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Predicting models for work outcomes in patients with schizophrenia and its clinical application

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Negative symptoms and social function have been known to predict work outcomes in patients with schizophrenia. Recent studies report that specific subdomains of these predictors were particularly important in prediction. The aims of this study were (1) to determine which subdomains of negative symptoms and social function were the most important predictors of work outcomes among patients with schizophrenia, and (2) to use these factors to produce charts to demonstrate the estimated probabilities of workable hours. Data were obtained from 293 patients with schizophrenia. Four separate logistic regression analyses were conducted using psychiatric symptoms, intellectual ability, and social function as independent variables to predict work hours (0, 10, 20, or 30 h per week). The Experiential deficit domain of negative symptoms, comprising of volitional, social, and hedonic deficits, and the Independence-Performance domain including self-care and daily-living skills were significant in most regression models. Charts illustrating the probabilities of the ability to work were produced based on these two predictors. Our study identified specific domains of negative symptoms and social function were relevant to work outcomes in patients with schizophrenia. The charts illustrating the probabilities of workable hours provide objective information about the capacity to work among patients with schizophrenia.

Keywords Schizophrenia, Work outcomes, Negative symptoms, Social function

Schizophrenia is a major psychiatric illness that poses a large financial burden to society, yielding direct costs (e.g., medical treatments or social services) as well as indirect costs (e.g., premature death by suicide and productivity loss due to poor vocational functioning)[1]. Specifically, the indirect costs of schizophrenia are substantial in Japan because of higher rates and longer periods of hospitalization[2]. According to governmental survey in 2022, it is estimated that employed mental disorders account for less than 0.2% of the entire working population in Japan[3]. The figure may be even lower by narrowing down the target to schizophrenia only.

In addition to the socio-economic issues, a lack of work experience may adversely affect patients' subjective quality of life by decreasing their self-efficacy or self-esteem[4,5]. Therefore, it seems necessary to provide objective feedback regarding the ability to work among these individuals in order to reduce disease-related costs and to promote their well-being and functional recovery.

Factors affecting work outcomes in patients with schizophrenia were shown to be negative symptoms, cognition, intellectual ability, functional capacity, and social function[6,7]. Using several contributing factors including negative symptoms and social function, a previous study has presented prediction models for probabilities of workable hours (e.g., 0, 10, or 20 h per week)[8].

The structure of negative symptoms (e.g., blunted affect, alogia, avolition, asociality, and anhedonia) has been continuously discussed[9,10]. It has been suggested that negative symptoms can be categorized into 2 domains, i.e.,

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expressive deficits and experiential deficits (for review, see Correll & Schooler, 2020[11]). The former domain refers to poor emotional expressivity and poverty of speech, whereas the latter domain includes avolition, withdrawal, and anhedonia. These two domains (hereafter denoted in upper case: Expressive deficits and Experiential deficits) are universally detected in schizophrenia irrespective of regional or cultural differences[12,13].

Social function, another potential predictor of work outcome, can also be characterized by two domains[14]. One of them covers prosocial or recreational activities, including interpersonal relationships and recreational activities, whereas the other consists of abilities to live independently such as self-care, daily-living skills, and vocational functioning[14].

Differential degrees of contribution to work status may present within the domains of both negative symptoms and social function in patients with schizophrenia. The Experiential deficits in negative symptoms has a greater impact on work outcomes than the Expressive deficits[15,16]. Similarly, independent living ability, a component of social function, is assumed to have greater influence on work outcomes than prosocial or recreational activities probably because everyday living behaviour well reflects cognitive ability in patients with schizophrenia[17]. Thus, it seems necessary to examine the role of each domain of negative symptoms and social function in predicting work status in patients with schizophrenia.

The clinical application of the prediction models should also be considered. By using significant predictors in the models, it is possible to estimate the probability that an individual can work for a certain amount of time[8]. A feasible presentation of such results would be beneficial for clinicians and patients. For example, "at-a-glance charts" of the estimated probabilities for workable hours per week could be used objective feedback about work capacity in real world settings.

