ORIGINAL ARTICLE

Individuals with schizophrenia who act violently towards others profit unequally from inpatient treatment—Identifying subgroups by latent class analysis

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Abstract

Background: People with schizophrenia show a higher risk of committing violent offenses. Previous studies indicate that there are at least three subtypes of offenders with schizophrenia.

Objectives: Employing latent class analysis, the goals of this study were to investigate the presence of homogeneous subgroups of offender patients in terms of remission in psychopathology during inpatient treatment and whether or not these are related to subtypes found in previous studies. Results should help identify patient subgroups benefitting insufficiently from forensic inpatient treatment and allow hypotheses on possibly more suitable therapy option for these patients.

Methods: A series of latent class analyses was used to explore extensive and detailed psychopathological reports of 370 offender patients with schizophrenia before and after inpatient treatment.

Results: A framework developed by Hodgins to identify subgroups of offenders suffering from schizophrenia is useful in predicting remission of psychopathology over psychiatric inpatient treatment. While "early starters" were most likely to experience remission of psychopathology over treatment, "late late starters" and a subgroup including patients from all three of Hodgins' subgroups in equal proportions benefited least. Negative symptoms generally seemed least likely to remit.

Conclusion: Psychiatric treatment may have to be more tailored to offender patient subgroups to allow them to benefit more equally.

KEYWORDS
forensic psychiatry, Hodgins typology, latent class analysis, offenders with schizophrenia spectrum disorder, psychopathology, treatment effects

1 | INTRODUCTION

People suffering from schizophrenia spectrum disorder (SSD) are more likely to be convicted of violent or non-violent crimes compared to the general population, as confirmed by a large number of studies (Fazel, Gulati, Linsell, Geddes, & Grann, 2009; Hodgins & Klein, 2017; Wallace, Mullen, & Burgess, 2004). Although most of the specific characteristics of violent offenders suffering from SSD are still unclear, there are well-documented factors that can strengthen the link between SSD and offending, such as substance abuse disorder, a history of violence and antisocial personality disorders. Since research has broadened its focus on identifying subgroups within the offender population (e.g., regarding the age of onset of the disorder and antisocial behavior or various clinical factors and comorbidities), knowledge about the origins of offenses committed by people with SSD has increased and offers a starting point for more individualized therapy concepts that are better suited to the patients' needs.

Before outlining the objectives of the present study, a short overview of previous findings on offending in people with SSD and the challenges of treatment will be provided.

A systematic review of 20 studies between 1980 and 2009 (Fazel et al., 2009) found that schizophrenia is related to a 1- to 6-fold increased risk of violent behavior in males and a 4- to 29-fold increased risk in females compared to the general population. The risk of homicide among persons with SSD was 19.5 times higher than in the general population. A comorbidity with substance use disorders (SUD) increases the risk of violence by a factor of 3–25 and was also found to be associated with more severe psychopathology and aggression (Drake & Mueser, 2001, 2002; Drake, Mueser, Clark, & Wallach, 1996; Fazel, Wolf, Palm, & Lichtenstein, 2014; Stevens, Laursen, Mortensen, Agerbo, & Dean, 2015).

Other studies suggested that serious acts of violence are committed in response to acute symptomatology (Appelbaum, Robbins, & Monahan, 2000; Bo, Abu-Akel, Kongerslev, Haahr, & Simonsen, 2011; Chan & Shehtman, 2019; Link & Stueve, 1994; Stompe, Ortwein-Swoboda, & Schanda, 2004) and that past stressors and victimization (Kirchebner, Sonnweber, Nater, Günther, & Lau, 2020; Oakley, Harris, Fahy, Murphy, & Picchioni, 2016; Persson, Belfrage, & Kristiansson, 2017; Swanson et al., 2006) play an important role in increasing the risk of violent offending in SSD-patients.

Another explanatory approach focuses on comorbid antisocial personality and conduct disorder. Patients with SSD and antisocial personality disorder (APD) are at increased risk for more pronounced psychiatric symptoms, treatment resistance, aggression, legal problems and SUD (Mueser et al., 1997). Similar results were reported for patients with SSD and conduct disorder during childhood and adolescence (Mueser et al., 1999).

