on preventing very long delays in treatment and target unemployed patients as well as people that have not been in contact with any mental health professional in the past.

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Introduction

Interest in duration of untreated psychosis (DUP) has increased significantly since a growing body of evidence has shown a shorter DUP leading to higher engagement in treatment, and increased chances of recovery in the short-term (Marshall *et al.*, 2005, Perkins *et al.*, 2005, Doyle *et al.*, 2014) as well as in the long-term (White *et al.*, 2009, Larsen *et al.*, 2011, Penttilä *et al.*, 2014, Tang *et al.*, 2014) in patients with a first episode of psychosis (FEP). Early intervention in psychosis (EIP) is further associated with a decrease in inpatient admissions, length of stay, and related treatment costs (Behan *et al.*, 2015, Valmaggia *et al.*, 2015). Treatment delay itself creates disutility for patients due to delayed benefits, anxiety while waiting, and a reduced ability to maintain social networks and employment commitments (Lindsay *et al.*, 1984, Propper, 1995, Revier *et al.*, 2015). In England, a policy focus on reducing DUP has recently gained new emphasis by the introduction of an EIP maximum waiting time target (Department of Health, 2014, NHS England *et al.*, 2016).

Both the incidence of psychosis and DUP are correlated not only with clinical factors but also with socioeconomic factors such as reduced social networks, unemployment, and less family involvement (Drake *et al.*, 2000, Morgan *et al.*, 2006, O'Donoghue *et al.*, 2016). Relatives and friends are often involved in the help-seeking process and engage the patient in order to receive treatment (Fridgen *et al.*, 2013). In more socioeconomically deprived areas this supportive social network may be less well established, and delays within mental health services are likely to contribute further (Birchwood *et al.*, 2013). While the existence of a socioeconomic gradient of waiting for physical health interventions is well established (Siciliani, 2016), little is known about the relationship of socioeconomic status and DUP.

Our aim was to empirically investigate inequalities in DUP by socioeconomic deprivation, controlling for the severity of hallucinations and delusions, and previous mental health service use. We advance the literature in a number of ways: (1) this is the first study that focuses on the relationship between DUP and socioeconomic deprivation in England, (2) this is the first study to use administrative data to measure DUP which allows us to include a large number of mental health providers from different regions in England, (3) we explicitly model non-linearity to account for the skewed nature of DUP, and (4) we look at the whole distribution of DUP using quantile regression.

Method

Data and sampling

This study uses secondary patient-level data from the Mental Health Services Data Set (MHSDS). The MHSDS is a national administrative database of mental health related treatment in hospitals and community settings within the English NHS (NHS Digital, 2017). We look at the latest data releases

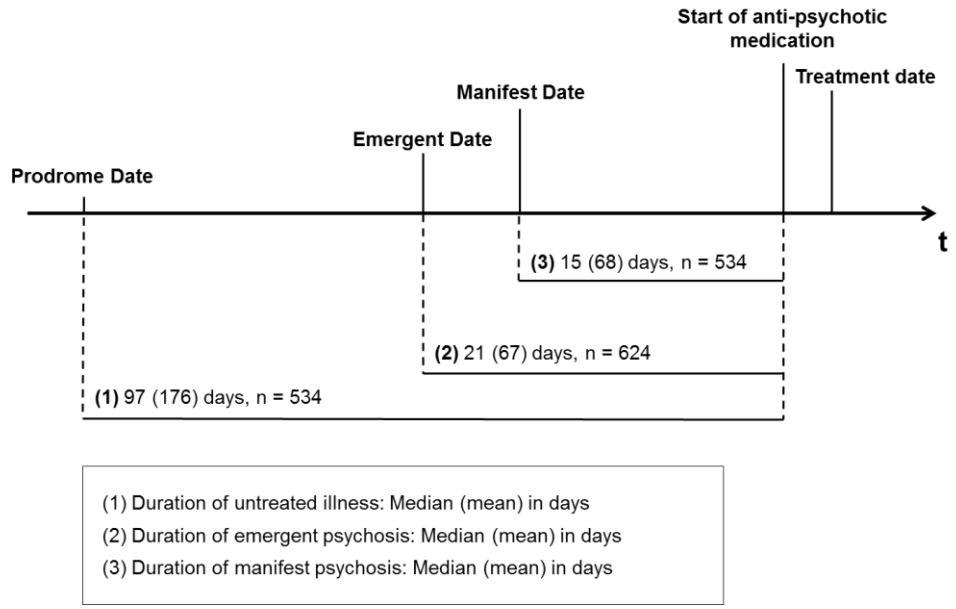
available to us. Patients were included if both their FEP and their anti-psychotic treatment started within the study period April 2012 to March 2015. We exploited the MHSDS variable "EMERPSYCHDATE" and "MANPSYCHDATE" corresponding to the emergent and manifest date of the psychosis to identify relevant patients. This information is recorded by a clinician or care coordinator at the first detailed assessment following referral to an EIP service.