The aims of this study were (1) to determine which subdomains of negative symptoms and social function were the most prominent predictor in predicting work outcomes in patients with schizophrenia, and (2) to produce charts presenting the estimated probabilities of workable hours based on those factors.

Methods

Participants

Data were obtained from 293 patients meeting DSM-4 or DSM-5 criteria for schizophrenia[18]. They were treated at the Department of Psychiatry, Osaka University Hospital or National Centre Hospital, National Centre of Neurology and Psychiatry. The details of their demographic and clinical characteristics are summarized in Table 1. The study was approved by the Ethical Committee of Osaka University and the Ethical Committee of National Center of Neurology and Psychiatry. All participants provided written informed consent. The study was performed in accordance with the Declaration of Helsinki.

Variable	Mean	SD
N (M/F)	293 (144/149)	
Age, y	38.328	12.717
Years of education, y	13.529	2.337
Age at onset, y	24.700	10.888
Duration of illness, y	13.625	10.412
Neuroleptics, mg[a]	602.598	586.203
Full scale IQ	82.505	17.155
Estimated premorbid IQ[b]	100.250	10.676
IQ discrepancy[c]	-17.745	12.408
PANSS Total score	91.604	19.214
Expressive deficits subscale score[d]	12.826	3.1872
Experiential deficits subscale score	10.761	2.8617
SFS total score	96.076	31.032
SFS adjusted score[e]	90.901	29.647
Withdrawal/Social Engagement	9.564	2.622
Interpersonal Communication	6.478	2.992
Independence-Performance	22.691	8.470
Independence-Competence	26.698	8.986
Recreation	17.405	6.805
Prosocial Activities	8.691	6.974
Employment/Occupation	4.550	3.642
Work hours per week[f]	9.287	15.036

Table 1. Characteristics of participants. [a]Chlorpromazine (CPZ) equivalent. [b]Premorbid IQ was estimated using the Japanese version of the Adult Reading Test (JART). [c]Full scale IQ-Estimated premorbid IQ. [d]Expressve deficits:PANSS N1, N3, N6, G7; Experiential deficits:PANSS N2, N4, G16. [e]SFS Total score-Employment/Occupation score. [f]Work hours stratified by SAA domains are noted sTable1 in the supplementary material.

Assessments

Psychotic symptoms

Psychotic symptoms were assessed using the Positive and Negative Syndrome Scale for Schizophrenia (PANSS)[19]. To replicate the two factor structure of negative symptoms, i.e. Expressive deficits and Experiential deficits, in the Asian sample[12,13], confirmatory factor analysis (CFA) was conducted specifying the Expressive deficits factor (N1, Blunted Affect; N3, Poor Rapport; N6, Lack of Spontaneity; G7, Motor Retardation) and the Experiential deficits factor (N2, Emotional Withdrawal; N4, Passive Social Withdrawal; G16, Active Social Avoidance). The details of the CFA are summarized in the supplementary material, sTable 2.

Intellectual ability

Intellectual ability was evaluated by current IQ, premorbid IQ, and their discrepancy. The former two were estimated by using the Wechsler Adult Intelligence Scale-Third Edition[20] and the Japanese version of the Adult Reading Test[21], respectively. IQ discrepancy was calculated by subtracting premorbid IQ from current IQ[22].

Social function

Social function was evaluated by using the Japanese version of the modified Social Functioning Scale (SFS) designed for the MATRICS Standardization and Psychometric Study[23,24]. The details of the modified version of the SFS were explained in our previous study[8], and the validity of the Japanese version has been reported in previous studies[5,25]. The scale consists of 7 domains: Withdrawal, Social Engagement, Interpersonal Communication, Independence-Performance, Independence-Competence, Recreation, and Employment/Occupation, as in the original version of the SFS[26,27]. To avoid overlap with dependent variable (i.e. work hours a week), the adjusted total score was calculated excluding the Employment/Occupation subscale score from the total score. This adjustment increased the validity of the prediction.