Yet another explanatory concept suggested three distinct subgroups of offender patients (Hodgins, 2008; Hodgins, Piatosa, & Schiffer, 2013), which were based on differences in disease development, common comorbidities (most notably conduct disorder, APD, and SUD), criminal conduct, criminal history, demographics and other biographic factors. Subgroups were termed early starters (ES),

late starters (LS) and late late starters (LLS). ES are characterized by committing crimes before being diagnosed with schizophrenia, with conduct problems already manifesting during an often bereaved childhood, likely in combination with substance abuse (Hodgins, 2008). By contrast, LS typically will be treated for schizophrenia just before committing a first crime and their violent behavior correlates with the presence of positive symptoms and cognitive disorganization (Hodgins, 2008, 2017). Finally, LLS are offender patients suffering from schizophrenia over many years without any sign of violent aggression until they unexpectedly commit a serious crime such as homicide (often targeting individuals caring for them; Hodgins, 2008; Hodgins et al., 2013).

With regard to treatment, it was found that addressing both the SSD and the SUD at the same time has been shown to be most effective. Recent evidence suggests a combination of antipsychotic medication and psychosocial interventions (i.e., supported employment, family interventions, social and self-management skills training, cognitive behavioral interventions) to be most effective in preventing relapse of both SSD and SUD in the community setting (Acquilano, Noel, Gamache, Hendrick, & Drake, 2020; Drake et al., 2006; Lecomte et al., 2019). However, treatment for some patients with SSD (often with a PD and/or SUD as a comorbidity), who are in inpatient treatment, remains challenging and different subgroups are suggested to have different treatment needs (Hodgins, 2014; Schiffer et al., 2017). It is unclear if current treatment is individualized enough to meet these needs equally. Thus, forensic treatment may have to become more tailored to individual patient needs, as otherwise some patient subgroups may be left out resulting in a higher risk of recidivism.

In contrast to general psychiatry, forensic psychiatry is not only treating patients, but also has to answer society's request to reduce the risk of reoffending—even against the will of forensic patients (Howner et al., 2018). Antipsychotic medication has been evidenced to reduce violent incidents by up to 45% (Fazel, Zetterqvist, Larsson, Långström, & Lichtenstein, 2014) with remission in psychopathology as the most probable mediator (Witt, Van Dorn, & Fazel, 2013). While the remission of positive symptoms may be relevant for an immediate reduction of aggressiveness (Witt et al., 2013), a remission of negative symptoms may be necessary to ensure continuous (antipsychotic) treatment compliance and social reintegration later on in community settings (Downs et al., 2019; Kirkpatrick, Fenton, Carpenter, & Marder, 2006; Llerena, Reddy, & Kern, 2018; Tattan & Creed, 2001). But there is little research on the effectiveness of forensic inpatient treatment on reducing psychopathology. Thus, while other research has focused on predictors of future violence in patients with SSD (Buchanan, Sint, Swanson, & Rosenheck, 2019), the present study aims to identify factors leading to insufficient remission of psychopathology over forensic inpatient treatment.

Different foci of treatment may be needed depending on individual comorbidities and such biographical and criminal factors as were already explored by Hodgins (Whiting & Fazel, 2020). Since latent class/profile analysis (LCA/LPA) has already been used to quantitatively confirm Hodgins' framework (Lau, Günther, Kling, &

Kirchebner, 2019; Penney, Prosser, & Simpson, 2018), the present study employed LCA to investigate exploratively whether these subgroups can also be identified in terms of psychopathology and remission of symptoms.

LCA is a type of finite mixture model designed for the analysis of multivariate categorical data (Linzer & Lewis, 2011). It aims at the formation of subgroups (classes) of individuals in a population, based on the observed variables of these individuals. Since LCA is a probabilistic method, there is no one-to-one relationship between a class and the occurrence of a variable in an individual within that class, but rather each class consists of individuals who are more likely to have a particular combination of variables than individuals in another class.

Our specific objectives were to investigate (1) the presence of homogenous subgroups of offender patients in terms of their remission in psychopathology over inpatient treatment employing LCA and (2) whether or not Hodgins' classes of offender patients are linked to these subgroups. New findings in this particular field of research is intended to help clinicians identify patient subgroups with insufficient therapeutic success in forensic inpatient treatment and thus to find a possibly more suitable therapy option for these patients.

