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Prevalence and Correlates of Obsessive-Compulsive Symptoms in Individuals with Schizophrenia, Schizoaffective Disorder or Bipolar Disorder

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Abstract

Objective: Although frequently reported in psychosis, obsessive-compulsive symptoms (OCS) are often not recognized and thus undertreated. We aimed to estimate the prevalence of OCS and obsessive-compulsive disorder (OCD) in patients with schizophrenia, schizoaffective disorder or bipolar disorder in clinical records and identify clinical associations of OCS co-occurrence.

Methods: Data were retrieved from the South London and Maudsley NHS Foundation Trust Biomedical Research Centre (SLaM BRC) case register. The study population was restricted to individuals diagnosed with schizophrenia (ICD F20.x), schizoaffective disorder (ICD F25.x) or bipolar disorder (ICD F31.x) between 2007 and 2015. OCS and OCD were ascertained from structural fields and via Natural Language Processing (NLP) software applied to free-text records. Clinical characteristics were obtained from Health of the Nation Outcome Scales (HoNOS) for the analyses on associations between clinical characteristics and OCS/OCD status using logistic regressions with confounders considered.

Results: We identified 22,551 cases of schizophrenia, schizoaffective disorder or bipolar disorder in the observation window. Among these, 5,179 (23.0%) were identified as having OCS (including an OCD diagnosis) and 641 (2.8%) specifically with co-morbid OCD. OCS/OCD was associated with an increased likelihood of recorded aggressive behavior (OR=1.18; 95% CI: 1.10 - 1.26), cognitive problems (OR=1.21; 95% CI: 1.13 - 1.30), hallucinations and delusions (OR=1.11; 95% CI: 1.04 - 1.20) and physical problems (OR=1.17; 95% CI: 1.09 - 1.26).

Conclusion: OCS and OCD are frequently recorded for patients with schizophrenia, schizoaffective disorder and bipolar disorder, and are associated with more severe psychiatric clinical characteristics.. Automated information extraction tools hold potential to improve recognition and treatment of co-occurring OCS/OCD for psychosis.

Keywords natural language processing, obsessive compulsive disorder, obsessive compulsive symptoms, schizophrenia, bipolar disorder, schizoaffective disorder, electronic health records

Introduction

The presence of co-occurring obsessive and/or compulsive symptoms (OCS) has been suggested to predict adverse outcomes in individuals with schizophrenia, schizoaffective disorder and bipolar disorder (1, 2). For example, several studies have reported that comorbid OCS are associated with earlier age of onset, higher psychotic symptom severity and poorer social and vocational function (3, 4). Understanding the factors associated with OCS among individuals with severe mental disorders can help to identify vulnerable subgroups and potentially inform more personalised treatment.

The OCS-related impairment has considerable implications, as comorbidity rates for OCS and obsessive-compulsive disorder (OCD) are significantly higher than expected among patients with schizophrenia, schizoaffective disorder or bipolar disorder. While the lifetime prevalences of schizophrenia and OCD are around 0.6% (5) and 2 to 3% (6) respectively, the prevalence of comorbid OCD in patients with schizophrenia and schizoaffective disorder are about 12-23% (7, 8) and 13-23% for bipolar disorder (2).

Published studies, however, are often not consistent with regard to the extent of the comorbidity. Estimates of OCD/OCS prevalence are influenced by the method of assessment, varying through different study populations. Some of the previous studies relied on selected samples, e.g. specialized clinical facilities or convenience samples (2, 8) or had relatively small sample sizes (9), prone to selection bias or limited statistical power.

Electronic health records hold the potential to capture real-world data on individuals on a large scale. Important clinical information is not only kept in structured data, such as diagnostic codes, but also recorded in unstructured free-text fields. The use of natural language processing (NLP) algorithms on unstructured data has been well demonstrated and creates the possibility to derive clinical insights in representative samples of the source population. In this area of research, NLP could give an advantage by the ability to measure rates of diagnosed OCD not just OCS, and the ability to look for associations with other clinical parameters.

In current study, we used NLP techniques to support automated, text-based ascertainment of recorded OCS and OCD among patients with schizophrenia, schizoaffective disorder or bipolar disorder in electronic clinical records from a large UK mental health case registry and

explore factors related with co-occurrence of OCS and OCD, including demographic factors and clinical characteristics.