Work

Total work hours per week in the past 3 months were used as work status variable which was obtained from the Social Activity Assessment (SAA)[28]. This scale evaluates Work for pay, Work at Home, and Student work. If a participant experienced multiple types of work, the work hours were summed. Although both the SFS and the SAA could be administered in a self-report manner, most data of the current study was collected by interview to patients.

Statistical analyses

Logistic regression analysis for prediction models

Logistic regression analyses were conducted to construct predicting models. Nonlinear modelling was used as it was assumed that probability (e.g. the possibility of working more than 20 h per week is approximately 53%) was more suitable for presenting in charts, and also for verbal feedback, rather than exact number of hours (e.g. 20.5 h per week). The significance of nonlinear modelling for clinical settings is explained in our previous study[8]. Four separate regression analyses were conducted according to different dependent variables. The outline is summarized in the upper part of Fig. 1. Dependent variables were stratified by a criterion of the 0, 10, 20, or 30 h per week noted as 0-, 10-, 20-, or 30-h criterion, respectively. Patients were classified into either the above (=1) or the below (=0) criterion depending on their actual number of work hours. The independent variables were demographic background (education), intellectual ability (current IQ, premorbid IQ, and IQ discrepancy), negative symptoms (factor scores on the Expressive deficits factor and the Experiential deficits factor obtained from CFA) and social function (SFS adjusted total scores and subdomain scores). All the dependent variables were standardized. A forward selection method with a likelihood ratio criterion was applied. Model fits and coefficients were tested by the likelihood test and the Wald test, respectively. The predictive accuracy was estimated by the sum of the ratios correctly classified (i.e., patient's observed outcome = 1[0] and the estimated probability ≥ 0.5 [< 0.5]).

Charts of estimated probabilities of work hours

Using significant variables in predicting models, logistic regression analyses were newly performed to produce charts for each criterion. The outline is presented in the lower part of Fig. 1. The independent variables were not standardized in this model and the subscale scores of symptom factors, rather than factor scores, were used so that the charts presented actual assessment scores. The results of regression analyses for charts are presented in e supplementary material sTable3. The estimated probabilities (p) at each criterion were calculated using logits ($log[p/(1-p)]$) obtained from regression equations (see supplements for details, sFigure 1). To enhance clinical utility, the charts were zoned according to the probabilities as follows: Grade A, $p \geq 0.8$[80%]; Grade B, $p \geq 0.6$[60%]; Grade C, $p \geq 0.4$[40%]; Grade D, $p \geq 0.2$[20%]; Grade E, $p < 0.2$[less than 20%]).

Results

Logistic regression analysis

The results are summarized in Table 2. The Independence-Performance was significant in all the regression models. The Experiential deficits was also significant in all the models except the model with the 0 h per week criterion.

Charts

Based on the results from logistic regression analyses, the Independence-Performance and Experiential deficits were used as entries to the charts (Fig. 2b–d), with the exception of the 0-h criterion (Fig. 2a). A single entry

Purpose	Independent variables	Dependent variables
Prediction models	**Psychotic symptoms** Expressive deficits factor score Experiential deficit factor score **Demographic** Education **Intellectual abilities** Current IQ Premorbid IQ IQ discrepancy **SFS subdomains** Adjusted total score Withdrawal/Social Engagement Interpersonal Communication Independence-Performance Independence-Competence Recreation Prosocial activities	0/1 dichotomized by 0h/w 0/1 dichotomized by 10h/w 0/1 dichotomized by 20h/w 0/1 dichotomized by 30h/w
Chart for 0-hour-criterion	Independence-Performance	0/1 dichotomized by 0h/w
Chart for 10, 20, 30-hour criterion	Independence-Performance Expr Experiential deficits subscale score	0/1 dichotomized by 10h/w 0/1 dichotomized by 20h/w 0/1 dichotomized by 30h/w

Fig. 1. Summary of logistic regression analyses.

