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Autism-like features in individuals at clinical high risk for psychosis: a longitudinal research using the PANSS Autism Severity Score (PAUSS)

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ABSTRACT

Purpose: The PANSS Autism Severity Score (PAUSS) is a widely used measure of autism-like features in early psychosis, including mental states at "Clinical High Risk for Psychosis" (CHR-P). However, evidence regarding its relevance to long-term outcomes and treatment response is very scarce. Thus, the main aim of this investigation was to compare baseline clinical characteristics and longitudinal outcomes/treatment response between CHR-P subjects with or without autistic features recruited into a specialist early intervention service during a 2-year follow-up period.

Methods: CHR-P participants completed the Social and Occupational Functioning Assessment Scale (SOFAS) and the Positive And Negative Syndrome Scale (PANSS) at baseline and over the follow-up. Kaplan-Meyer survival analysis, mixed-design ANOVA, and binary logistic regression analysis were performed.

Results: Thirty-six (16.8%) of the 214 enrolled CHR-P individuals scored above the PAUSS cut-off of 30 (PAUSS + subgroup). At baseline, they showed higher PANSS and SOFAS scores, as well as higher prevalence rates of substance abuse and individuals not engaged in education, employment, or training. Over the follow-up period, they showed worse clinical and functional outcomes, including higher incidence rates of hospital re-admission (28.7% vs. 11.6%; Hazard Ratio [HR] = 3.38) and conversion to psychosis (26.0% vs. 12.0%; HR = 2.71), as well as lower likelihood of both functional (Hazard Risk [HR] = 4.23) and symptomatic (HR = 6.50) remission. However, our specialist intervention has proven effective in improving psychopathological and functional parameters over time even in the PAUSS + subgroup.

Conclusions: Our findings suggest that the PAUSS specifically identifies a CHR-P subgroup with greater clinical and functional severity at presentation and worse longitudinal outcomes.

1. Introduction

Autism Spectrum Disorders (ASD) and psychosis are both disabling, early-onset neurodevelopmental disorders that frequently co-occur with a pooled prevalence rate of 9.4% (Selten et al., 2015; Varcin et al., 2022). In this regard, these two conditions have historically been considered related (Kanner, 1965) and have been found to share some risk factors (e.g., specific genetic pathways, abnormalities in brain development and synaptic connectivity, obstetric complications, social cognition deficit) and overlapping symptoms (Chisholm et al., 2015; Kushima et al., 2018; Ferrara et al., 2023). Furthermore, a relatively recent meta-analysis reported that ASD diagnosis is a predisposing factor for the onset of psychosis, with ASD patients being 3.55 times more likely to experience a psychotic episode than healthy controls (Zheng et al., 2018).

However, although ASD was initially considered an early manifestation of psychosis (Kanner, 1965), psychosis and autism have been classified as separate disorders from the III edition of the Diagnostic and Statistical Manual of mental disorders (DSM-III) (APA, 1980) to the present day. The main reasons for their nosographic separation lie in distinct neurodevelopmental trajectories (autism manifests in early childhood and is a lifelong condition, while psychosis manifests later

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with episodic onset) and differences in the core features of their phenomenology (autism presents a stable "self-world" relationship, influenced by deficits in social cognition and communication, restricted/repetitive behaviors, and atypical cognitive processing, while psychosis shows an impaired integration between "self", "others", and "environment", with symptoms of reality distortion and disorganization) (Ballerini et al., 2024).

Over the past two decades, both ASD and psychosis have been hypothesized to be influenced by dysregulated development of the social brain (Pourcain et al., 2018) and to represent opposite ends of a social cognition continuum, from hypo-active (autistic) mechanistic social cognition (with impairment in theory of mind and social interactions) to a hyper-active (psychotic) mentalistic social cognition (interacting with the environment and focused on its paranoid interpretation) (Abu-Akel et al., 2015). This model would be regulated by alterations in genomic and anatomical structures, involving the interacting circuits of amygdala, prefrontal cortical, and hippocampus (Kalin, 2022).

In more recent years, there has been increasing interest in exploring the clinical overlap between ASD features and prodromal symptoms of psychosis, particularly the most shared clinical characteristics, including deficits in social interaction, unusual thought content, and stereotyped behaviors (De Crescenzo et al., 2019; Pelizza et al., 2025a). Specifically, meta-analytic results showed that 11.6% of individuals at *Clinical High Risk for Psychosis* (CHR-P) also have an ASD diagnosis, and that prodromal psychosis symptoms are very common in ASD, affecting over 40% of subjects (particularly, disorganized speech, unusual thinking, and perceptual disturbances) (Eussen et al., 2015; Vaquerizo-Serrano et al., 2022). Furthermore, youth with ASD at CHR-P typically had greater difficulties in syntactic and pragmatic language, as well as poorer global and social functioning, compared to ASD individuals without CHR-P (Solomon et al., 2011; Foss-Feig et al., 2019). Additionally, some studies frequently reported social cognitive deficits (a core symptom in ASD) in young individuals at *Clinical High Risk for Psychosis* (CHR-P) (Pelizza et al., 2021a).

Given the unfavorable impact on functioning, this longitudinal study *aimed* at comparing baseline sociodemographic and clinical characteristics between CHR-P individuals with or without autistic characteristics treated within an Early Intervention in Psychosis (EIP) program, and at exploring intergroup comparisons in clinical outcomes during 2 years of follow-up. Following recent developments on the psychometric assessment of autism attributes in the early stage of psychosis (including CHR-P conditions), we used a new, promising, and rapid psychopathological score derived from 8 specific items of the Positive And Negative Syndrome Scale (PANSS): the "PANSS Autism Severity Score" (*PAUSS*) (Kastner et al., 2015). Specifically, we also assessed the longitudinal stability of the PAUSS in the total sample, as well as its associations with response to the treatment components of our EIP program.

2. Methods

2.1. Subjects and setting

CHR-P participants were consecutively recruited within the "Parma At-Risk Mental States" (*PARMS*) program between January 2016 and December 2022. The PARMS protocol is a diffused EIP service that was implemented in all community adult and adolescent mental health centers in Parma (Northern Italy) (Pelizza et al., 2023a).