Measures

Duration of untreated psychosis

DUP measures the time from the first onset of psychotic symptoms to the initiation of treatment (Norman *et al.*, 2001). Following Singh *et al.* (2005), DUP can be subdivided into three phases: (1) duration of untreated illness: from first change in behaviour to start of anti-psychotic medication; (2) duration of emergent psychosis: from first psychotic symptom to start of anti-psychotic medication; (3) duration of manifest psychosis: from definite diagnosis to start of anti-psychotic medication. The MHSDS contains the prodromal date (first noticeable change in behaviour), the emergent date (first positive psychotic symptom), the manifest date (psychotic symptoms lasting for a week), the date of anti-psychotic medication, and the treatment date (medication taken for 75% of the next month). Figure 1 compares median and mean durations of all three phases of FEP in our sample. We used the emergent date as DUP start and the date of anti-psychotic medication as the endpoint. If there was no valid emergent or medication date we used the manifest or treatment date instead.

Fig. 1. Median (mean) days for three different definitions of duration of untreated psychosis (DUP)



Socioeconomic status (SES)

We measure SES through the index of multiple deprivation (IMD) 2010 which captures deprivation at small area, or lower super output area (LSOA) level (McLennan *et al.*, 2011). The IMD or comparable indices based on small areas are a widely used and accepted measure in the analysis of socioeconomic inequalities in health and in particular with regard to waiting times not only in England (Laudicella *et al.*, 2012, Gutacker *et al.*, 2015, Siciliani, 2016) but also internationally (Johar *et al.*, 2013, Sharma *et al.*, 2013, Kaarboe *et al.*, 2014). The IMD includes seven domains of deprivation (income, employment, health and disability, education, barriers to housing, crime, and living environment) which are measured by 38 different indicators. Domains are each weighted according to their perceived importance to calculate the overall index. Each LSOA is ranked, where a rank of 1 equals the most deprived and a rank of 32,482 equals the least deprived area. We derived quintiles of the rank based on the distribution in the general population to indicate the 20% least deprived to the 20% most deprived small areas in England.

Severity of hallucinations and delusions

The severity of hallucinations and delusions is likely to impact a patient's DUP as patients may lack insight into their illness, fear of being stigmatised, or not be able to attend appointments due to their condition (Compton *et al.*, 2011). To approximate the patient's severity of condition we used the Health of the Nation Outcome Scales (HoNOS). HoNOS is a clinically validated tool that was developed to measure the health and social functioning of people with severe mental illness (Wing *et al.*, 1998, Orrell *et al.*, 1999). HoNOS ratings consist of 12 scales of which we use item 6 which focuses on problems with hallucinations and delusions. The scale is evaluated between 0 (no problem) and 4 (severe to very severe problems). We used the score closest to the psychosis start and within a maximum window of 30 days after the treatment started.

Previous mental health service use

Patients' ability to navigate themselves through the health care system might be influenced by previous experience of service contacts. Therefore, we considered additional variables of previous mental health service use not related to psychosis. For each patient we counted the number of mental health related professional contacts, outpatient episodes, and ward stays in the twelve months prior to the psychosis start.

Patient demographics

We included a set of patient characteristics: age at onset, gender, ethnicity, marital status, accommodation status, employment status, number of physical comorbidities, and number of mental comorbidities. Comorbidities were counted as the number of ICD-codes recorded as secondary diagnoses for each patient. ICD-codes starting with an "F" where categorised as mental illness

comorbidities, while all others as physical comorbidities. Each patient characteristic was measured at the time of the psychosis start. We additionally controlled for the primary diagnosis group measured at the start of the anti-psychotic treatment to distinguish between affective and non-affective psychoses.

Model and statistical methods

We define DUP as the number of days elapsed between the emergence of the patient's psychosis and the start of the first anti-psychotic prescription. Formally, the model is specified as

$$DUP_{ijk} = \beta_1' d_j + \beta_2' s_{ik} + \beta_3' p_{ijk} + y_i + \alpha_k + u_{ijk} \quad (1)$$

where DUP_{ijk} is the DUP for patient $i = 1, \dots, n$ living in the LSOA $j = 1, \dots, J$ and being treated at provider $k = 1, \dots, K$. The socioeconomic status is represented by the vector d_j which contains a factor variable for the quintiles of overall deprivation at LSOA-level. The vector s_{ik} contains factor variables to account for severity, namely the HoNOS subscale and the variables of previous service use. The vector p_{ijk} summarises the patient demographics. We included year dummies y_i to eliminate any effects due to changes over time not being captured in the control variables and used provider fixed effects α_k to control for differences in DUP between providers, thus estimating the within-provider variation. Previous literature has shown the importance of controlling for provider related differences in waiting times (Laudicella *et al.*, 2012, Sharma *et al.*, 2013). Controlling for variations between providers by introducing provider fixed effects allows us to control for the fact that wealthier and better educated people may choose providers with shorter waiting times. As a result, all observed variation needs to be interpreted as inequalities within providers rather than between. The term u_{ijk} represents the idiosyncratic error. All analyses were conducted in Stata version 14.1 (StataCorp 2014).