Methods

Setting and study population

The study was conducted using clinical data from electronic health records of people receiving secondary mental healthcare from the South London and Maudsley NHS Foundation Trust (SLaM). SLaM has near-monopoly provision of mental health services to a defined geographic catchment of approximately 1.36 million residents of Lambeth, Southwark, Croydon and Lewisham in south London, UK. SLaM services encompass all aspects of secondary mental healthcare across all age groups, including inpatient, community, general hospital liaison and forensic services, as well as tertiary national specialist services. Electronic clinical records have been used comprehensively in all SLaM services since 2006, and the Clinical Record Interactive Search (CRIS) system, supported by SLaM's National Institute for Health Research (NIHR) Biomedical Research Centre (BRC), was developed in 2008 to enable researchers to search and retrieve de-identified data from the clinical records efficiently for research purposes. The protocol for this case register has been described in detail elsewhere (9) and, currently, there are over 500,000 service users represented in CRIS. Individuals who had received a diagnosis of schizophrenia spectrum (ICD-10 code: F20.x), bipolar disorder (F31.x) or schizoaffective disorder (F25.x) during the observation period (from 1st January 2007 to 31st December 2016, inclusive), and whose clinical/functional status had been assessed by a clinician using the Health of the Nations Outcome Scale (HoNOS) (10) at least once during this observation period were included in this dynamic cohort. CRIS has received ethical approval as an anonymised data resource for secondary analyses (Oxford Research Ethics Committee C, reference 18/SC/0372.

Assessment of obsessive/compulsive symptoms

Natural language processing (NLP) algorithms allowed information to be extracted from unstructured clinical text records (i.e. free-text fields entered by clinicians, including recorded patient reviews, treatment notes, and clinical correspondence), which would not otherwise be available as structured entities. These have been widely developed and applied in CRIS to enhance the depth of data available for analysis on a large scale (9). We developed NLP

algorithms specifically to extract documentation of obsessive/compulsive symptoms from free-text fields in clinical assessments and correspondence in CRIS using Generalised Architecture for Text Engineering (GATE) software (11). Full details concerning the development of this NLP application and the criteria for identifying obsessive/compulsive symptoms for NLP have been described previously (12). In brief, coding rules to determine the presence of OCS, including OCD, in clinical assessments and correspondence were based on the items in the Yale Brown Obsessive Compulsive Scale (Y-BOCS) (13). The OCS algorithm was able to identify OCS (including OCD) with a precision (i.e. positive predictive value) of 0.67 and a recall (i.e. sensitivity) of 0.77 and instances of a recorded clinical diagnosis of OCD were identified with a precision/recall of 1.00/0.85. In addition, the application was supplemented with output from a pre-existing NLP algorithm ascertaining text associated with diagnosis statements which performed at a precision/recall of 0.98/0.88 for OCD (ICD10 code F42) (9). Data from the algorithms for OCS and psychiatric diagnosis, and structured fields in CRIS were combined to produce the outcome measure of OCS, including OCD.

Assessment of socio-demographic and clinical characteristics

Study subjects were grouped into diagnostic categories based on the mental disorder diagnosis, received before or during the observation period. Information on diagnosis came from both the NLP algorithm (previously described) and from recorded structured diagnostic fields, in which ICD-10 codes were applied. Where study subjects had received more than one diagnosis of interest during the observation period, the diagnosis was hierarchically assigned as schizophrenia, schizoaffective disorder, and then bipolar disorder. Other variables extracted for analysis included secondary comorbid diagnoses of alcohol use disorder (F11), opioid use disorder (F10), and major depressive disorder (F33) that were diagnosed before or during the observation period. These comorbidities were also extracted from structured fields and free-text fields using the GATE psychiatric diagnosis application described above. Data on age, sex, ethnicity, marital status, postcode (for index of multiple deprivation score) and use of medication were defined from routinely completed fields. Age at onset was calculated at the date on which the individual received their first schizophrenia, schizoaffective disorder or bipolar disorder diagnosis date during the observation period. Ethnicity was classified into the following groups: ‘White British’, ‘Other white’, ‘South Asian’, ‘East Asian’, ‘Black Caribbean’, ‘Other black’, and ‘Others, mixed,