Inclusion criteria of this research were: age 12-25 years, seeking specialist help for mental health, and baseline presence of CHR-P criteria as defined in the "Comprehensive Assessment of At-Risk Mental States" (CAARMS) - i.e., "Vulnerability Group" (VG), "Brief Limited Intermittent Psychotic Symptoms" (BLIPS), and "Attenuated Psychotic Symptoms" (APS) (Yung et al., 2005) (see Supplementary Materials for details on CAARMS criteria). *Exclusion criteria* were previous frank psychotic episodes, previous antipsychotic treatment, medical illness manifesting with psychiatric symptoms, and known intellectual disability (IQ $<$ 70). Previous antipsychotic treatment was considered a proxy for past psychotic disorder, consistently with the original CAARMS psychosis threshold (Di Lisi et al., 2024).

This research complied with the 1964 Helsinki Declaration and its later amendments and obtained local ethical approval (AVEN Ethics Committee protocol no. 559/2020/OSS*/AUSLPR). All participants (including guardians in the case of minors) provided written informed consent to participate in the study.

2.2. Assessment

For the specific goals of this investigation, clinical assessment included the CAARMS, the PANSS (Kay et al., 1987), and the Health of the Nation Outcome Scale (HoNOS) (Wing et al., 1998). The *CAARMS* is a semi-structured clinical interview developed to assess mild psychopathology and CHR-P conditions. It also defines the threshold for psychosis using the "positive symptoms" domain score and includes the Social and Occupational Functioning Assessment Scale (*SOFAS*). The approved Italian version of the CAARMS (Pelizza et al., 2019) was administered by qualified PARMS staff members. Regular supervised scoring workshops were conducted to ensure interrater reliability (Biancalani et al., 2025). It has been shown to have good to excellent psychometric properties in Italian CHR-P subjects (Catalano et al., 2025). A SOFAS score $>$61 at follow-up assessments was used as a criterion of functional remission (Schennach-Wolff et al., 2009).

The *PANSS* is a semi-structured clinical interview developed to measure psychopathology in psychosis. It is also commonly used in the early stages of psychosis, including CHR-P conditions (Ricci et al., 2024). The Italian version of the PANSS (Pancheri et al., 1995) was administered by qualified PARMS researchers, who considered a score $\leq$3 on the 8 items defined in the "Remission in Schizophrenia Working Group's" criteria as an index of symptomatic remission (Andreasen et al., 2005).

The PANSS items selected for the *PAUSS* (see Supplementary Materials [Table S2] for details) were hypothesized to cover the three major domains of ASD described in the DSM-IV-TR criteria (i.e., deficit in social interaction, deficit in social communication, and repetitive/stereotyped behaviors) (APA, 2000). It has been shown to have sufficient convergent validity with ASD gold-standard measures (Nibbio et al., 2022), adequate criterion validity in differentiating autistic individuals from psychiatric controls (Jeong et al., 2024), and adequate internal consistency to support aggregation of items into a single severity score (Bioque et al., 2026). In the original validation study, subjects scoring above the 30th percentile on the PAUSS (i.e., scores between 30 and 52) were considered to have autistic features (Kastner et al., 2015). Specifically, it has been found that PAUSS severity levels in CHR-P subjects are lower compared to patients with schizophrenia, but greater than in individuals with mood disorder (Ribolsi et al., 2022). In a mixed sample of subjects at CHR-P and with first episode psychosis (FEP) in Japan, the subgroup with high PAUSS scores showed greater psychiatric symptom severity and lower global functioning at baseline. Furthermore, a significant between-group difference in PAUSS scores persisted during the 18-month follow-up period (Komatsu et al., 2025). The psychometric properties of the PAUSS have also been confirmed in international samples of FEP patients, in which it has been shown to correctly identify individuals with schizophrenia in comorbidity with ASD (Deste et al., 2018; Pina-Camacho et al., 2020). However, although the PAUSS is now a popular scale to assess autistic features in early psychosis, evidence on its longitudinal stability and treatment response is very poor, particularly in CHR-P states. These conflicting findings may undermine its clinical meaning, especially considering recent FEP studies suggesting poor long-term stability of the PAUSS (Chisholm et al., 2024; Pelizza et al., 2026).

The *HoNOS* was a clinical interview developed to assess mental health and social outcomes in patients with mental illness, including early psychosis (Pelizza et al., 2023b). As proposed in the original

validation study, four main domains of the instrument were used in this investigation: "Social problems", "Psychiatric symptoms", "Impairment", and "Behavioral problems" (Wing et al., 1999). Furthermore, a score ≤2 on items 9, 10 and 11 was used as a further index of functional remission (Kortrijk et al., 2012).

Our assessment test battery was administered at entry and annually during the follow-up period. The CAARMS criteria were also tested longitudinally to identify conversion to psychosis or persistence of CHR-P conditions. Moreover, a *sociodemographic/clinical questionnaire* collecting data on suicidal tendencies, disengagement, hospital admissions, treatments, and functional recovery was also completed during the follow-up (see Supplementary Materials [Table S3] for details). Finally, DSM-5 diagnoses (APA, 2013) were formulated at baseline by two qualified PARMS team members using the "Structured Clinical Interview for DSM-5 mental disorders" (*SCID-5*) (First et al., 2016).

2.3. Procedures

After the initial assessment (T0), CHR-P subjects were classified into two groups based on the presence of clinically significant *autistic features* (i.e., PAUSS score ≥30). Initially, comparisons between groups were investigated on sociodemographic/clinical characteristics at entry. The two subgroups were then compared based on clinical/functional outcomes during the 2-year follow-up. Specifically, we examined a broad range of meaningful outcomes and indices of treatment response.

The *PARMS* program offers all CHR-P individuals a multiprofessional team (i.e., clinical psychologist, psychiatrist, and a case manager for early rehabilitation), who provides specialized psychosocial interventions, along with a psychopharmacological treatment (where appropriate), within 4 weeks of enrollment (Pelizza et al., 2025b). The duration of our EIP intervention was 2 years. Specifically, psychosocial interventions included individual psychotherapy based on cognitive-behavioral principles, family psychoeducation, and a dedicated case-management to promote early recovery-oriented rehabilitation (see Supplementary Materials [Table S4] for details).