2 | METHODOLOGY

2.1 | Description of the sample

A complete description of the sample, including sociodemographic data, comorbidities, and other aspects is provided in the Supplementary Materials. Offender patients explored in the present study were predominantly male (91.6%, $n = 339$) and had a mean age of 34.15 years (SD 10.23). The majority of the sample were single (80.3%, $n = 297$), unemployed at the time of the index-offense (71.4%, $n = 264$) and born outside of Switzerland in the rest of Europe, the Middle East and Africa (54.9%, $n = 203$). 79.5% ($n = 294$) of the participants met criteria for schizophrenia, 13.5% ($n = 50$) met criteria for other schizophrenia spectrum disorders, and 7% ($n = 26$) met criteria for schizoaffective disorder (see Supplementary Material for further demographic details). Diagnoses provided by treating psychiatrists at the end of treatment were confirmed during retrospective file analysis, which relied on ICD-9 chapters 295.0–295.9 and ICD-10 chapters F20.0–F25.9 (World Health Organization, 1978, 2016) for diagnostic assessment. Due to the importance of the psychiatric assessments on which legal decisions were based, professional translators were engaged whenever language barriers were present. During forensic psychiatric inpatient treatment, all offender patients with SSD received a similar treatment including the most effective antipsychotic medication with the least unwanted side effects available at the time, recurring psychotherapy sessions, and occupational therapy. Psychotherapy was conducted by psychiatrists and psychologists trained in cognitive behavioral, systemic and/or psychodynamic psychotherapy as required by the professional accreditation bodies for psychologists and psychiatrists in Switzerland. Comorbidities such as SUDs or PDs were treated simultaneously along with SSD. Antipsychotics were generally selected by the treating psychiatrist at the time of treatment, following current guidelines and recommendations. Although data was collected over a period of more than 30 years with significant changes in treatment during that time, most data stemmed from a time period after 2000 (296 of the 370 cases), when atypical antipsychotic agents were already used as a standard treatment. The aim of forensic psychiatric inpatient treatment has always been to reduce symptoms of the psychiatric illness (SSD) as well as the prevention of further violence.

2.2 | Source and primary processing of data

Retrospective file analysis was conducted with 370 offenders with SSD, who were treated at the Center for Inpatient Forensic Therapies at the Zurich University Hospital of Psychiatry between 1982 and 2016. The same files were previously analyzed in a study on biographical and diagnostic data differentiating Hodgins' three subtypes of offenders (Lau et al., 2019). Data on psychopathology was drawn at three points in time: As close as possible before the index offense leading to criminal detention was committed (time 1), at the beginning of forensic hospitalization in the consequence of the index offense (time 2) and just before release from forensic inpatient treatment to a long-term holding facility or community setting (time 3). Psychopathological symptoms were extensively documented by licensed psychiatrists diagnosing and treating patients prior to the index offense. Psychopathology was also documented by forensic psychiatrists immediately after admission of offenders to the forensic center and before their release or transfer. For psychopathological symptoms recorded prior to forensic hospitalization 12 items related to the positive and negative syndrome scale (PANSS; Kay, Fiszbein, & Opler, 1987) were used for content analysis, rating each item as being absent, discretely or distinctly present. These 12 items were: Any positive symptoms, any negative symptoms, delusions, hallucinations, disturbance of volition, passive/apathetic social withdrawal, conceptual disorganization, blunted affect, emotional withdrawal, lack of spontaneity and flow of conversation, active social avoidance, and poor attention. Adoptions of all 30 items of the PANSS were used to categorize and scale psychopathological symptoms recorded by forensic psychiatrists at the beginning and end of forensic hospitalization, again rating each item as being absent, discretely or distinctly present.

Details on the process of retrospective file analysis, the rating protocol used for coding, and quality measures such as inter-rater reliability (with Cohen's Kappa equaling 0.78; Brennan & Hays, 1992) are already presented elsewhere (Lau et al., 2019). Research was approved by the Zurich Cantonal Ethics Committee (Ref.-No. KEK-ZH-NR 2014-0480).

2.3 | Data analysis

Data were quantitatively assessed using R Studio version 1.1.383. Prior to applying any statistical technique, multiple imputation (Greenland & Finkle, 1995; Zhou, Eckert, & Tierney, 2001) by chained equations (MICE; Van Buuren, Boshuizen, & Knook, 1999) was applied to optimally address missing values. MICE maintains the variability of missing data, and integrates the uncertainty caused by estimating them. It is considered one of the best performing methods for imputing missing values (Ambler, Omar, & Royston, 2007). The entire data set was used to impute missing values, with a total of 20 iterations of imputation.