and unknown' according to categories defined by the UK Office for National Statistics. Marital status was taken from the last available status and categorised as being in a relationship ('married', 'civil partnership', or 'cohabiting') and no relationship ('divorced', 'civil partnership dissolved', 'separated', 'single', 'widowed' or 'unknown'. Socioeconomic status was measured using the Index of Multiple Deprivation score, which measures relative levels of deprivation in small-area neighbourhoods in the UK, given in percentiles (14) The Index of Multiple Deprivation is comprised of seven domains of deprivation taken from the 2011 UK census: income, employment, health and disability, education skills and training, barriers to housing and services, crime, and living environment at the level of Lower Super Output Area (LSOA), with an average population of 1,722 in London. The address in England at LSOA level, recorded closest in time to the first schizophrenia, schizoaffective disorder and bipolar disorder diagnosis received during the observation period, was used to obtain deprivation scores, with a separate category for homelessness. Information on clinical/functional status was obtained from the 12-item Health of the Nation Outcome Scale (HoNOS) (10). The HoNOS, which is routinely completed in SLAM patients, is commonly used as an outcome measure among mental health service providers in the UK. Current analysis included the following HoNOS items: item 1, assessing overactive aggressive behaviour; item 2, assessing non-accidental self-injury; item 4, assessing cognitive problems; item 5, assessing physical illness or disability problems; item 6, assessing hallucinations and delusions; and item 7, assessing depressed mood. HoNOS items are scored according to the following Likert scale categories: 0) not a problem; 1) minor problem requiring no action; 2) mild problem but definitely present; 3) moderately severe problem; and 4) severe to very severe problem. For our study, scores were categorised as present (1-4) vs. absent (0) binary variables for further analyses.

Statistical analysis

Characteristics of demographics and clinical characteristics of the sample by presence of OCS/OCD are presented. Descriptive statistics were summarised as means and SD for continuous variables and as frequencies with percentages for categorical variables. Logistic regression analyses were undertaken to estimate the crude and adjusted associations between socio-demographic, clinical characteristics, and OCS/OCD in the sample, with potential interactions with psychiatric diagnosis (schizophrenia, schizoaffective disorder, bipolar disorder)

assessed using log-likelihood ratio tests. All analyses were performed using Stata 12.0 and significance level (alpha level) was set at 0.05.

Results

As shown in the flowchart of the data source in Figure 1, a total of 21,551 individuals were included in this study with schizophrenia (n=13,754), schizoaffective disorder (n=1,113) and bipolar disorder (n=6,684) identified within the observation period. Their mean age was 42.2 years old (SD = 16.2) and 11,431 (53.0%) were male. In the cohort, 5,179 (24.0%; 95% CI: 23.5 - 24.6%) people were identified as having recorded OCS (including OCD diagnosis). The prevalence of OCS (including OCD) slightly varied by psychiatric diagnosis, with 24.6% for schizophrenia (95% CI: 23.9 - 25.3%), 25.3% for schizoaffective disorder (95% CI: 22.8 - 28.0%), and 22.6% for bipolar disorder (95% CI: 21.6 - 23.6%). In addition, 2,574 individuals (11.9%; 95% CI: 11.5 - 12.4%) were identified as having co-morbid OCD. Individuals recorded as having OCS/OCD were more often of male gender, non-white British origin, living in deprived neighborhoods and more often single. Presence of comorbid alcohol use disorder, opioid use disorder, and major depressive disorder were all significantly positively associated with the co-occurrence of OCS/OCD symptoms. Details were shown in Table 1.

Table 2 displays associations between recorded OCS/OCD and mental or physical health symptoms assessed by HoNOS. After full adjustment, OCS/OCD was significantly associated with recorded aggressive behaviour (adjusted OR=1.18; 95% CI: 1.10 - 1.26), cognitive problems (1.21; 1.13 - 1.30), hallucinations/delusions (1.11; 1.04 - 1.20), and physical illness/disability (1.17; 1.09 - 1.26), but not significantly with non-accidental self-injury or depressed mood. As including co-morbid major depressive disorder in the model might have represented over-adjustment for depressed mood (measured using HONOS), a further analysis was run without this covariate; however, results were similar (Supplementary Table 1).