2.4. Statistical analysis

Data were analyzed using JASP, version .96.0 for Windows (JASP Team, 2026). All tests were two-tailed with a significance level set at .05. Where appropriate, Bonferroni's correction was considered to limit multiple comparisons (Sedgwick, 2014). At baseline, the two groups were compared using the Chi-square (X^2) test for categorical parameters and the Mann-Whitney *U* test for continuous measures.

For our longitudinal analyses, time-to-event outcome variables (e.g., new hospital admission, treatment drop-out) were examined using Kaplan-Meyer survival analyses, while not time-to-event dependent variables (e.g., current suicidal ideation, functional recovery) were explored using binary logistic regression analyses with the PAUSS cut-off score as the independent parameter (Burneo et al., 2008). Finally, a mixed-design ANOVA was performed to examine between-group comparisons on longitudinal clinical/functional outcomes assessed with the SOFAS, PANSS, and HoNOS, as well as on PARMS treatment components.

3. Results

In this research, 36 (16.8%) out of 214 CHR-P individuals recruited (110 [51.4%] males; mean age = 19.27 ± 3.81 years) had a PAUSS cut-off score above of 30 and were included in the PAUSS + group. Sociodemographic and clinical features of the two subsamples are shown in Table 1.

3.1. Baseline data

Compared to PAUSS-, PAUSS + individuals showed higher

Table 1
Baseline clinical and sociodemographic and comparisons in the two CHR-P subgroups (n = 214).

Variable	PAUSS- (n = 178)	PAUSS+ (n = 36)	X^2/z	p
Gender (male)	86 (48.3%)	24 (66.7%)	4.037	**.045**
Age (at entry)	18.84 ± 3.71	21.39 ± 3.61	−3.471	**.001**
Education (in years)	11.63 ± 2.41	10.46 ± 2.62	−2.322	**.020**
Civil status			.095	.341
Single	170 (90.5%)	33 (91.7%)	[-1.0]	
Married/cohabitant	8 (4.5%)	3 (8.3%)	[1.0]	
Living status			1.488	.475
Alone	11 (6.2%)	4 (11.1%)	[1.1]	
Living with partner	15 (8.4%)	4 (11.1%)	[.5]	
Living with parents	152 (85.4%)	28 (77.8%)	[-1.1]	
Ethnic group			8.413	.380
White	158 (88.8%)	28 (78.8%)	[-1.8]	
Black	3 (1.7%)	4 (11.1)	[1.9]	
Asian	4 (2.2%)	0 (.0%)	[-.9]	
North African	9 (5.1%)	3 (8.3%)	[.8]	
Hispanic	4 (2.2%)	1 (2.8%)	[.2]	
Migrant Status	28 (15.7%)	9 (25.0%)	1.799	.180
Occupation			9.847	**.021**
NEET	46 (25.8%)	18 (50.0%)	[2.9]	
Student	107 (60.1%)	12 (33.3%)	[-2.9]	
Employed	25 (14.0%)	6 (16.7%)	[.4]	
Source of referral			4.288	.509
Primary care	63 (35.4%)	12 (33.3%)	[-.2]	
Family members	19 (10.7%)	4 (11.1%)	[.1]	
Self-referral	22 (12.4%)	6 (16.7%)	[.7]	
Emergency room	27 (15.2%)	3 (8.3%)	[-1.1]	
School/Social services	25 (14.0%)	3 (8.3%)	[-.9]	
Other mental healthcare services	22 (12.4%)	8 (22.2%)	[1.6]	
First-degree family members with psychosis	57 (32.1%)	17 (47.2%)	1.004	.117
Baseline hospital admission	22 (12.4%)	8 (22.2%)	2.416	.198
Past suicide attempt	16 (9.0%)	6 (16.7%)	1.914	.223
Previous specialist contact	94 (52.8%)	14 (38.9%)	2.321	.128
DUI (in weeks)	61.38 ± 54.49	28.74 ± 23.73	−3.556	**.001**
DAAP (in weeks)	11.03 ± 23.78	21.92 ± 23.00	−3.654	**.001**
Substance abuse (at entry)	24 (13.5%)	10 (27.8%)	4.597	**.032**
CHR-P subgroup				
APS	117 (65.7%)	23 (63.9%)	.012	.914
BLIPS	20 (11.2%)	11 (30.6%)	9.022	**.009**
Genetic vulnerability	41 (23.1%)	2 (5.6%)	4.167	.123
PANSS scores				
Positive symptoms	10.27 ± 3.66	12.62 ± 6.17	−1.125	.261
Negative symptoms	16.32 ± 6.24	33.38 ± 5.33	−5.766	**.005**
Disorganization	14.11 ± 4.07	28.69 ± 4.55	−5.827	**.005**
Affect	14.64 ± 4.97	16.31 ± 7.42	−.268	.789
Resistance/Excitement-activity	7.10 ± 3.31	8.92 ± 3.61	−2.163	.155
Total score	64.59 ± 14.97	102.77 ± 17.46	−5.341	**.005**
G12 "Lack of judgment/insight"	2.12 ± 1.39	2.85 ± 1.57	−1.831	.067
SOFAS score	49.64 ± 7.61	41.60 ± 10.41	−3.132	**.002**
HoNOS scores				
Behavioral problems	2.35 ± 1.97	3.56 ± 2.25	−3.089	**.032**
Impairment	1.67 ± 1.48	3.97 ± 2.16	−5.872	**.004**
Psychiatric symptoms	6.01 ± 2.41	7.86 ± 2.36	−3.837	**.004**
Social problems	4.71 ± 2.84	10.86 ± 3.30	−7.868	**.004**

(*continued on next page*)

Table 1 (*continued*)

Variable	PAUSS- (n = 178)	PAUSS+ (n = 36)	X^2/z	p
Total score	14.75 ± 5.43	26.25 ± 7.27	−7.498	**.001**
Treatments				
Baseline AP prescription	74 (41.6%)	21 (58.3%)	3.407	.065
Equivalent dose of risperidone (mg/day)	2.81 ± 1.98	2.47 ± 2.37	−1.547	.122
Baseline AD prescription	50 (28.1)	7 (19.4%)	1.145	.285
Baseline MS prescription	16 (9.0%)	6 (16.7%)	1.914	.167
Baseline BDZ prescription	45 (25.3%)	8 (22.2%)	.150	.698
Baseline individual psychotherapy	103 (57.8%)	23 (63.9%)	.271	.602
Baseline family psychoeducation	88 (49.4%)	24 (66.7%)	3.171	.075
Baseline case management	83 (46.6%)	26 (72.2%)	7.482	**.006**