Both the Shapiro-Wilk test (Shapiro *et al.*, 1965) and the Shapiro-Francia test (Shapiro *et al.*, 1972) strongly reject the null hypothesis of DUP_{ijk} being normally distributed. We accounted for the skewness of DUP by using generalised linear regression methods (Nelder *et al.*, 1972) which were found to appropriately fit waiting time data and deal with its non-normality (Marques *et al.*, 2014). GLM allows predictions of waiting time on the raw scale which avoids the problem of re-transformation and simplifies interpretation of results. The modified Park test confirmed the gamma distribution to fit the data best. Both the Pregibon link test (Pregibon, 1980) and the modified Hosmer-Lemeshow goodness-of-fit test (Hosmer *et al.*, 2005) accepted the log link function. The RESET test (Ramsey, 1969) further confirmed the model specification. Results of the model diagnostics can be found in Appendix 1. We used cluster robust standard errors for 31 provider clusters. To extend our results we analysed the impact of socioeconomic deprivation at different quantiles of the DUP distribution. Quantile regression has been suggested to account for

heterogeneous effects of predictors across different quantiles of DUP (Guloksuz *et al.*, 2016). Especially in the presence of extreme outliers it can provide more accurate estimates. Due to small sample sizes we could only estimate the effect of socioeconomic deprivation and unemployment on DUP without including further covariates.

Sensitivity analyses

We conduct a number of sensitivity analyses to test the robustness of our results. First, we test to what extent the start and end point definitions of our DUP measure influenced the results: (i) we use only the emergent and the prescription date as start and end dates (no substitution of manifest and treatment date), (ii) we use the same DUP definition but include only observations that have a valid treatment date, (iii) we calculate DUP with the end point being the treatment date only and compare results with and without provider fixed effects. Second, we test the results for the impact of potential outliers: (i) we restrict the sample to the ages 14 to 35 as the main target group for early intervention services, (ii) we exclude patients with a DUP of zero as this may be an artefact in the data recording, (iii) we exclude patients with a DUP longer than 2 years and 1.5 years respectively. Third, we use marital, accommodation, and employment status as alternative measures of SES at the patient-level and look at the differences compared to using our small-area SES measure or a combination of the two.

Results

Descriptive Statistics

We identified 1,368 patients with a valid psychosis start and treatment date within the study period (full sample). Six observations were dropped due to missing LSOA codes and 97 observations due to missing HoNOS scores. We further excluded 365 patients from the analysis if the HoNOS rating happened more than 30 days after the treatment start to account for the level of severity at the early stages of the psychosis. 16 providers (22 corresponding patients) were dropped as they treated fewer than three patients. The final sample comprised 887 patients (65% of full sample) and 31 providers (60%) (see Appendix 2 for more details).

Table 1 summarises the demographic characteristics of the study sample and compares it to the full sample as well as to other recent FEP studies. The cohort was on average 26 years old, predominantly male (65.6%), of White origin (69.8%), and single (66.2%). Most patients lived in mainstream housing (70.9%), many were unemployed (31.3%) and diagnosed with schizophrenia (38%). There are no significant differences between demographic characteristics of the study sample and the full sample implying that there is no selection bias due to the exclusion of incomplete observations (see

also Appendix 3). Further, our study sample appears to be comparable to other recent FEP studies by Tsiachristas *et al.* (2016), O'Donoghue *et al.* (2016), Kirkbride *et al.* (2012), Morgan *et al.* (2006).

Table 1. Demographic characteristics of the study sample compared to the full sample and other FEP studies

	Study sample	**Full sample**	**Other FEP studies**	**References**
n	887	1,368	831, 292, 357, 495	1,2,3,4
DUP in days, median (mean, SD)	22 (73.8, 125.8)	21 (65.9, 115.5)	36 (406, 1036)	4
DUP = 0, n (%)	112 (12.6)	192 (14.0)	-	
Total HoNOS score (range 0-48), mean (SD)	15.3 (6.7)	14.39 (7.1)	-	
HoNOS item 6: Hallucinations and delusions (range 0-4), mean (SD)	2.33 (1.3)	2.11 (1.4)	-	
Patient age, mean (SD)	26.7 (10.09)	26.12 (10.54)	24.7 (4.62)*	1
Gender - Male (%)	65.6	65.4	65.5, 66.2, 57.8	1,3,4
Ethnicity - British White (%)	69.7	69.8	56.7, 79.1, 43.8	1,3,4
Marital status - Single (%)	66.2	66.7	68.5, 72.5	2,4
Employment				
Unemployed (%)	31.3	30.3	29.16, 50.0	1,3
Employed (%)	21.8	19.7	12.24, 25.0	1,3
Students (%)	17.3	18.7	9.96, 19.0	1,3
Missing (%)	14.2	14.8	48.62, 2.0	1,3
Accommodation				
Mainstream housing (%)	70.9	69.9	45.6	1
Homeless (%)	9.4	8.8	4.4	1
Institutionalised (%)	5.1	5.2	-	
Missing (%)	13.6	15.0	42.3	1
Diagnosis				
Schizophrenia (%)	38.0	37.0	44.9	2
Affective disorders (%)	12.2	10.4	11.0	2
Missing (%)	34.2	37.9	-	