Next, an LCA was computed on variables describing changes in psychopathology over inpatient treatment (35 items; see Supplementary Materials) with solutions ranging from one to five classes. Model fit criteria were used to select the appropriate number of classes (three; see explanation below). Then, an LCA for that number of classes was recalculated, now using Hodgins-related classes (Lau et al., 2019) as a covariate. The inclusion of a covariate permits to conduct a "one-step" latent class regression model, in which the latent class membership is predicted by the covariate. In comparison to LCA without a covariate (where the same prior probabilities of latent class membership are assigned), in LCA with a covariate, the prior probabilities are varied based on the covariate (Linzer & Lewis, 2011). All LCAs were computed using the poLCA package implemented in R, which estimates the latent class model by maximizing the log-likelihood function using the expectation maximization algorithm. For a given number of classes, each latent class analysis was repeated 500 times with different starting values (prior probabilities) to avoid local extrema.

2.4 | Model fit criteria

A set of different measures was computed to assess model fit, select the final model and compare results with previous literature: Maximum log-likelihood, Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC) and entropy. While maximum log-likelihood exclusively measures goodness of model fit, BIC and AIC are a parsimony measures aiming to avoid overfitting. Entropy is a measure of classification uncertainty (Asparouhov & Muthén, 2018), with values higher than 0.8 indicating a good separation between classes. For a particular number of classes, the model with the lowest log-likelihood was selected. To subsequently compare models between different numbers of classes, information criteria were evaluated. BIC penalizes additional model parameters stronger than AIC and hence can be considered more conservative in preventing overfitting. In consequence, AIC has been reported to overestimate the correct number of components in a finite mixture model (Soromenho, 1994), while BIC did perform well (Roeder & Wasserman, 1997). For this reason, BIC was prioritized over AIC in selecting the best model fit. Model fit criteria are presented in Table 1 in the results section.

2.5 | Comparability of classes

To analyze if the different classes were comparable with regard to sociodemographic data, clinical aspects and comorbidities, descriptive statistics of selected variables not included in the LCA along with statistical tests for significance are presented in the Supplementary Materials. For this analysis the raw data without imputation was used. Differences between categorical variables were assessed with a chi-square test. Differences between continuous variables were assessed with an ANOVA or independent-samples Kurskal–Wallis test for normal and non-normal distributions, respectively. *p*-values were corrected for multiple testing using the Bonferroni method. Values <0.05 were considered statistically significant.

3 | RESULTS

In Table 1 model fit criteria for different LCA solutions are presented. Model fit criteria demonstrate that the best LCA solution structures the heterogeneity within change in psychopathology over inpatient treatment into three subgroups (since this solution has the lowest BIC). The BIC for the three class solution was even slightly lower, when Hodgins classes were used as a covariate. Therefore, this demonstrates that Hodgins framework is useful in predicting change in psychopathology over inpatient treatment. The graphical representation of that LCA using Hodgins' subgroups as covariate (as shown in Figure 1) indicates that class three with 155 patients is primarily composed of Hodgins' ES. Class two with 157 patients is predominantly composed of Hodgins' LLS. Class one with only 58 patients contains members of all three of Hodgins' subgroups. This also means that members of Hodgins LS are spread over all three classes.

Details on exact changes in psychopathology in the three subgroups identified in the current study and how they may relate to Hodgins' subgroups are presented in the Supplementary Materials. A simplification of this information is presented in Table 2. These results show that class one (58 patients, mix of Hodgins' subgroups) does not benefit from inpatient treatment in terms of remission of most psychopathological symptoms. Class two (157 patients, Hodgins' LLS) similarly only benefits in terms of some symptoms (positive symptoms and hostility related symptoms). Class three (155 patients, Hodgins' ES), however, does benefit from inpatient treatment. For all three classes negative symptoms are least likely to diminish.