Note. CHR-P = Clinical High Risk for Psychosis; PAUSS = PANSS Autism Severity Score; PAUSS+ = CHR-P individuals with baseline PAUSS of ≥30; PAUSS- = CHR-P individuals with baseline PAUSS of <30; NEET = Not [engaged] in Education, Employment or Training; DUI = Duration of Untreated Illness; DAAP = Duration of Active Attenuated Psychosis (defined as the cumulative period since the onset of attenuated psychotic symptoms during which an individual experiences either (a) positive symptoms within the attenuated/subthreshold range, as operationalized by the CAARMS, or (b) transient full-threshold psychotic symptoms, whether treated or untreated); APS = Attenuated Psychotic Symptoms; BLIPS = Brief Limited Intermittent Psychotic Symptoms; PANSS = Positive And Negative Syndrome Scale; SOFAS = Social and Occupational Functioning Assessment Scale; HoNOS = Health of the Nation Outcome Scale; AP = Antipsychotic medication; AD = Antidepressant medication; MS = Mood Stabilizer; BDZ = Benzodiazepine. Frequencies (and percentages), mean rank, Chi-square (X^2) and Mann-Whitney U (z) test values are reported. Adjusted residuals are in square brackets. Statistically significant p values are in bold. Bonferroni corrected p values are reported.

prevalence rates of male gender, NEET (Not in Education, Employment, or Training) subjects, current substance abuse, BLIPS, and proposed case management. Specifically, according to Veldman et al. (2024), the operational definition of NEET included participants who were not in education or employment and were also not involved in training or vocational support activities. Furthermore, PAUSS + individuals had higher age at entry, fewer years of education, and a longer duration of both untreated illness (DUI) and active attenuated psychosis (DAAP). Compared to PAUSS-, PAUSS + individuals showed higher severity levels in PANSS "Negative symptoms" and "Disorganization" factor subscores, in PANSS and HoNOS total scores, and in all HoNOS domain subscores (Table 1).

3.2. Longitudinal data

During the follow-up, 85 (39.7%) CHR-P individuals dropped out of the PARMS program, 25 during the first year of treatment. Regarding the PAUSS + subgroup, 32 (88.8%) reached the 1-year evaluation time point and 28 (77.7%) completed the follow-up period.

Compared to PAUSS-, PAUSS + subjects had higher incidence rates, over 2 years, of hospital readmission (28.7% vs. 11.6%; Hazard Ratio [HR] = 3.38) and transition to psychosis (26.0% vs. 12.0%; HR = 2.71) (Table 2; see also Supplementary Materials [Fig. S1] for details on Kaplan-Meyer survival functions). Furthermore, the PAUSS + subgroup showed lower 1-year incidence risks of functional recovery (43.7% vs./3.2%; HR = .294), SOFAS (34.3% vs. 60.5%; HR = 2.786) and HoNOS (3.1% vs. 40.8%; HR = .21.33) functional remission, PANSS symptomatic remission (15.6% vs. 72.0%; HR = 13.87), as well as a higher 1-year incidence risk of persistence of CHR-P criteria (68.8% vs. 33.1%; HR = .225) (Table 3). However, only the lower incidence risks of HoNOS functional remission (21.4% vs. 54.5%; HR = 4.23) and PANSS symptomatic remission (25.0% vs. 68.3%; HR = 2.49) remained statistically significant at the 2-year follow-up assessment.

Mixed-design ANOVA results overall showed a longitudinal improvement in all SOFAS, HoNOS, and PANSS scores (Table 4). Over the 2 years of follow-up, evidence of statistically significant "group effects" was found for PANSS total scores, PANSS "Negative" and "Disorganization" factor subscores, SOFAS and HoNOS total scores, and all HoNOS domain subscores. Specifically, compared to PAUSS-, PAUSS + subjects longitudinally showed lower SOFAS functioning and higher severity levels on the PANSS and HoNOS dimensions (see Supplementary Materials [Fig. S2] for details on profile plots). Statistically significant "interaction (time x group) effects" were also observed for PANSS total scores, PANSS "Disorganization" and "Negative Symptoms" subscores, SOFAS and HoNOS total scores, and all HoNOS dimension subscores. Notably, compared to PAUSS-, PAUSS + individuals had more relevant longitudinal improvements in all of these clinical and functional domains.

Finally, at follow-up, results from our mixed-design ANOVA showed time effects for all PARMS psychosocial treatments (Table 5). However, a statistically significant lower number of individual psychotherapy sessions in the PAUSS + subgroup was found, resulting in both group and interaction effects (see also Supplementary Materials [Fig. S3] for details of profile plots).

4. Discussion

Autism-like features also manifest in individuals with mental disorders other than autism, fragmenting the prototypical phenotype into dimensional autistic traits (Mottron and Bzdok, 2020). Within the multiple clinical forms of *psychosis*, a distinct subtype with relevant autistic features has recently been proposed (Kwok et al., 2024). In this regard, evidence suggests that the prevalence rate of autism in samples of patients with psychosis is much higher than in the general population. Specifically, point prevalence rates for autism-like traits ranged from 9.6% to 61%, while those for diagnosed autism spectrum disorder ranged widely from 1% to 52% across inpatient and outpatient samples (Kincaid et al., 2017). This specific *autistic phenotype* in psychosis is clinically characterized by severe impairment in emotion processing and social communication/interaction, and is associated with greater psychopathological severity, poorer global and cognitive functioning, earlier age at onset, longer duration of untreated psychosis, and worse prognosis (Davut et al., 2023; Pelizza et al., 2025c).

Because autism-like features have also been described in early psychosis, with prevalence rates in FEP ranging from 9% to 18% (Treise et al., 2021; Underwood et al., 2023), the main aim of this research was to explore the occurrence of autism-like characteristics in a sample of young CHR-P individuals and their longitudinal associations with clinical aspects and treatment response over 2 years of follow-up. In this regard, evidence on outcomes and prognosis in people with co-occurring early psychosis and autistic phenotype is very scarce and requires further investigations. Quickly derived from the PANSS, the PAUSS is now a popular index of autism-like features in psychosis, which does not require, like the gold-standard diagnostic tools for ASD, extensive training and is not time consuming. Its psychometric properties are encouraging, but data on longitudinal stability and replicability are still inconsistent, especially in individuals at CHR-P. This longitudinal study also aimed to fill this gap.