Note: DUP = Duration of untreated psychosis. Full sample includes all patients with a valid psychosis start date and a valid prescription 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. "Institutionalised" includes accommodation with mental health or other care support or criminal justice, acute or long-stay healthcare facility, or sheltered housing. References: 1 = Tsiachristas et al. (2016), 2 = O'Donoghue et al. (2016), 3 = Kirkbride et al. (2012), 4 = Morgan et al. (2006). * Study sample was restricted to 16 to 35 year old patients.

In Table 2, all covariates included in the model are presented for the study sample in total and by socioeconomic deprivation quintile. There is an increase in FEP patients as the level of deprivation increases. At least 71% of all providers in our sample treated patients from all five socioeconomic

quintiles. We note that providers are counted multiple times if they treated patients from more than one socioeconomic quintile. The median DUP overall was 22 days (mean = 73.8 days). Patients from the least deprived quintile waited shortest followed by a clear increase in DUP with every deprivation quintile - with the exception of the most deprived quintile. On average, patients had mild to moderately severe problems with hallucinations and delusions according to their HoNOS score (mean = 2.33). We note that patients from the most deprived quintiles differ in a number of characteristics from the rest of the sample. Compared to the study sample, they are more likely to be single, unemployed, homeless, and in contact with mental health services before the psychosis. The sample is distributed across all 9 English regions with the largest proportion of patients from the South East (25.7%) and the smallest proportion from the North East (0.3%) (see Appendix 4).

Table 2. Distribution of patients, providers, and patient characteristics by socioeconomic status

	Study sample	**Least deprived**	**2nd least deprived**	**3rd least deprived**	**4th least deprived**	**Most deprived**
Number of patients (%)	887 (100)	145 (16.3)	142 (16.0)	180 (20.3)	191 (21.5)	229 (25.8)
Number of providers, n (%)	31 (100)	22 (71)	23 (74)	29 (94)	24 (77)	25 (81)
Duration of untreated psychosis median (mean)	22 (73.8)	14 (46.3)	21 (75.2)	25.5 (80.5)	34 (100.3)	20 (62.8)
Total HoNOS score (range 0-48) mean (SD)	15.4 (6.7)	15.0 (6.5)	15.2 (6.9)	15.0 (6.5)	15.9 (6.8)	15.6 (6.8)
Hallucinations and delusions (HoNOS 6) (range 0-4), mean (SD)	2.3 (1.3)	2.2 (1.4)	2.3 (1.3)	2.4 (1.3)	2.3 (1.3)	2.5 (1.3)
Mean number of service contacts	2.8 (8.6)	2.8 (8.1)	2.3 (9.4)	2.3 (6.9)	2.8 (9.5)	3.3 (8.9)
Mean number of outpatient episodes	0.09 (0.4)	0.14 (0.5)	0.05 (0.3)	0.7 (0.3)	0.07 (0.3)	0.10 (0.6)
Mean number of ward stays	0.09 (0.4)	0.06 (0.3)	0.08 (0.5)	0.09 (0.4)	0.09 (0.5)	0.14 (0.5)
Mean number of physical comorbidities	0.01 (0.1)	0.01 (0.1)	0.02 (0.2)	0.01 (0.1)	0.01 (0.1)	0.2 (0.1)
Mean number of mental comorbidities	0.02 (0.2)	0.01 (0.1)	0.01 (0.1)	0.01 (0.1)	0.04 (0.3)	0.01 (0.1)
Patient demographics						
Patient age, mean (SD)	26.7 (10.1)	28.0 (14.1)	28.8 (13.4)	25.5 (9.0)	26.5 (11.1)	25.8 (7.4)
Gender - Male (%)	65.6	65.5	59.9	67.8	62.3	70.3
Ethnicity - British White (%)	69.7	78.6	78.9	68.3	68.1	61.1
Marital status - Single (%)	66.2	56.6	57.8	63.9	71.2	75.1
Employment						
Employed (%)	21.8	26.9	30.3	20.6	23.0	13.1
Unemployed (%)	31.3	21.4	30.3	28.3	27.2	44.1
Students (%)	17.3	25.5	16.2	14.4	18.6	13.5
Long-term disabled (%)	8.1	6.2	4.9	8.9	8.9	10.0
Other employment (%)	7.3	9.0	5.6	8.9	7.3	6.1
Accommodation						
Mainstream housing (%)	70.9	84.8	74.7	69.4	71.7	60.3
Homeless (%)	9.4	3.5	7.0	11.1	6.3	15.7
Institutionalised (%)	5.1	2.8	5.6	1.1	7.3	7.4
Diagnosis						
Schizophrenia (%)	38.0	31.1	26.8	41.7	41.4	43.7
Affective disorders (%)	12.2	13.8	17.6	6.7	12.6	11.8
Substance abuse (%)	7.9	5.5	9.2	6.7	6.8	8.3
Financial year						