Criterion (h/w)[a]	Independent variables	B	SE B	Wald	df	p	Exp (B)[b]	95%CI Lower	95%CI Upper	χ^2	df	p	Predicting accuracy
0-h criterion	Independence-Performance	0.797	0.153	27.140	1	0.000	2.218	1.644	2.993	51.496	2	0.000	66.7%
	Withdrawal	0.284	0.144	3.893	1	0.048	1.328	1.002	1.762				
	Constant	0.270	0.129	4.352	1	0.037	1.310						
10-h criterion	Independence-Performance	1.146	0.216	28.146	1	0.000	3.145	2.060	4.803	73.713	2	0.000	79.4%
	Experiential deficits factor	0.422	0.169	6.225	1	0.013	1.525	1.095	2.124				
	Constant	-1.280	0.174	54.318	1	0.000	0.278						
20-h criterion	Independence-Performance	1.864	0.421	19.618	1	0.000	6.453	2.828	14.725	74.933	3	0.000	81.8%
	Experiential deficits factor	0.670	0.198	11.462	1	0.001	1.954	1.326	2.879				
	Independence-competence	-0.884	0.421	4.416	1	0.036	0.413	0.181	0.942				
	Constant	-1.944	0.224	75.430	1.00	0.000	0.143						
30-h criterion	Independence-Performance	1.280	0.322	15.790	1	0.000	3.597	1.913	6.763	53.769	2	0.000	88.3%
	Experiential deficits factor	0.647	0.227	8.121	1	0.004	1.910	1.224	2.981				
	Constant	-2.825	0.323	76.508	1	0.000	0.059						

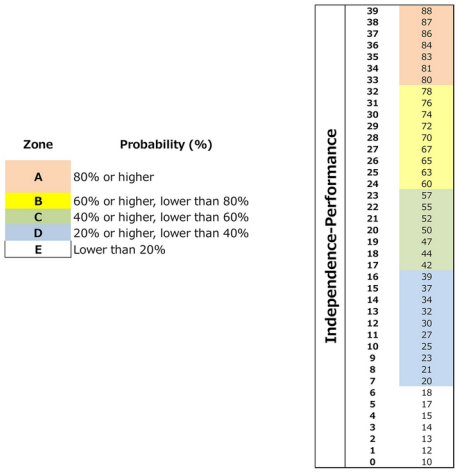
Table 2. Results from logistic regression analyses. [a]0-hour criterion, 0 vs. longer than 0;10-h criterion, less than 10 vs. 10 or longer; 20-h criterion, less than 20 vs. 20 or longer; 30-h criterion, less than 30 vs. 30 or longer. [b]Exp (B) represents an odds ratio.

was appropriate for the 0-h criterion as only the Independence-Performance was significant. An example of reference for a probability (%) is depicted in Fig. 2e. The five zones (A-E) noted in the Methods section are shown in different colours. With respect to the criterion of longer working hours, the Grade A zones ($p \geq 0.8$[80%]) were less noticeable and eventually disappeared at the 30-h criterion (Fig. 2d).

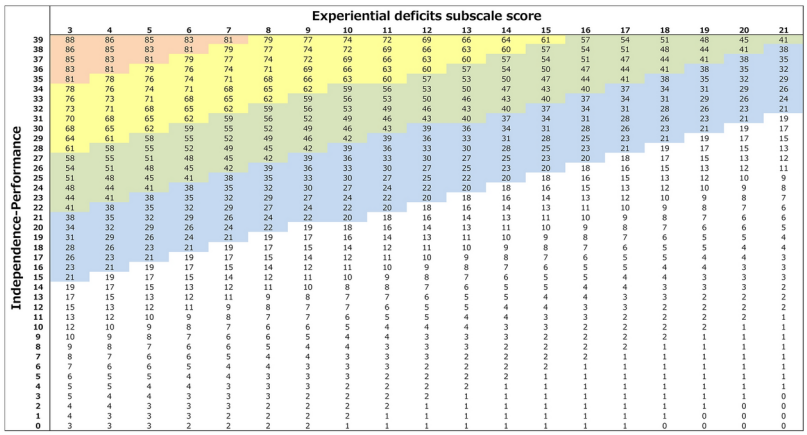
Discussion

This study aimed to determine which subdomains of negative symptoms and social function predict work status, as represented by working hours per week, among patients with schizophrenia. Logistic regression analyses revealed significant contributions of the Experiential deficits on negative symptoms and the Independence-Performance on social function to work outcomes. Using these factors, charts were produced to illustrate the probabilities of working for a certain number of hours a week.