In this investigation, approximately *one-sixth* (16.8%) of CHR-P subjects scored above the PAUSS cut-off score at baseline. This rate is slightly higher than that reported in a recent meta-analysis which suggested an overall prevalence rate of 11.4% for ASD diagnosis in four studies including 875 individuals at CHR-P (Vaquerizo-Serrano et al., 2022). Conversely, Komatsu and colleagues (2026) observed that none of their Japanese CHR-P participants had severe autistic symptoms (i.e., PAUSS score of >30). These discrepancies between surveys are due to differences in the diagnostic instruments used to identify autism-like features (e.g., DSM-5 criteria versus PAUSS) and in the size and

Table 2
Kaplan-Meier survival analysis results: comparisons on 2-year time-to-event outcome incidence rates among the two CHR-P subgroups.

CHR-P subgroup	Number of events	1-cumulative proportion surviving at the time		Mean (in months) for 2-year *service disengagement* incidence rate			
		Estimate	SE	Estimate	SE	95% CI	
						Lower bound	Upper bound
PAUSS-	77	.432	.037	17.848	.534	16.803	18.894
PAUSS+	8	.222	.075	20.167	1.121	17.969	22.364
(Overall)	85	-	-	18.238	.486	17.286	19.191
Log Rank (Mantel-Cox)				X^2	df	p	
				3.432	1	.064	

CHR-P Subgroup	Number of events	1-cumulative proportion surviving at the time		Mean (in months) for 2-year *new hospitalization* rate			
		Estimate	SE	Estimate	SE	95% CI	
						Lower bound	Upper bound
PAUSS-	16	.116	.028	23.006	.273	22.472	23.541
PAUSS+	9	.287	.081	21.000	.974	19.090	22.910
(Overall)	25	-	-	22.667	.280	22.118	23.215
Log Rank (Mantel-Cox)				X^2	df	p	
				6.741	1	**.009**	

CHR-P Subgroup	Number of events	1-cumulative proportion surviving at the time		Mean (in months) for 2-year *new suicide attempt* incidence rate			
		Estimate	SE	Estimate	SE	95% CI	
						Lower bound	Upper bound
PAUSS-	10	.072	.023	23.389	.222	22.953	23.824
PAUSS+	2	.062	.043	23.250	.513	22.244	24.256
(Overall)	12	-	-	23.365	.204	22.965	23.765
Log Rank (Mantel-Cox)				X^2	df	p	
				.008	1	.930	

CHR-P Subgroup	Number of events	1-cumulative proportion surviving at the time		Mean (in months) for 2-year *new self-harm behavior* incidence rate			
		Estimate	SE	Estimate	SE	95% CI	
						Lower bound	Upper bound
PAUSS-	21	.160	.033	22.842	.292	22.270	23.413
PAUSS+	6	.187	.069	21.750	.828	20.127	23.373
(Overall)	27	-	-	22.660	.281	22.110	23.211
Log Rank (Mantel-Cox)				X^2	df	p	
				.485	1	.486	

CHR-P Subgroup	Number of events	1-cumulative proportion surviving at the time		Mean (in months) for 2-year *psychosis transition* incidence rate			
		Estimate	SE	Estimate	SE	95% CI	
						Lower bound	Upper bound
PAUSS-	17	.120	.028	22.930	.281	22.379	23.481
PAUSS+	8	.260	.080	21.375	.938	19.538	23.213
(Overall)	25	-	-	22.667	.280	22.118	23.215
Log Rank (Mantel-Cox)				X^2	df	p	
				4.348	1	**.037**	

Note. CHR-P = Clinical High Risk for Psychosis; PAUSS = PANSS Autism Severity Score; PANSS = Positive And Negative Syndrome Scale; PAUSS+ = CHR-P individuals with baseline PAUSS of ≥30; PAUSS- = CHR-P individuals with baseline PAUSS of <30; SE = Standard Error; 95% CI = 95% Confidence Intervals; Log Rank = Logarithm Rank Test; X2 = Chi-Square test; df = degrees of freedom; p = statistical value. Significant statistical p values are in bold. Service disengagement = complete lack of contact or untraceable for at least 3 months despite a need of treatment, counted from the date of the last face-to-face meeting with the clinical staff; Suicide attempt = potentially injurious, self-inflicted behavior without a fatal outcome for which there was (implicit or explicit) evidence of intent to die, derived from direct information reported by the patient (or by a relative well informed about the facts) or documented in the clinical notes; Self-harm behavior = acts of deliberate self-harm or intoxication with alcohol or drugs, but where there was no clear intention to die.

clinical characteristics of the samples (e.g., our participants were younger and larger in number than in the Japanese research and had higher mean PAUSS total score at baseline [19.97 ± 9.47 versus 12.00 ± 6.50]). However, this finding is lower than that found in FEP patients, including those treated at the Parma Department of Mental Health (Pelizza et al., 2025d). Future multicenter research on larger and more homogeneous CHR-P populations is needed, especially using gold-standard measures for ASD diagnosis.

Compared to PAUSS-, PAUSS + participants showed *worse global functioning* at entry, as evidenced by lower SOFAS scores and lower subscores in the "Social problems" domain of the HoNOS, as well as a higher prevalence rate of NEET individuals. Although in line with what reported in other comparable CHR-P studies (Sprong et al., 2008; Foss-Feig et al., 2019; Komatsu et al., 2026), this functional decline notably appears to start early in their lives, already during the school period, as supported by the lower number of years of educations achieved in our PAUSS + subgroup. Furthermore, it presumably involved more common proposals for case management interventions, particularly to promote early recovery-oriented rehabilitation aimed at social and work inclusion within the community (Pelizza et al., 2020; Leuci et al., 2022).