Considering the three psychiatric diagnosis groups, a significant interaction was found for the OCS/OCD association with hallucinations/delusions (log-likelihood ratio Chi-square value = 7.87, p-value = 0.02) in a fully-adjusted model, but not for any other HoNOS scale investigated. Further stratification by diagnosis indicated that this association was only significant in patients with bipolar disorder (OR = 1.24; 95% CI: 1.08 - 1.42; Table 3), with a similar strength of association in schizoaffective disorder (OR=1.23; 95% CI: 0.91 - 1.66) but an association close to the null value in patients with schizophrenia.

Discussion

In the study described here, we assessed OCS/OCD in individuals with schizophrenia, schizoaffective disorder or bipolar disorder using NLP to ascertain this recorded comorbidity across a large clinical population. The co-occurrence of OCS/OCD in individuals with schizophrenia, schizoaffective disorder and bipolar disorder was associated with a number of indicators of higher clinical severity. In our large sample drawn from routine mental healthcare data, the prevalence of comorbid OCS/OCD (23.0%) in the combined diagnostic groups was lower than had been previously reported for schizophrenia (30%)(8) and comparable to that previously reported for bipolar disorder (13 - 23%)(2). However, prevalence in previous studies has mainly been obtained from trained clinicians applying DSM-5 criteria and using a scale such as the YBOCS to assess the severity of OCS. Although the YBOCS scale was used to inform the OCS NLP application, the current estimates are still based on the unprompted documentation of OCS in clinical texts authored by a range of clinicians and health care professionals, as well as from descriptions of patients' self-reported symptoms. Our ostensibly lower OCS/OCD estimates may speak to the challenges that mental health professionals face in clinical practice in distinguishing obsessions from delusions. For instance, a key criterion for differentiating psychotic symptoms and OCS has been the presence of insight into obsessions and compulsions (15, 16). However, when a patient presents with obsessions and poor insight, it remains difficult to disentangle that obsession from delusions. Furthermore, it is also possible that there exists a lack of awareness regarding the possible co-morbidity of OCS in individuals with schizophrenia, schizoaffective disorder or bipolar disorder, resulting in under-recording. In addition, although the NLP algorithm for ascertaining OCS/OCD was supplemented by clinical diagnoses in structured fields and the results of other algorithms targeting diagnoses, the precision and recall were not perfect and may have resulted in some cases being missed.

Individuals with OCS/OCD comorbidity were more likely to have hallucinations/delusions, aggressive behavior, cognitive difficulties, and physical illness/disabilities, and also were more likely to have a diagnosis of comorbid depressive, alcohol use disorder or opioid use disorder. Previous reports on the association between OCS comorbidity and psychotic symptom severity in schizophrenia have been inconsistent. Several previous studies did not find significant associations (4, 17, 18), or fewer positive or negative

symptoms in patients with OCS (19-21). The meta-analysis of Cunill (1), summarizing results of 18 studies of individuals with schizophrenia, concluded no differences in positive or negative symptom severity in OCD versus non-OCD subgroups; for patients with OCS, a higher symptom severity was described for positive and negative symptoms compared to those without OCS, although methodological explanations could probably explain this difference. Some studies have found that aggressive behaviour in schizophrenia is associated with clinical factors, such as positive symptoms (22) as well as social factors, such as having physical disease (23) and being unmarried (24). As individuals with OCS comorbidity have more unfavourable social characteristics, this could underlie the association between OCS comorbidity with aggressive behavior in our sample. In the current study, individuals with comorbid OCS/OCD were more likely to be reported to have cognitive problems. Earlier studies have noted negative associations of OCD with neurocognitive functioning in individuals with schizophrenia (1, 25), including in attention set shifting (25, 26) and cognitive flexibility (26). In particular, executive functioning and abstract capacity were reported to be impaired. Previous research after 68 patients with OCD, bipolar disorder or both disorders did not indicate impaired recognition in individuals related to OCD comorbidity (27). Our observed associations with alcohol and opioid use disorders are consistent with previous findings for bipolar disorder (28, 29), although previous research found no associations of OCD with substance use (other than nicotine) in schizophrenia (4, 15, 30). The effect estimates of OCS/OCD co-occurrence observed in the current study are small (e.g. adjusted OR = 1.11 for hallucinations and delusions) to moderate (e.g. adjusted OR = 1.21 for cognitive problems). However, effect sizes might not necessarily reflect their related clinical importance. Given the serious implications of these outcomes of interest, including overactive aggressive behaviour and non-accidental self-injury, the results could still provide very useful insights for further investigations. The associations between OCS/OCD and depressed mood or non-accidental self-injury were no longer significant after adjustment for socio-demographics and clinical features as confounders. Previous studies have reported associations between OCS in schizophrenia and higher severity of depressive symptoms (3, 21, 31, 32). Also, in people with bipolar disorder, there is evidence that OCS may be more prevalent during depressive than euthymic or manic states, and people with bipolar disorder and OCD have more frequent depressive episodes than those with bipolar disorder alone (33, 34). Our study group described the 5-year course of OCS and OCD in first episode psychosis and concluded that comorbid OCD