The Independence-Performance on the SFS may be a highly important measure of functional recovery in patients with schizophrenia and other mental disorders. First, the domain assesses mostly daily living skills, including self-care and household choirs, which are critical skills for independent living. Therefore, the



a



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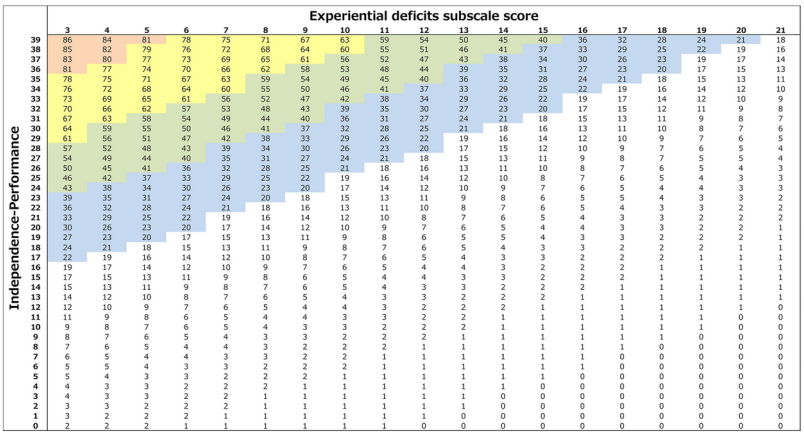
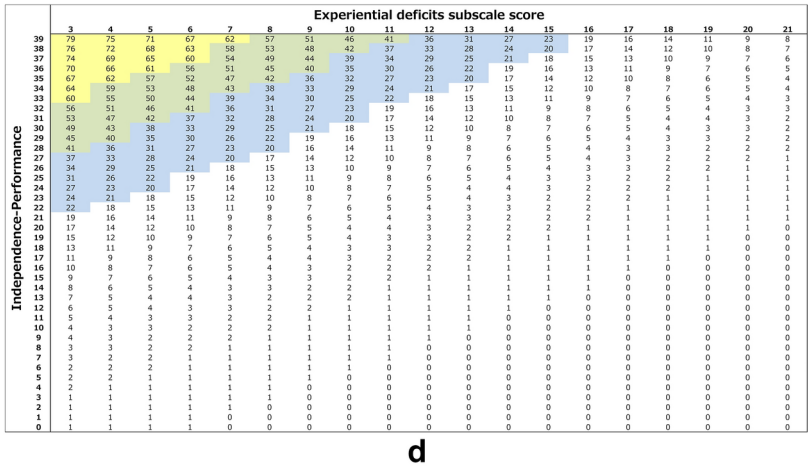


c

Fig. 2. (**a**) Chart at 0-h criterion (probability, %). (**b**) Chart at 10-h criterion (probability, %). (**c**) Chart at 20-h criterion (probability, %). (**d**) Chart at 30-h criterion (probability, %). (**e**) Example of reference.

demographic (e.g., generations and sex) or cultural variations are relatively minor compared with other domains of the SFS (e.g., Recreation). Second, most daily-living acts are simple and customary performed, and therefore, they are easily recorded by handy device such as a smartphone. An introduction of digital device could enhance reliability of the prediction for work outcome. In addition, the aggregation of such information could form the basis of digital phenotype, that may support individual functional recovery. Third, performance on daily living skills is strongly associated with cognition in patients with schizophrenia[17]. This suggests that the assessment of



d

Example
Pt. XX Experiential deficits subscale score 31
SFS_Independence-Performance score 9