Finally, the three classes were compared with each other in terms of a number of sociodemographic, clinical (e.g., comorbidities and substance use) and criminal parameters using chi-square, ANOVA or independent-samples Kruskal–Wallis tests (results are presented in the Supplementary Materials). Results indicated that these parameters did not affect the outcome of inpatient treatment at statistical significance, although there are clear trends for those variables proposed by Hodgins' framework (Hodgins et al., 2013). For instance, in class 3 (best outcome, predominantly ES) and in class 2

TABLE 1 Latent class analysis model fit evaluation criteria

Number of classes	Number of estimated parameters	Residual degrees of freedom	Maximum log-likelihood	AIC	BIC	Entropy	Number of times solution was found
1	66	304	−8669	17,470	17,728	-	500/500
2	133	237	−7813	15,892	16,412	0.907	499/500
3	200	170	−7488	15,376	16,159	0.975	1/500
3 (with covariate)	202	168	−7481	15,367	**16,157**	0.971	123/500
4	267	103	−7295	15,125	16,170	0.986	9/500
5	334	36	−7137	14,942	16,249	0.982	1/501

Note: Values most informative for model selection are bold.

Abbreviations: AIC, Akaike's Information Criterion; BIC, Bayesian Information Criterion; entropy, measure of classification uncertainty; covariate, subgrouping based on Hodgins' framework.
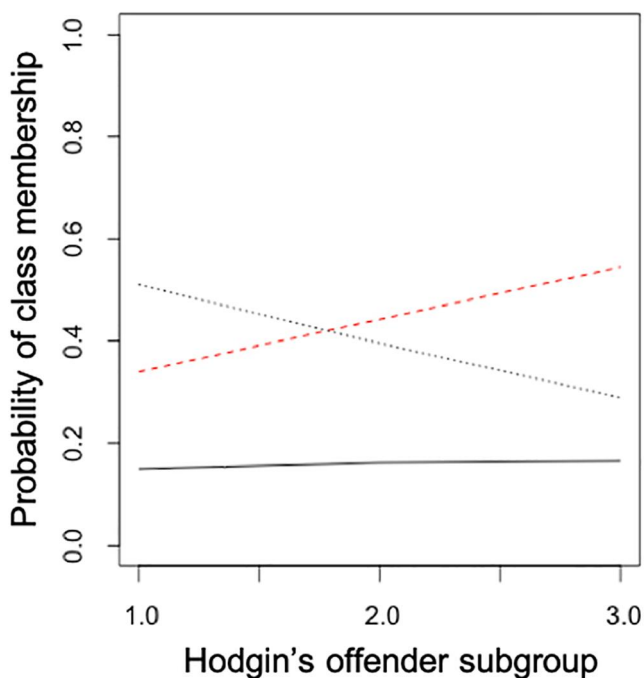

FIGURE 1 Differentiability of three offender subgroups in terms of changes in psychopathology over psychiatric inpatient treatment based on Hodgins' (2013) framework. *X*-axis, Covariate—Hodgins' three offender subgroups; *Y*-axis, probability of subgroup membership based on psychopathological variable manifestations; continuous line: Class 1, dashed line: Class 2; dotted line: Class 3

(least beneficial outcome, predominantly LLS), SUDs and PDs were more prevalent.

4 | DISCUSSION

The present study aimed to explore differences between offender patient subgroups with SSD in terms of their psychopathological response to psychiatric inpatient treatment. Results show that only one subgroup (class 3, 155 patients) benefited on most dimensions of psychopathology. This subgroup was predominantly composed of ES described in Hodgins' framework (Hodgins, 2008; Hodgins et al., 2013; Lau et al., 2019). Of the other two subgroups, who did not benefit enough, one was predominantly composed of Hodgins' LLS and the other of an equal mix of ES, LS and LLS. Confirming prior research (Roffman et al., 2013; Turkington & Morrison, 2012), negative symptoms were least likely to remit. Results confirm prior research suspecting Hodgins' typology to be useful in predicting the psychopathological response of patients to psychiatric inpatient treatment, but not to the extent and in the manner expected (Hodgins & Klein, 2017).