was only associated with more severe depressive symptoms, but not with suicidality (17). Other studies also supported the earlier found association between comorbid OCD and depressive symptoms (35, 36), as well as suicidal ideation and suicide attempts in patients with schizophrenia (37). Thus, more studies focusing on the complex roles played by OCS/OCD in relation to depressed mood or non-accidental self-injury behaviors among people with severe mental illness might be of help to further address these inconsistencies. The phenomenological overlap between OCS and psychotic disorders represents a challenge to clinicians and researchers. However, the limited utility of antipsychotics, the effectiveness of antidepressants in treating OCS in schizophrenia and the persistence of OCS after successful treatment of schizophrenia (38) suggests that co-morbid OCS in this patient group represents more than just an expression of enduring psychosis. Previous researchers found the symptom profile of OCS/OCD in schizophrenia to be similar to that seen in patients with OCD only (39). This corresponds to the believe that OCS are continuous trait instead of a dichotomy (40).

Previous studies of obsessive/compulsive symptoms in individuals with schizophrenia have been limited by smaller patient samples that were specifically recruited to a research project (15, 41). One of the key strengths of our study was our large sample of people with schizophrenia, schizoaffective disorder or bipolar disorder that is representative of the clinical population in a defined geographical catchment area. Nevertheless, our study has several limitations. First, misclassification of OCS/OCD cannot be fully ruled out, but it would be mostly likely have resulted in underestimation of the prevalence of OCD. Although Chandran et al. showed that the algorithm was able to identify OCS with a positive predictive value of 0.67 and sensitivity of 0.77 (12), this information was generated for the evaluation of validity at document level. However, most patients have multiple documents, especially for the long-term service users of SLaM hospital. The probability of false negative would be reasonably low for them, if OCS/OCD was ever mentioned in electronic health records by clinicians. The only concern was that OCS/OCD had not been considered of clinical importance in daily psychiatric practice for treatment planning on people with schizophrenia, bipolar disorder or schizoaffective disorder up to now. For the sake of retrospective study design, if the clinicians had never recorded any information about OCS/OCD, the App would never be able to detect it. This typical kind of potential missing data issue was not specifically happening to our study only. Furthermore, we have no reason to believe that these potential errors would have been systematic,

so we would expect the bias would shift towards the null rather than causing spurious associations. Second, individuals with schizophrenia, schizoaffective disorder or bipolar disorder known to health care services are more likely to suffer from prolonged and relapsing clinical courses (42). Our results might be affected by prevalence bias such that individuals in the current study are more likely to have less favorable health outcomes. Therefore, caution is warranted if generalizing of our results to incident cases of schizophrenia, schizoaffective disorder or bipolar disorder. Third, in the present study, we used the OCS application to determine the presence or absence of OCS by examining the health record of patients diagnosed with schizophrenia, bipolar disorder or schizoaffective disorder, but it was not possible at this point to delineate the temporality of the occurrence of OCS. This may be of importance since OCS can be a prodromal symptom of schizophrenia-spectrum disorders (43). In the current study, we did have the date of the annotated document which might work as proxy for current or prior OCS/OCD presence. However, this was not per se reflecting the temporality of the issue. The observation period spanned ten years, yet currently the OCS application is limited in its ability to ascertain whether an individual was currently experiencing OCS or has experienced them in the past. Related attempts on the use of NLP to detect temporality for symptom onset in psychiatric healthcare text are still ongoing (44), but this remains a challenge in near future. Fourth, there may be the issue of residual confounding in the observed association between OCS/OCD and specific clinical characteristics assessed by the HoNOS. Although we adjusted for all well-accepted independent risk factors available in our dataset as confounders in final models, there might be some other potential confounders (e.g. head trauma or brain injury in correlation with cognitive disorders, or paranoia in relation to aggressive behaviors) to be further evaluated and properly controlled. Finally, both HoNOS and OCS/OCD could be recorded multiple times during the observation period (from 1st January 2007 to 31st December 2016). The exact temporality of the OCS/OCD occurrences in relation to HoNOS could not be confirmed with the current NLP algorithm. To address this issue as much as possible, we extracted the closest HoNOS assessment after the first date on which OCS/OCD was recorded in the data during the observation period.