Criterion 10-hour criterion (10 vs. longer than 10)
Probability 52%
Zone C

10-hour criterion chart (probability, %)

Independence-Performance	Experiential deficits subscale score 3	4	5	6	7	8	9	10
39	88	86	85	83	81	79	77	74
38	86	85	83	81	79	77	74	72
37	85	83	81	79	77	74	72	69
36	83	81	79	76	74	71	69	66
35	81	78	76	74	71	68	66	63
34	78	76	74	71	68	65	62	59
33	76	73	71	68	65	62	59	56
32	73	71	68	65	62	59	56	53
31	70	68	65	62	59	56	52	49
30	68	65	62	59	55	52	49	46
29	64	61	58	55	52	49	46	42
28	61	58	55	52	49	45	42	39
27	58	55	51	48	45	42	39	36
26	54	51	48	45	42	39	36	33

e

Figure 2. (continued)

the Independence-Performance could provide information about cognitive function as well as work outcomes. Possibly because of this strength, this domain has been chosen for the short version of the SFS[29].

To our knowledge, our study is the first to apply prediction models to produce charts for the probability of workable hours per week in patients with schizophrenia. This is meaningful as the charts are clinical application of the theoretical models in prediction. The charts may help clinicians provide their patients and caregivers with feasible feedback regarding attainable occupational outcomes. Practical feedback based on the charts could contribute to bridging an evidence-practice gap that has been addressed in clinical settings[30].

The charts could also be used as a self-management tool in patents with schizophrenia. It is known that they are generally reluctant to perform goal-directed activities due to the disturbance in conceiving anticipatory pleasures (i.e., expectations for rewards related to future activities)[31]. In fact, not only intrinsic motivation, but extrinsic motivation (e.g. seeking reward) is important in work outcome in patients with schizophrenia[32]. A visual presentation of the likelihood of successfully doing an appropriate amount of work may increase motivation in patients who are capable but discouraged to work. On the other hand, some patients with schizophrenia often overestimate their ability to work, particularly those who have limited experience in working[33,34]. Likewise, some patients tend to conceive jumping-to-conclusions bias, i.e. impetuous behaviour without concrete evidence[35]. In those cases, the charts may help patients assess their work capacity adjusting their insights.

Limitations

Some limitation should be noted. First, we did not include the WHO initiative measurement such as WHODAS 2.0. in the analyses. This may limit the comparability and generalizability of the results. Second, the Grade A zone, where the probability exceeds 0.8, disappears at higher criterion (i.e. 30 h/week, Fig. 2d). This finding suggests that the estimation might be difficult for patients with milder symptoms, and therefore who wish to work for longer time. In fact, a previous study[36] reported that the association between experiential deficits symptoms and vocational functioning (e.g., ability to stay on tasks or complete tasks) was weak in patients with mild experiential deficit symptoms, suggesting the difficulty of prediction for patients with minor symptoms. Third, it is possible that other intermediating factors (e.g. working environment, availability of social support or rehabilitation program, or stigma) might interfere with predicting work outcomes particularly in patients

with less severe symptoms and/or a better ability to live independently. The prediction models and charts in the current study should be extended to increase utility in relatively high-functioning patients. Further studies that incorporate these issues are warranted.

Conclusions

The experiential negative symptoms including volitional and hedonic deficits and the independent-living ability covering basic daily-living skills are major determinants of work outcomes in patients with schizophrenia. The charts proposed in this study would provide objective information to clinicians and patients regarding the capacity to work among individuals with schizophrenia.

Data availability

The data that support the findings of this study are available upon reasonable request to the senior author, R. H. (ryotahashimoto55@ncnp.go.jp).

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Author contributions

CS designed the study and wrote the manuscript. RH supervised it. TS revised the draft critically for important intellectual content. JM, HY, MF, and YY collected data. SI reviewed the analyses. All authors contributed to the manuscript writing.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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