Compared to PAUSS-, our PAUSS + individuals showed *greater psychopathological severity* at entry, as evidenced by higher PANSS total scores and higher subscores in the HoNOS "Psychiatric symptoms" domain, as well as a higher prevalence rate of BLIPS condition. Specifically, this clinical impairment seemed to mainly affect negative symptoms and the "cognitive-disorganized" dimension (including the "Impairment" domain of the HoNOS). In this regard, in a preliminary

Table 3
Binary logistic regression analysis results for 2-year not time-to-event outcome parameters in the two CHR-P subgroups.

Dependent variable	PAUSS-(n = 157)	PAUSS+ (n = 32)	Statistic test for PAUSS- subgroup				
			B (SE)	HR	95% CI for HR		p
					Lower	Higher	
1-year current suicidal ideation	42 (26.8%)	13 (40.6%)	−.630 (.403)	.534	.242	1.175	.119
1-year functional recovery	115 (73.2%)	14 (43.7%)	1.226 (.404)	.294	.133	.648	**.002**
1-year SOFAS functional remission	95 (60.5%)	11 (34.3%)	1.025 (.409)	2.786	1.249	6.214	**.012**
1-year HoNOS functional remission	64 (40.8%)	1 (3.1%)	3.060 (1.029)	21.333	2.840	160.273	**.001**
1-year PANSS symptomatic remission	113 (72.0%)	5 (15.6%)	2.630 (.518)	13.868	5.022	38.298	**.001**
1-year CHR-P criteria persistence	52 (33.1%)	22 (68.8%)	−1.491 (.417)	.225	.099	.510	**.039**
Dependent variable	PAUSS-(n = 101)	PAUSS+ (n = 28)	Statistic test for PAUSS- subgroup				
			B (SE)	HR	95% CI for HR		p
					Lower	Higher	
2-year current suicidal ideation	22 (28.1%)	5 (17.9%)	.248 (.549)	1.281	.437	3.758	.652
2-year functional recovery	76 (75.2%)	23 (82.1%)	.271 (.432)	.512	.481	3.575	.596
2-year SOFAS functional remission	68 (67.3%)	21 (75.0%)	−.133 (.435)	.875	.373	2.053	.759
2-year HoNOS functional remission	55 (54.5%)	6 (21.4%)	1.478 (.502)	4.228	1.640	11.730	**.003**
2-year PANSS symptomatic remission	69 (68.3%)	7 (25.0%)	1.867 (.486)	6.496	2.495	16.770	**.001**
2-year CHR-P criteria persistence	30 (29.7%)	13 (46.4%)	.718 (.437)	.488	.207	1.148	.100

Note. CHR-P = Clinical High Risk for Psychosis; SOFAS = Social and Occupational Functioning Assessment Scale; HoNOS = Health of the Nation Outcome Scale; PANSS = Positive And Negative Syndrome Scale; PAUSS+ = CHR-P individuals with baseline PAUSS of ≥30; PAUSS- = CHR-P individuals with baseline PAUSS of <30; B = regression coefficient, SE = Standard Error; HR = Hazard Ratio; 95% CI = 95% confidence intervals for HR; p = statistical significance. Significant statistical p values are bold. Cumulative incidence rates are reported. Only FEP participants who concluded the 2-year follow-up period are included in the analysis.
Current suicidal ideation = BPRS item 4 score ≥2; Functional recovery = return to work/school; SOFAS functional remission = SOFAS score >60; HoNOS functional remission = HoNOS item 9, 10 and 11 subscores <2; PANSS symptomatic remission = PANSS item P1, P2, P3, N1, N4, N6, G5, G9 subscores ≤3.

report on 12 CHR-P women, Ribolsi and coauthors (2022) found that autistic-like features (measured with the PAUSS) were significantly correlated with the severity of formal thought disorders measured with the Scale for the Assessment of Thought, Language, and Communication (TLC) (Andreasen, 1986). Similarly, Solomon and colleagues (2011) observed significantly greater impairment in structural and pragmatic language in 15 ASD individuals at CHR-P. Although this may apparently confirm Bleuler's hypothesis about autism and association disorders as central features of psychosis (Pelizza et al., 2021b), it must be said that the PAUSS was developed on PANSS items structurally included in the negative and disorganized domains and its correlation could be intrinsically link to symptom overlap. The more severe psychopathological picture in the PAUSS + subgroup was further confirmed by the greater severity of behavioral problems measured with the HoNOS, including ongoing *substance abuse* (defined as a current pattern of uncontrolled use of a substance despite harmful consequences and recurrent social, occupational, legal, or interpersonal adverse effects) (Nielsen et al., 2017). In this sense, drug use also could be interpreted as a self-treatment behavior aimed at alleviating the increased psychological distress experienced by CHR-P subjects with autism-like characteristics. However, compared to PAUSS-, our PAUSS + participants interestingly showed *shorter DUI* and DAAP. This could be similarly related to the greater severity of the clinical presentation, which more easily induces early help-seeking behaviors.

Regarding other sociodemographic characteristics, our PAUSS + individuals had a higher prevalence of *males*, in line with what was reported in comparable CHR-P studies (Foss-Feig et al., 2019; Vaquerizo-Serrano et al., 2022). Consistent with our other findings, male gender in CHR-P conditions and FEP is often associated with worse daily functioning at baseline and more serious clinical presentation (Poletti et al., 2024). However, our participants with severe autism-like features demonstrated an *older age* at entry, in contrast to the earlier onset of CHR-P status and younger age of clinical presentation reported in CHR-P subjects with comorbid ASD examined in other international investigations (Eussen et al., 2015; Jutla et al., 2020; Maat et al., 2020). Anyway, the finding that participants with severe autism-like features appeared to be older at presentation requires further discussion. Indeed, one possible interpretation is that autism characteristics may contribute to delayed recognition or referral to CHR-P services, for example, due to help-seeking difficulties, social communication problems, or diagnostic overshadowing of emerging psychosis-risk symptoms by longstanding neurodevelopmental characteristics.

Overall, our longitudinal analysis showed *worse outcome* results in PAUSS + individuals compared to PAUSS- ones. Specifically, they had higher incidence rates of *hospital re-admission* and *conversion to psychosis* over time. Furthermore, the PAUSS + subgroup was associated with *lower probability of functional and symptomatic remission* during the 2-year follow-up period, as demonstrated by its significant negative predictive role in relation to the HoNOS functional remission and PANSS symptomatic remission indices. During the first year of follow-up, PAUSS + individuals also showed a lower likelihood of functional recovery (simply defined as return to work/school) and SOFAS functional remission, as well as a higher likelihood of persistence of CHR-P criteria. In this regard, previous findings on psychosis conversion in people at CHR-P with comorbid autistic features are inconsistent. Indeed, Foss-Feig and colleagues (2019) found no statistically significant intergroup differences in terms of transition to psychosis, while Guillory and coauthors (2018) reported slightly higher conversion rates in the ASD group at CHR-P.