Future studies will address this issue to increase the accuracy of the estimate of OCS, including OCD, in individuals with schizophrenia, schizoaffective disorder or bipolar disorder. Finally, the application of NLP to mental health records may not identify OCS as accurately as a direct diagnostic assessment and assessing severity using the YBOCS scale.

To conclude, our data suggest that OCS/OCD can be identified at scale in clinical records using automated methods, that the symptoms/disorder are common in patients with schizophrenia, schizoaffective disorder or bipolar disorder and are associated with poorer clinical status. Since treatment procedures are different, adequate detection of OCS in individuals with severe mental illness is warranted. The current findings highlight the potential of automated information extraction tools in mental health research and clinical practice.

Clinical Points

- Although obsessive-compulsive symptoms (OCS) or obsessive-compulsive disorder (OCD) frequently co-occur in patients with schizophrenia, schizoaffective disorder or bipolar disorder, they are often not recognized and thus undertreated.
- Automated information extraction tools hold potential for adequate detection of OCS/OCD in patients with schizophrenia, schizoaffective disorder or bipolar disorder.
- The existence of OCS/OCD was found to be related to the clinical characteristics of these mental disorders, implying that OCS/OCD might be potential treatment targets in clinical practice.

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Data Sharing

The data linkage accessed by CRIS remains within an NHS firewall and a patient-led oversight committee presides over research governance for all CRIS projects and dissemination. Data access is encouraged upon adherence to these conditions. Interested parties may contact RS (robert.stewart@kcl.ac.uk), CRIS academic lead.

References

1. Cunill R, Castells X, Simeon D. Relationships between obsessive-compulsive symptomatology and severity of psychosis in schizophrenia: a systematic review and meta-analysis. J Clin Psychiatry. 2009;70(1):70-82.
2. Cederlof M, Lichtenstein P, Larsson H, Boman M, Ruck C, Landen M, et al. Obsessive-Compulsive Disorder, Psychosis, and Bipolarity: A Longitudinal Cohort and Multigenerational Family Study. Schizophr Bull. 2015;41(5):1076-83.
3. Lysaker PH, Whitney KA. Obsessive-compulsive symptoms in schizophrenia: prevalence, correlates and treatment. Expert Rev Neurother. 2009;9(1):99-107.
4. Poyurovsky M, Faragian S, Pashinian A, Heidrach L, Fuchs C, Weizman R, et al. Clinical characteristics of schizotypal-related obsessive-compulsive disorder. Psychiatry Res. 2008;159(1-2):254-8.
5. McGrath J, Saha S, Chant D, Welham J. Schizophrenia: a concise overview of incidence, prevalence, and mortality. Epidemiol Rev. 2008;30:67-76.
6. Ruscio AM, Stein DJ, Chiu WT, Kessler RC. The epidemiology of obsessive-compulsive disorder in the National Comorbidity Survey Replication. Mol Psychiatry. 2010;15(1):53-63.
7. Achim AM, Maziade M, Raymond E, Olivier D, Merette C, Roy MA. How prevalent are anxiety disorders in schizophrenia? A meta-analysis and critical review on a significant association. Schizophr Bull. 2011;37(4):811-21.
8. Swets M, Dekker J, van Emmerik-van Oortmerssen K, Smid GE, Smit F, de Haan L, et al. The obsessive compulsive spectrum in schizophrenia, a meta-analysis and meta-regression exploring prevalence rates. Schizophr Res. 2014;152(2-3):458-68.
9. Perera G, Broadbent M, Callard F, Chang CK, Downs J, Dutta R, et al. Cohort profile of the South London and Maudsley NHS Foundation Trust Biomedical Research Centre (SLaM BRC) Case Register: current status and recent enhancement of an Electronic Mental Health Record-derived data resource. BMJ Open. 2016;6(3):e008721.
10. Wing J, Curtis RH, Beevor A. Health of the Nation Outcome Scales (HoNOS). Glossary for HoNOS score sheet. Br J Psychiatry. 1999;174:432-4.
11. Cunningham H, Tablan V, Roberts A, Bontcheva K. Getting more out of biomedical documents with GATE's full lifecycle open source text analytics. PLoS Comput Biol. 2013;9(2):e1002854.
12. Chandran D, Robbins DA, Chang CK, Shetty H, Sanyal J, Downs J, et al. Use of Natural Language Processing to identify Obsessive Compulsive Symptoms in patients with schizophrenia, schizoaffective disorder or bipolar disorder. Sci Rep. 2019;9(1):14146.
13. Goodman WK, Price LH, Rasmussen SA, Mazure C, Fleischmann RL, Hill CL, et al. The Yale-Brown Obsessive Compulsive Scale. I. Development, use, and reliability. Arch Gen Psychiatry. 1989;46(11):1006-11.
14. Department for Communities and Local Government. English indices of deprivation 2015. https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015. Accessed Sep 2019.
15. de Haan L, Sterk B, van der Valk R. Presence of obsessive compulsive symptoms in first-episode schizophrenia or related disorders is associated with subjective well-being and quality of life. Early Interv Psychiatry. 2013;7(3):285-90.
16. Buckley P HM. Comorbid Psychiatric Disorders in Schizophrenia: More than Just a Chance Cooccurrence. . In: De Haan L SF, Zink M editor. Obsessive-Compulsive Symptoms in Schizophrenia Springer International Publishing. p. 3-10.