Prior research suggested ES, with antisocial behavior beginning prior to onset of schizophrenia by definition, may need psychotherapeutic interventions (cognitive behavioral treatment) in addition to psychopharmacological treatment (Hodgins & Klein, 2017). ES would not benefit as much as other subgroups from contemporary inpatient treatment, which was assumed to primarily consist of antipsychotic medication (Hodgins, 2008, 2014). Instead, the present study found ES to benefit most from available inpatient treatment and that LLS are disadvantaged over inpatient treatment. One explanation is provided in a recent study (Völlm et al., 2017), where SSD patients with PDs and SUDs (commonly associated with ES) have been shown to differ in their resistance to inpatient treatment depending on the severity of violence and type of crime committed. These findings are supported by trends observable in the comparison of the subgroups identified here (see Supplementary Materials). Trends show that SUDs and PDs are common both in class 3 (best outcome, predominantly ES) and class 2 (least beneficial outcome, predominantly LLS) and highlight the importance for screening for such comorbidities (Brunette et al., 2018; Mueser, 2020; Noel, Woods, Routhier, & Drake, 2016). Another explanation is that at the current place of study, a variety of psychotherapeutic interventions has been applied in addition to psychopharmacology over the last 30 years. The topic of noncompliance with psychotherapy was predominant in class 3 (ES) and class 2 (LLS, treatment resistant), but not at statistical significance. Frequent themes of psychotherapy sessions are presented in the Supplementary Materials with little difference between

TABLE 2 Subgroup composition and changes in psychopathology

Item	Class 1	Class 2	Class 3
Predominant Hodgins' (2013) subgroup (also see Figure 1)	ES, LS, LLS	LLS	ES
Number of patients	58	157	155
PANSS-score (Δ admission to discharge): somatic concern	No change	No change	No change
PANSS-score (Δ admission to discharge): guilt feelings	No change	No change	No change
PANSS-score (Δ admission to discharge): excitement	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): lack of spontaneity and flow of conversation	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): stereotyped thinking	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): anxiety	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): mannerisms and posturing	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): depression	No change	No change or more symptoms	Less symptoms
PANSS-score (Δ admission to discharge): motor retardation	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): disorientation	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): poor attention	No change	No change or more symptoms	Less symptoms
PANSS-score (Δ admission to discharge): disturbance of volition	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): blunted affect	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): emotional withdrawal	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): poor rapport	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): passive/apathetic social withdrawal	No change	No change or more symptoms	Less symptoms
PANSS-score (Δ admission to discharge): difficulty in abstract thinking	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): active social avoidance	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): grandiosity	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): hostility	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): tension	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): uncooperativeness	No change	No change	No change or less symptoms
PANSS-score (Δ admission to discharge): unusual thought content	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): poor impulse control	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): preoccupation	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): delusions	No change	No change or less symptoms	Less symptoms
PANSS-score (Δ admission to discharge): conceptual disorganization	No change	No change	Less symptoms
PANSS-score (Δ admission to discharge): hallucinations	No change	No change or less symptoms	Less symptoms
PANSS-score (Δ admission to discharge): suspiciousness/persecution	No change	No change or less symptoms	Less symptoms
PANSS-score (Δ admission to discharge): lack of judgment and insight	No change	No change	Less symptoms
Δ in aggregated negative symptoms from prior to index offense to discharge	No change and less symptoms	Less symptoms	Less symptoms

TABLE 2 (Continued)

Item	Class 1	Class 2	Class 3
Δ in aggregated positive symptoms from prior to index offense to discharge	Less symptoms	Less symptoms	Less symptoms
Δ in PANSS-positive scale from admission to discharge	Less symptoms	Less symptoms	Less symptoms
Δ in PANSS-negative scale from admission to discharge	Less symptoms	Less symptoms	Less symptoms
Δ in PANSS-total from admission to discharge	Less symptoms	Less symptoms	Less symptoms

Note: sΔ = change.

Abbreviations: ES, early starters; LS, late starters; LLS, late late starters; PANSS, Positive and negative syndrome scale (Kay et al., 1987).

subgroups. Hodgins' ES may have been described as treatment resistant in clinical settings (Hodgins, 2008, 2014) in which it may have been less common to add psychotherapeutic (cognitive behavioral) interventions to antipsychotic treatment. In fact, the availability and use of psychotherapeutic interventions differs significantly even between European countries (Foisy, Szafran, & Tantam, 2001; Van Broeck & Lietaer, 2008). Also, there seems to be a current gap in research on Hodgins' LLS—possibly due to past research underestimating the size of the subgroup of LLS (Hodgins, 2008) and the need of LLS to be explored in more detail.