2012/13 (%)	33.2	34.5	33.1	34.4	36.7	28.4
2013/14 (%)	40.0	40.7	41.6	34.4	42.4	41.1
2014/15 (%)	26.8	24.8	25.4	31.1	20.9	30.6

Note: DUP = Duration of untreated psychosis. Categorical variables may not sum up to 100% as categories of missing values are not presented. The number of providers refers to those that treated at least one patient from the given socioeconomic quintile, providers can be counted more than once if they treated patients from more than one socioeconomic quintile. "Hallucinations and delusions" refers to the HoNOS item number 6. Service contacts, outpatient episodes and ward stays refer to mental health related service use in the 12 months prior to the psychosis start.

Estimation results

Estimation results from Table 3 confirm a socioeconomic gradient in DUP for the first four deprivation quintiles (least to fourth least deprived). Patients in the second least deprived quintile have a 35.5 day longer DUP than patients from the least deprived quintile. Patients from the third and fourth least deprived quintiles face a DUP that is 24 and 31 days longer than the patients' DUP from least deprived neighbourhoods. The most deprived quintile has a negative coefficient indicating a slightly shorter DUP for patients from most deprived areas compared to the least deprived quintile. However, the result is not statistically significant. Experiencing very severe problems with hallucinations and delusions has a significant impact on DUP. Patients suffering from severe hallucinations and delusions wait 21 days shorter than patients having no problems at all. Negative coefficients for moderately severe problems and minor problems indicate the same severity gradient in DUP, however the estimates are not statistically significant. Mental health professional contacts in the 12 months prior to the psychosis start, significantly reduce DUP by 36 days for 1 to 10 contacts, and by 53 days for more than 10 contacts compared to no contact at all. Having had an outpatient mental health consultant episode before the psychosis, did not show a significant effect on DUP. However, for patients with more than three previous ward stays related to a mental health condition, DUP was 60 days shorter. Patient numbers in the latter case were low which might have affected their statistical significance. Regarding other patient characteristics, we find a small effect of age on DUP. Further there is a strong relationship between employment status and DUP. Patients being unemployed have a 40 day longer DUP than employed patients. Also students have a 30 day longer DUP compared to patients in employment. We could not find any significant inequalities in DUP with regard to gender, ethnicity, marital status, or accommodation status.

Table 3. Generalised Linear Model regression results

Generalized Linear Models	No. of obs = 887; Residual df = 857
Optimization: ML	Scale parameter = 2.081926
Variance function: V(u) = u^2 [Gamma]	Link function: g(u) = ln(u) [Log]
Log pseudolikelihood: -4371.70295	

	Coef.	Robust Std.Err.	[95% Conf. Interval]		marg. eff. dy/dx
Socioeconomic status (reference category: Least deprived quintile)					
2nd least deprived quintile	0.4593***	(0.1305)	[0.2035	0.7150]	35.5