Finally, although our mixed-design ANOVA results showed statistically significant group effects in terms of *greater severity of psychopathology and global functioning* (i.e., in PANSS total scores, SOFAS scores, and all HoNOS scores) for the PAUSS + subgroup at all time points, interaction effects indicated higher *longitudinal improvement* in these clinical and functional dimensions for PAUSS + individuals. This suggests the effectiveness of the PARMS treatment components also in the PAUSS + subsample, despite the smaller number of individual psychotherapy sessions provided. In this regard, we found a statistically significant decrease in PAUSS total scores over the follow-up period in the total CHR-P sample (17.61 ± 8.04 [baseline] versus 15.62 ± 7.67 [1-year], z = −4.21, p = 0.001; versus 15.15 ± 7.36 [2-year], z = −4.61, p = 001). However, the reduction in clinical and functional parameters may also be influenced by differences in initial severity between groups, with the degree of improvement in the PAUSS + subgroup amplified by higher scores at presentation. In an interesting 1-year follow-up study, Komatsu and coworkers (2025) similarly observed that psychiatric

Table 4
Mixed-design ANOVA results: clinical outcome parameters across the 2-year follow-up period in the two CHR-P subgroups.

Variable	Time effects				Group effects				Interaction effects (time x group)			
	df	F	p	η2	df	F	p	η2	df	F	p	η2
PANSS scores												
Positive symptoms	1.5	15.512	**.001**	.137	1	2.263	.136	.023	1.5	2.004	.138	.020
Negative symptoms	1.5	32.443	**.001**	.249	1	58.981	**.001**	.376	1.5	10.915	**.001**	.100
Disorganization	1.5	62.098	**.001**	.388	1	72.761	**.001**	.426	1.5	27.986	**.001**	.222
Affect	1.5	36.858	**.001**	.273	1	.823	.367	.008	1.5	2.628	.091	.026
Resistance/Excitement-activity	1.6	7.596	**.002**	.072	1	1.815	.181	.018	1.6	1.766	.181	.018
Total score	1.5	44.910	**.001**	.314	1	33.428	**.001**	.254	1.5	10.949	**.001**	.100
G12 Lack of judgment/insight item	1.6	2.928	**.049**	.039	1	2.255	.136	.022	1.6	.472	.582	.005
SOFAS score	1.6	51.028	**.001**	.352	1	13.069	**.001**	.122	1.6	3.326	**.049**	.034
HoNOS scores												
Behavioral problems	1.4	58.698	**.001**	.318	1	2.281	.133	.018	1.4	3.775	**.038**	.029
Impairment	1.8	35.815	**.001**	.220	1	29.311	**.001**	.188	1.8	5.820	**.004**	.044
Psychiatric symptoms	1.6	85.673	**.001**	.403	1	4.596	**.034**	.035	1.6	3.347	**.046**	.026
Social problems	1.7	89.882	**.001**	.414	1	53.321	**.001**	.296	1.7	16.158	**.001**	.113
Total score	1.6	138.238	**.001**	.523	1	36.931	**.001**	.227	1.6	12.118	**.001**	.088

Variable (Group effects)	EMM (SE)	
	PAUSS-(n = 101)	PAUSS+ (n = 28)
T0 PANSS Negative symptoms	16.682 (.661)	33.917 (1.789)
T1 PANSS Negative symptoms	14.193 (.731)	29.083 (1.980)
T2 PANSS Negative symptoms	13.568 (.751)	22.750 (2.032)
Δ T0-T2 EMM (difference)	3.114	11.167
T0 PANSS Disorganization	14.227 (.434)	29.167 (1.174)
T1 PANSS Disorganization	12.216 (.518)	23.417 (1.402)
T2 PANSS Disorganization	11.989 (.534)	17.833 (1.447)
Δ T0-T2 EMM (difference)	2.238	11.334
T0 PANSS Total score	65.068 (1.658)	105.250 (4.489)
T1 PANSS Total score	54.080 (2.054)	84.833 (5.562)
T2 PANSS Total score	52.409 (2.319)	67.833 (6.281)
Δ T0-T2 EMM (difference)	12.659	37.417
T0 SOFAS score	49.471 (.820)	39.818 (2.280)
T1 SOFAS score	62.188 (1.347)	46.455 (3.744)
T2 SOFAS score	65.094 (1.390)	57.636 (3.864)
Δ T0-T2 EMM (difference)	−15.623	−17.818
T0 HoNOS Behavioral problems	2.570 (.211)	3.357 (.399)
T1 HoNOS Behavioral problems	1.310 (.174)	2.071 (.330)
T2 HoNOS Behavioral problems	1.060 (.148)	.964 (.279)
Δ T0-T2 EMM (difference)	1.510	2.393
T0 HoNOS Impairment	1.703 (.162)	3.464 (.307)
T1 HoNOS Impairment	1.079 (.137)	2.714 (.259)
T2 HoNOS Impairment	.990 (.130)	1.893 (.246)
Δ T0-T2 EMM (difference)	.713	1.571
T0 HoNOS Psychiatric symptoms	6.119 (.251)	7.571 (.477)
T1 HoNOS Psychiatric symptoms	4.050 (.249)	5.250 (.473)
T2 HoNOS Psychiatric symptoms	3.525 (.245)	3.750 (.465)
Δ T0-T2 EMM (difference)	2.594	3.821
T0 HoNOS Social problems	5.079 (.305)	10.571 (.579)
T1 HoNOS Social problems	3.723 (.281)	7.429 (.534)
T2 HoNOS Social problems	3.238 (.271)	5.964 (.516)
Δ T0-T2 EMM (difference)	1.841	4.607
T0 HoNOS Total score	15.490 (.603)	24.964 (1.139)
T1 HoNOS Total score	10.120 (.619)	17.464 (1.170)
T2 HoNOS Total score	8.800 (.625)	12.571 (1.181)
Δ T0-T2 EMM (difference)	6.690	12.123