17. de Haan L, Sterk B, Wouters L, Linszen DH. The 5-year course of obsessive-compulsive symptoms and obsessive-compulsive disorder in first-episode schizophrenia and related disorders. Schizophr Bull. 2013;39(1):151-60.
18. Faragian S, Pashinian A, Fuchs C, Poyurovsky M. Obsessive-compulsive symptom dimensions in schizophrenia patients with comorbid obsessive-compulsive disorder. Prog Neuropsychopharmacol Biol Psychiatry. 2009;33(6):1009-12.
19. Tibbo P, Kroetsch M, Chue P, Warneke L. Obsessive-compulsive disorder in schizophrenia. J Psychiatr Res. 2000;34(2):139-46.
20. Poyurovsky M, Fuchs C, Weizman A. Obsessive-compulsive disorder in patients with first-episode schizophrenia. Am J Psychiatry. 1999;156(12):1998-2000.
21. de Haan L, Hoogenboom B, Beuk N, van Amelsvoort T, Linszen D. Obsessive-compulsive symptoms and positive, negative, and depressive symptoms in patients with recent-onset schizophrenic disorders. Can J Psychiatry. 2005;50(9):519-24.
22. Appelbaum PS, Robbins PC, Monahan J. Violence and delusions: data from the MacArthur Violence Risk Assessment Study. Am J Psychiatry. 2000;157(4):566-72.
23. Palijan T, Radeljak, S, Kovac, M . Relationship between comorbidity and violence risk assessment in forensic psychiatry - the implication of neuroimaging studies. . Psychiatr Danub. 2010;22:253–6.
24. Volavka J. Violence in schizophrenia and bipolar disorder. . Psychiatr Danub. 2013;25:24–33.
25. Patel DD, Laws KR, Padhi A, Farrow JM, Mukhopadhaya K, Krishnaiah R, et al. The neuropsychology of the schizo-obsessive subtype of schizophrenia: a new analysis. Psychol Med. 2010;40(6):921-33.
26. Schirmbeck F, Rausch F, Englisch S, Eifler S, Esslinger C, Meyer-Lindenberg A, et al. Stable cognitive deficits in schizophrenia patients with comorbid obsessive-compulsive symptoms: a 12-month longitudinal study. Schizophr Bull. 2013;39(6):1261-71.
27. de Filippis R, Aloi M, Bruni A, Gaetano R, Segura-Garcia C, De Fazio P. Bipolar disorder and obsessive compulsive disorder: The comorbidity does not further impair the neurocognitive profile. J Affect Disord. 2018;235:1-6.
28. Perugi G, Toni C, Frare F, Travierso MC, Hantouche E, Akiskal HS. Obsessive-compulsive-bipolar comorbidity: a systematic exploration of clinical features and treatment outcome. J Clin Psychiatry. 2002;63(12):1129-34.
29. Timpano KR, Rubenstein LM, Murphy DL. Phenomenological features and clinical impact of affective disorders in OCD: a focus on the bipolar disorder and OCD connection. Depress Anxiety. 2012;29(3):226-33.
30. Dekker N, Swets M, Investigators G. Substance use in a large sample of patients with schizophrenia or related disorders and co-morbid obsessive-compulsive symptoms. Aust N Z J Psychiatry. 2013;47(9):868-74.
31. Hunter H, Lysaker PH. Associations of comorbid obsessive–compulsive symptoms with psychotic and affective symp- toms and general functioning. In: de Haan L, Schirmbeck F, Zink M, editors. Obsessive–compulsive symptoms in schizophrenia. Berlin: Springer; 2015. p. 77-88.
32. Kim SW, Jeong BO, Kim JM, Shin IS, Hwang MY, Paul Amminger G, et al. Associations of obsessive-compulsive symptoms with clinical and neurocognitive features in schizophrenia according to stage of illness. Psychiatry Res. 2015;226(1):368-75.
33. Goes FS, McCusker MG, Bienvenu OJ, Mackinnon DF, Mondimore FM, Schweizer B, et al. Co-morbid anxiety disorders in bipolar disorder and major depression: familial aggregation