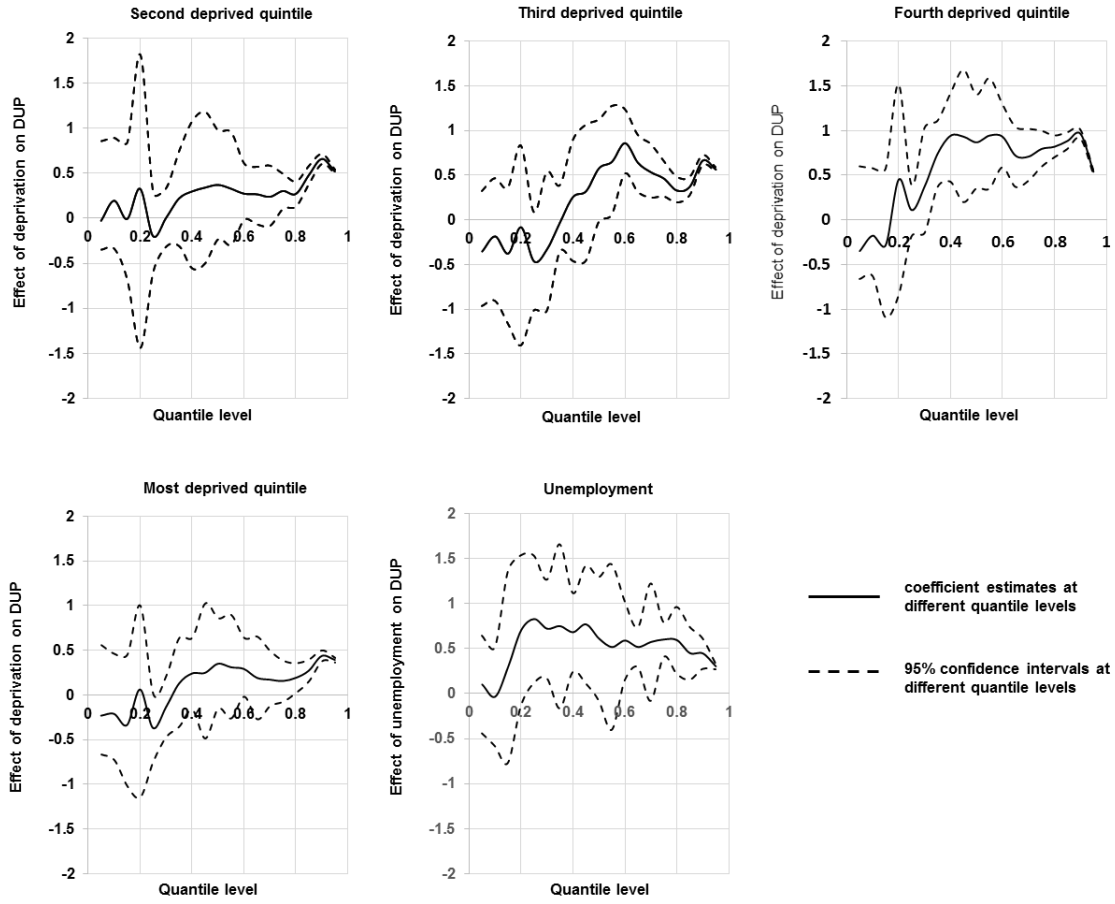
3rd least deprived quintile	0.3305***	(0.0990)	[0.1365	0.5246]	23.86
4th least deprived quintile	0.4103*	(0.1834)	[0.0508	0.7697]	30.89
Most deprived quintile	-0.0121	(0.1547)	[-0.3153	0.2911]	-0.73
Severity of hallucinations and delusions					
(reference category: No problems)					
Minor problems	-0.1469	(0.2555)	[-0.6476	0.3538]	-11.95
Mild problems	0.0107	(0.1929)	[-0.3673	0.3887]	0.94
Moderately problems	-0.1691	(0.2002)	[-0.5615	0.2233]	-13.61
Severe problems	-0.2711*	(0.1177)	[-0.5018	-0.0404]	-20.77
Previous mental health service use					
(reference category: Zero service contacts, outpatient episodes, and ward stays)					
1-10 Service contacts	-0.5258**	(0.1631)	[-0.8454	-0.2062]	-35.79
>10 Service contacts	-0.9294**	(0.2973)	[-1.5120	-0.3468]	-52.96
1-3 Outpatient episodes	-0.7132	(0.5472)	[-1.7857	0.3592]	-40.10
> 3 Outpatient episodes	-0.2109	(0.6354)	[-1.4562	1.0344]	-14.95
1-3 Ward stays	-0.7257	(0.4348)	[-1.5779	0.1265]	-40.76
> 3 Ward stays	-1.4165**	(0.5190)	[-2.4337	-0.3993]	-59.83
Patient demographics					
Age	-0.0172*	(0.0087)	[-0.0343	-0.0001]	-1.34
Female	0.0590	(0.1391)	[-0.2137	0.3316]	4.63
Ethnicity					
(reference category: White or White British)					
Mixed ethnic group	0.3261	(0.2909)	[-0.2442	0.8963]	28.71
Asian or Asian British	-0.4739	(0.2438)	[-0.9517	0.0039]	-28.11
Black or Black British	0.1981	(0.2008)	[-0.1955	0.5916]	16.32
Other ethnic group	-0.0236	(0.2767)	[-0.5659	0.5187]	-1.74
Marital status (reference category: Single)					
Married/Civil partner	-0.0596	(0.1360)	[-0.3261	0.2070]	-4.32
Divorced/Separated	-0.0123	(0.3142)	[-0.6281	0.6034]	-0.92
Accommodation					
(reference category: Mainstream housing)					
Homeless	0.0106	(0.2166)	[-0.4140	0.4352]	0.82
Institutionalised	0.0767	(0.2474)	[-0.4083	0.5616]	6.14
Other Accommodation	-1.0811***	(0.2229)	[-1.5179	-0.6443]	-50.89
Employment (reference category: Employed)					
Unemployed	0.5715***	(0.1473)	[0.2828	0.8602]	39.98
Student	0.4563*	(0.2025)	[0.0595	0.8531]	29.98
Long-term disabled	0.2700	(0.2441)	[-0.2085	0.7485]	16.07
Other employment	0.1926	(0.4149)	[-0.6205	1.0057]	11.01
Diagnosis (reference category: Schizophrenia)					
Substance abuse	-0.0959	(0.2228)	[-0.5327	0.3409]	13.12
Affective disorders	-0.4313	(0.2455)	[-0.9125	0.0500]	-10.72
Other diagnosis	-0.3492	(0.2763)	[-0.8908	0.1924]	-0.62
Number of physical comorbidities	-2.1372	(1.1791)	[-4.4482	0.1739]	-75.00
Number of mental comorbidities	-0.9658	(0.5174)	[-1.9799	0.0483]	-166.00

Note: * p<0.05, ** p<0.01, *** p<0.001. Dependent variable is duration of untreated psychosis in days (DUP). Included are year dummies for 3 financial years and provider dummies for 31 providers. Marginal effects are average marginal effects in days. For factor levels they present the discrete change from the reference category. Cluster robust standard errors were applied for 31 provider clusters.