Note. ANOVA = analysis of variance; CHR-P = Clinical High Risk for Psychosis; PAUSS = PANSS Autism Severity Score; PANSS = Positive And Negative Syndrome Scale; PAUSS+ = CHR-P individuals with baseline PAUSS of ≥30; PAUSS- = CHR-P individuals with baseline PAUSS of <30; HoNOS = Health of the Nation Outcome Scale; SOFAS = Social and Occupational Functioning Assessment Scale; df = degrees of freedom; F = F statistic value; p = statistical significance; η2 = partial eta squared; EMM = Estimated Marginal Mean; SE = Standard Error. As all Mauchly's tests of sphericity are statistically significant ($p < 0.05$), Greenhouse–Geisser corrected degrees of freedom to assess the significance of the corresponding F value are used. Statistically significant p values are in bold. Only CHR-P participants who concluded the 2-year follow-up period are included in the analysis.

symptoms, as well as cognitive and global functioning, improved over time in both groups, but that significant differences in these parameters between groups at presentation disappeared after one year. Overall, our results support the idea that autism-like features may be considered both transient (state) characteristics and enduring traits in CHR-P individuals. Future research with larger sample and follow-up periods longer than two years are needed to validate the long-term stability of the PAUSS.

4.1. Limitations

The first limitation is related to the PARMS protocol, which was not specifically focused on ASD diagnosis. Therefore, future studies using gold-standard tools for autism are needed. Furthermore, being built on

Table 5
Mixed-design ANOVA results: specialized treatment components of the PARMS program across the 2-year follow-up period in the two CHR-P subgroups.

Variables	Time effects				Group effects				Interaction effects (time x group)			
	df	F	p	η2	df	F	p	η2	df	F	p	η2
Equivalent dose of risperidone (mg/day)	1.	.905	.406	.007	1	1.503	.223	.012	1.8	.756	.458	.006
Individual psychotherapy sessions	1.1	89.026	**.001**	.410	1	5.147	**.025**	.039	1.1	4.898	**.024**	.037
Family psychoeducation sessions	1.1	78.968	**.001**	.382	1	.028	.867	.001	1.1	.026	.893	.001
Case management sessions	1.1	48.366	**.001**	.274	1	2.065	.153	.016	1.1	1.914	.167	.015

Variable (Group effects)	EMM (SE)	
	PAUSS-(n = 101)	PAUSS+ (n = 28)
T0 Individual psychotherapy sessions	.000 (.000)	.000 (.000)
T1 Individual psychotherapy sessions	11.812 (.949)	7.586 (1.770)
T2 Individual psychotherapy sessions	19.356 (1.517)	11.966 (2.832)
Δ T2-T0 EMM (difference)	19.356	11.996

Note. ANOVA = analysis of variance; PARMS = Parma At-Risk Mental States; CHR-P = Clinical High Risk for Psychosis; PAUSS = PANSS Autism Severity Score; PANSS = Positive And Negative Syndrome Scale; PAUSS+ = CHR-P individuals with baseline PAUSS of ≥30; PAUSS- = CHR-P individuals with baseline PAUSS of <30; df = degrees of freedom; F = F statistic value; p = statistical significance; η2 = partial eta squared. As all Mauchly's tests of sphericity are statistically significant ($p < 0.05$), Greenhouse–Geisser corrected degrees of freedom to assess the significance of the corresponding F value are used. Statistically significant p values are in bold. Only CHR-P participants who concluded the 2-year follow-up period were included in the analysis.

the three clinical domains of ASD described in the DSM-IV-TR) (APA, 2000), the PAUSS does not adequately represent the current two-domain diagnostic model of the DSM-5 (APA, 2013), which exclusively includes deficit in social interaction and repetitive behavior/restricted interests. A re-adaptation of the PAUSS to take this conceptual misalignment into account is recommended.

Second, our participants were enrolled in a single CHR-P service, and a multicenter perspective would be necessary. Furthermore, other key weaknesses include the lack of a control group (particularly patients diagnosed with ASD) and the relatively small sample size, especially in terms of PAUSS + individuals. Indeed, without a control group, it is difficult to attribute longitudinal improvements in psychopathology and daily functioning specifically to our specialist PARMS interventions. Future research with a larger number of PAUSS + subjects is therefore needed.

Third, although the PANSS has been widely used in the early stage of psychosis, the PAUSS requires further psychometric analysis in the CHR-P population. Specifically, it was developed to assess psychopathology in patients with full-blown psychosis and may be insensitive in measuring attenuated psychotic symptoms, with the risk of underestimating CHR-P symptomatology and autistic-like features (Poletti et al., 2023). Therefore, future studies examining the psychometric properties of the PAUSS in larger samples of young people at CHR-P are urgently needed.

Fourth, another limitation is related to the fact that we were unable to specify the substances involved, in particular cannabis, psychostimulants, or other substances potentially relevant to the risk of psychosis or the manifestation of symptoms. Therefore, further research on this topic could better examine the contribution of the different substances used.

Finally, given the significant baseline differences between the groups in terms of age, gender, and education level, it should be noted that our logistic regression analyses were univariate and did not take these variables into account. Therefore, because the sample size and number of events had limited the inclusion of multiple covariates (including negative symptoms and cognitive impairment), our results should be interpreted as exploratory or unadjusted associations.

4.2. Conclusion

The PAUSS is now a widely used index for measuring autism-like features in early psychosis. The results of this research suggest that their baseline presence in CHR-P individuals is associated with greater impairment in global functioning and greater psychopathological severity (especially in terms of negative and disorganized symptoms) at presentation to our specialist service. It is also a useful early psychopathological predictor of poor clinical and functional outcomes, although sensitive to the specialized interventions provided in the PARMS program. Furthermore, being based on the PANSS, it may be better to represent an indirect indicator to assess the clinical severity of CHR-P conditions rather than a pure indicator of autistic features, especially given the poor long-term stability of its scores. Therefore, in our opinion, the PAUSS should not replace careful clinical judgment and the administration of gold-standard tools for the assessment of ASD traits and diagnosis.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

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Declaration of competing interest

The authors have nothing to declare.

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Appendix A. Supplementary data

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