and clinical characteristics of co-morbid panic disorder, social phobia, specific phobia and obsessive-compulsive disorder. Psychol Med. 2012;42(7):1449-59.
34. Issler CK, Monkul ES, Amaral JA, Tamada RS, Shavitt RG, Miguel EC, et al. Bipolar disorder and comorbid obsessive-compulsive disorder is associated with higher rates of anxiety and impulse control disorders. Acta Neuropsychiatr. 2010;22(2):81-6.
35. Lysaker PH, Marks KA, Picone JB, Rollins AL, Fastenau PS, Bond GR. Obsessive and compulsive symptoms in schizophrenia: clinical and neurocognitive correlates. J Nerv Ment Dis. 2000;188(2):78-83.
36. Lysaker PH, Whitney KA, Davis LW. Obsessive-compulsive and negative symptoms in schizophrenia: associations with coping preference and hope. Psychiatry Res. 2006;141(3):253-9.
37. Sevincok L, Akoglu A, Kokcu F. Suicidality in schizophrenic patients with and without obsessive-compulsive disorder. Schizophr Res. 2007;90(1-3):198-202.
38. Bottas A, Cooke RG, Richter MA. Comorbidity and pathophysiology of obsessive-compulsive disorder in schizophrenia: is there evidence for a schizo-obsessive subtype of schizophrenia? J Psychiatry Neurosci. 2005;30(3):187-93.
39. Grover S, Sahoo S, Surendran I. Obsessive-compulsive symptoms in schizophrenia: a review. Acta Neuropsychiatr. 2019;31(2):63-73.
40. Brakoulias V, Starcevic V, Sammut P, Berle D, Milicevic D, Moses K, et al. Obsessive-compulsive spectrum disorders: a comorbidity and family history perspective. Australas Psychiatry. 2011;19(2):151-5.
41. Schirmbeck F, Swets M, Meijer CJ, Zink M, de Haan L, Investigators G. Longitudinal association between cognitive performance and obsessive-compulsive symptoms in patients with psychosis and unaffected siblings. Acta Psychiatr Scand. 2016;133(5):399-409.
42. Jayatilleke N, Hayes RD, Chang CK, Stewart R. Acute general hospital admissions in people with serious mental illness. Psychol Med. 2018;48(16):2676-83.
43. Niendam TA, Berzak J, Cannon TD, Bearden CE. Obsessive compulsive symptoms in the psychosis prodrome: Correlates of clinical and functional outcome. Schizophrenia Research. 2009;108(1-3):170-5.
44. Viani N, Yin L, Kam J, Alawi A, Bittar AL, Dutta R, et al. Time expressions in mental health records for symptom onset extraction. In proceedings of the 9th International workshop on health text mining and information analysis (LOUHI 2018). 2018:183–92. Available at: https://kclpure.kcl.ac.uk/portal/files/102467507/Time_Expressions_in_Mental_VIANI_Published31October2018_GREEN_AAM.pdf (Access date: 23rd Jan, 2022)