The graphical analysis in Figure 2 confirms that the socioeconomic gradient is prevalent in the higher quantiles of the DUP distribution. The coefficients for all deprivation quintiles are smaller or negative

for the lower quantiles and increase along the DUP distribution. While estimates at the lower end are mainly insignificant with large confidence intervals, coefficients at the higher end of the DUP distribution are highly significant. In contrast, the effect of unemployment on DUP seems to slightly decrease along the DUP distribution.

Fig. 2. Differential effects of socioeconomic deprivation and unemployment by quantile



Sensitivity analyses

Estimation results for the sensitivity analyses can be found in Appendices 5 to 8. Results were shown to be robust against different definitions of the DUP measure (Appendix 5). Using only the emergent and prescription date as start and end point does not seem to influence the results in a significant way. Also, using only observations with a valid treatment date did not change the gradient we observe. Appendix 6 shows the results when using the treatment date as an alternative end point to calculate DUP. Again, the gradient remains similar with and without provider fixed effects. Restricting the sample to the ages 14 to 35 reveals an even stronger socioeconomic gradient compared to the full sample (Appendix 7). The socioeconomic gradient decreases in magnitude and the second least deprived quintile loses significance as we exclude DUP that exceeds 1.5 years. This suggests the

socioeconomic gradient is stronger for patients with very long waits which is further confirmed when we exclude patients with a zero DUP. In the subsample of non-zero DUP patients, we observe a clear socioeconomic gradient. Excluding marital, accommodation, and employment status as patient-level SES measures from the regression, does not change the observed gradient (Appendix 8). Among the patient-level variables, only employment has a significant effect which is similar to what we observe in the main model. The IMD quintiles seem to capture aspects of deprivation which are not included as separate covariates in the model. The most deprived quintile remains insignificant regardless of the specification.

Discussion

Since the prevalence of FEP in more deprived neighbourhoods is found to be higher compared to less deprived areas (O'Donoghue *et al.*, 2016) we asked whether the level of socioeconomic deprivation determines the patient's help-seeking behaviour and access to care. Being the first to investigate the relationship between DUP and socioeconomic deprivation in England, we were able to use a large sample from administrative data including a large number of mental health providers. Compared to other literature in the field we control for a rich set of covariates and apply statistical methods that adequately account for non-linearity in DUP. The results were robust in a number of sensitivity analyses.

Our findings revealed significant inequalities regarding the level of socioeconomic deprivation. The gradient, however, was not linear. Patients from the second least deprived quintiles have the longest DUP followed by patients from the fourth, and the third least deprived quintiles. For the most deprived quintile differences were not statistically significant. Severe hallucinations and delusions and previous mental health service contacts not related to the psychosis, significantly reduced the DUP. We did not find any significant inequalities in DUP with regard to age, gender, or ethnicity, which also confirms findings from previous studies (Morgan *et al.*, 2006, Large *et al.*, 2008, Cascio *et al.*, 2012, Ghali *et al.*, 2013). We used a comprehensive measure of SES which captures various aspects of socioeconomic deprivation and is widely used in other literature on health inequalities. It should be noted that our measure is relative - not every person living in a highly deprived area will themselves be deprived and vice versa. At a patient level, marital, accommodation, and employment status could serve as proxies for the patient's SES. Results consistently indicate that employment status plays an important role in the length of DUP as has been found by other studies (Morgan *et al.*, 2006). Marital and accommodation status, however, do not explain any differences in DUP. Since we control for provider fixed effects and patient-level SES variables in our model, the observed socioeconomic gradient in DUP is independent of provider characteristics and of the patient's marital, accommodation, and employment status.

Limitations

It remains to be explained why the most deprived neighbourhoods have a shorter DUP than the other deprivation quintiles which contradicts findings of a clear socioeconomic gradient within the physical health literature (Siciliani, 2016). It may be that patients from most deprived neighbourhoods enter the system more often through the criminal justice system which may shorten their DUP or they are more likely to be in contact with a GP due to a poorer general health. Comparing most deprived patients with the rest of the sample revealed that they are more likely to be single, unemployed, and homeless. They were also more likely to have been in contact with mental health services before the psychosis which seems to support our theory. Further, this could represent a recall bias by the patient. The information on the emergence of the psychosis relies on self-report. Patients from more deprived neighbourhoods may systematically report their symptom history differently from others due to different educational levels or insight into the disease.