The outcome of treatment may be affected by language barriers and cultural aspects of treating patients, especially those born abroad (55% in the present sample). However, offender patients born outside of Switzerland were equally distributed over all three subgroups, or even slightly more predominant in the one benefiting most from inpatient treatment (see Supplementary Materials). Given the increased prevalence of SSD in forensic patients with immigrant or ethnic minority backgrounds (Denzel, van Esch, Harte, & Scherder, 2016; Perry, Neltner, & Allen, 2013), future research efforts on how this offender subgroup differs from other offenders with SSD would be desirable.

There also seems to be a lack of research on the relationship between childhood maltreatment (CM) and treatment outcome. Results presented in the Supplementary Materials hint trends for a relationship between CM and psychopathological development over inpatient treatment. Such a relationship between CM and poorer treatment outcome has been suggested elsewhere (Lee et al., 2017; Thomas, Höfler, Schäfer, & Trautmann, 2019) and should be explored in more detail. Furthermore, there is limited research on the treatment of negative symptoms (Kirkpatrick et al., 2006). This may be due to studies identifying delusions (or positive symptoms in general) to drive aggression in patients with schizophrenia (Coid et al., 2013; Witt et al., 2013). Means to treat aggression in schizophrenia may have been prioritized over treatment of psychopathology (Howner et al., 2018). However, the adequate treatment of psychopathology is a prerequisite for remission in aggressive behavior (Witt et al., 2013): Antipsychotic medication, which primarily treats positive symptoms, is reported to reduce violent behavior by up to 45% (Fazel, Zetterqvist, et al., 2014). Nevertheless, the treatment of negative symptoms is equally important to ensure long term compliance with

(antipsychotic) treatment (Downs et al., 2019; Kirkpatrick et al., 2006; Tattan & Creed, 2001) and reintegration (Llerena et al., 2018) of patients in outpatient settings after release from inpatient treatment. Noncompliance to antipsychotics due to untreated negative symptoms may be one of the reasons why LLS commit a crime after years of being diagnosed with schizophrenia and may be addressed with closer monitoring and more individualized treatment plans.

4.1 | Limitations

While the Supplementary Materials present the broad themes of psychotherapeutic sessions, there is no detailed information on psychotherapeutic interventions employed during the period of data collection (1982–2016). Although most cases (296 out of 370) were treated after 2000 and it can be assumed that interventions adhere to international standards, there is no information on the evidence base of the psychotherapeutic interventions used. Nevertheless, the same methods were used in all three groups and thus comparability can be expected. Duration of inpatient treatment, as a proxy for psychotherapeutic efforts, was not included as a variable in data analysis, because some research advices against it and concludes that length of inpatient treatment does not correlate with treatment outcome (Davoren et al., 2015; Eckert, Schel, Kennedy, & Bulten, 2017).

A further limitation concerns the changes in antipsychotic medication in recent decades. It is likely that patients treated before the year 2000 (74 cases) suffered more side effects due to the more frequent use of typical antipsychotics, which may also have influenced compliance and thus the success of the therapy. Nevertheless, the cases prior to 2000 are distributed across all three subgroups and do not cluster in one subgroup.

Another limitation in the current study was the need for retrospective content analysis of extensive and detailed yet unstandardized reports of psychopathology to adopt some form of operationalization which would appreciate that richness of the data, while not being vulnerable to interpreting data by chance. Choosing the PANSS (Kay et al., 1987) to rate different aspects of psychopathology during retrospective file analysis is disputable, as the instrument was not established until at least 5 years after the first

cases analyzed here were admitted to forensic treatment. Yet, high inter-rater reliability evidences its accuracy in capturing the rich data preserved in all files analyzed.

A further limitation concerns the use of previously identified subgroups of offender patients based on Hodgins' framework as covariates in the LCAs of this study. Some may argue that these subgroups do not come close enough to Hodgins' framework, while others refute this by pointing out that there is no single variable best suited to capture the complexity of Hodgins' framework and serve as a covariate (Lau et al., 2019).

Despite some limitations, this study contributes to the ongoing refinement of subtyping the offender population suffering from SSD according to symptom patterns, socio-demographic characteristics or individual characteristics of the patients and will therefore enable clinicians to provide more reliable information on the prognosis of treatment success, compliance and also the future risk of recidivism.

CONFLICT OF INTEREST
None.

ETHICAL APPROVAL
The study has been evaluated by the "Kantonale Ethikkommission Zürich [Cantonal Ethics Committee Zurich]" and approval has been granted (committee's reference number: KEK-ZH-NR 2014-0480). The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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