Our study focuses on DUP as one of the key parameters in managing FEP patients. The importance of the DUP concept lies in its strong relationship to improved clinical outcomes while at the same time being a modifiable risk factor. The median DUP in our study was 22 days which is close to figures in some studies (Apeldoorn *et al.*, 2014) but shorter compared to other studies reporting a median DUP of 50 to 120 days (Birchwood *et al.*, 2013, Behan *et al.*, 2015, O'Donoghue *et al.*, 2016). On the one hand, differences may be caused by our study period being limited to three years. Thus, we possibly exclude a number of DUP observations exceeding the study period. If we are underestimating the DUP and it holds true that the socioeconomic gradient increases as the DUP increases, then we are likely to further underestimate socioeconomic inequalities. We also note a significant decline in DUP across the three years of study. It is likely that the increasing international awareness of early intervention has contributed to an overall reduction in DUP. Since previous studies use data from 1995 to 2011 our study provides a much more recent measure of DUP. On the other hand, differences may be rooted in the measurement of DUP. Despite its strengths, the DUP concept has been criticised in the literature as its definition varies across studies (Singh, 2007, Large *et al.*, 2008, Register-Brown *et al.*, 2014). From our data we are not able to provide information on the methods being applied to define the emergent date and what training the clinical teams received with regard to this. It is also very likely that methods varied between the providers in our sample. By applying provider fixed effects we controlled for any measurement differences between providers. However, we were not able to capture any variation if clinicians within the same provider were recording dates differently. This would have influenced results if clinicians within a provider would record dates for patients from socioeconomically more deprived areas differently to those from less deprived areas. We defined the first antipsychotic prescription as the treatment start as it can be consistently defined within our dataset. But we appreciate that the prescription of medication does not necessarily imply a patient has received effective treatment (Breitborde *et al.*, 2009). Using this approach introduces the problem of

reliably defining effective treatment. To date there is no agreed best way of measuring DUP (Register-Brown *et al.*, 2014). Assuming that effective treatment will be put in place from the first antipsychotic prescription, we are likely to underestimate the actual DUP and look at just a part of its full duration. We do, however, cover the period of help-seeking which is expected to be much more influenced by the patient's socioeconomic background than the aspect of receiving effective treatment after the first service contact. Our results were also robust against changing the DUP endpoint. Nevertheless, future research should aim to address this limitation by establishing a DUP measure that goes beyond the traditional definition using for example the acceptance onto the caseload of an EIP service as the endpoint. This approach will allow the inclusion of patients who never received any anti-psychotic medication.

Despite the policy relevance of DUP, the reporting of relevant data is not mandatory for providers. Hence, we cannot rule out that there is a bias in the composition of our sample as we may miss out FEP patients not being reported by providers. Our sample proved, however, to be comparable with FEP patient cohorts from other recent studies.

Finally, any unobserved heterogeneity cannot be ruled out due to factors such as drug abuse, family history in psychosis, or patients' social network. For example, there is evidence of interactions between age, gender, and cannabis use (Broussard *et al.*, 2013, Donoghue *et al.*, 2014). Also stigma-related processes have been found to influence help-seeking and service contact at early stages of psychotic disorders (Gronholm *et al.*, 2017). Although HoNOS is a validated tool in the application of psychoses it might not capture all aspects of disease related severity. This could lead to an over- as well as underestimation of the effects of socioeconomic deprivation on DUP depending on whether hallucinations or delusions are more prevalent in certain deprivation quintiles.

Implications for EIP services

DUP captures the complete waiting experience of the patient including time from first symptom to help-seeking, from referral to assessment, and from assessment to treatment. Therefore, we cannot distinguish between the patient's and the care system's contribution to the delay and factors are likely to interact with each other. However, socioeconomic deprivation is a contributing factor to a prolonged DUP independent of severity of hallucinations, previous service contacts, and patient demographics. Inequalities arise predominantly at the higher end of the DUP distribution. Policies to improve equitable access to care should therefore focus on preventing very long delays in treatment and target unemployed patients and students. Being known to mental health services for reasons other than psychosis seems to make it easier to access the system a second time regardless of the severity of the condition. Efforts aimed at shortening DUP should particularly target people that have not been in contact with any mental health professional in the past. For example, GP or other health professional education campaigns could improve awareness of the signs of early psychosis and encourage them to

refer patients promptly to specialist services (Lloyd-Evans *et al.*, 2011). Also information campaigns for young people and their families in schools or in mainstream media may contribute to a reduced stigmatising image of psychosis and will promote early help-seeking. The decrease in DUP over the past years indicates that the awareness of its importance has increased. However, significant variations within providers remain and should be addressed further to reduce inequalities.

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Conflict of interest

None.

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Appendix

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) **Small-area IMD and patient-level SES**			(2) **Small-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.