

Depressive symptoms in workers with high autistic trait scores according to job stress type

Tomoko SUZUKI^{1*}, Koji WADA^{1,2}, Michiko NAKAZATO³, Toshiyuki OHTANI⁴,
Yoko YOSHINAGA^{2,5}, Basilua Andre MUZEMBO⁶, Januka KHATIWADA¹,
Nattadech CHOOMPLANG¹, Ariuntuul GARIDKHUU¹ and Shunya IKEDA^{1,2}

¹Department of Public Health, School of Medicine, International University of Health and Welfare, Japan

²Department of Social Medical Sciences, Graduate School of Medicine, International University of Health and Welfare, Japan

³Department of Psychiatry, School of Medicine, International University of Health and Welfare, Japan

⁴Safety and Health Organization, Chiba University, Japan

⁵Medical Affairs, R&D Japan, Amgen K.K, Japan

⁶Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, Japan

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Abstract: Individuals with high levels of autistic traits are at a high risk of experiencing depressive symptoms, and are also vulnerable to job stress. This study aimed to identify which combination of autistic traits and type of job stress are related to depressive symptoms. Participants comprised 992 workers from different regions of Japan. Autistic traits, depressive symptoms, and job stress were measured using the Autism-Spectrum Quotient, K6 scale, and Job Content Questionnaire, respectively. Logistic regression was performed to estimate the odds ratio and 95% confidence interval. Workers with high autistic traits scores reported significantly more depressive symptoms for all job stress types, especially high job demand. Depressive symptoms differed according to autistic traits and job stress. In workers with high autistic trait subscale scores, those with active job stress reported more depressive symptoms than those with high strain job stress, except for the “poor imagination” trait. This is contrary to previous reports that the active stress type is generally less associated with depressive symptoms than the high-strain stress type. To prevent depressive symptoms in workers with high autistic trait scores, it is important to understand which combination of autistic traits and type of job stress contribute to depressive symptoms.

Key words: Active stress, Autistic traits, Depression, Depressive symptoms, High strain, Job control, Job demand, Job stress

Introduction

Individuals with autism spectrum disorder (ASD) are at a high risk of associated psychiatric disorders, particularly depression^{1–6}. The meta-analytic pooled estimates of cur-

*To whom correspondence should be addressed.

E-mail address: tsuzuki2992@gmail.com, tsuzuki7@iuhw.ac.jp

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rent and lifetime depression prevalence for adults with ASD are 23% and 37%, respectively⁷). Depression is common in adults with ASD. It has also been reported in individuals with high autistic trait scores (but no ASD). Young adults with strong autistic traits but no ASD diagnosis experience more psychiatric and psychosocial problems, including depression⁸). There is also an association between autistic traits and depression in university students⁹). Furthermore, workers with higher total autistic trait scores are also substantially more likely to have depressive symptoms¹⁰).

Stress has been identified as a risk factor for depression¹¹), and adults with ASD experience more stress than healthy volunteers¹²). A possible mechanism underlying this association is that individuals with autistic traits are more likely to develop affective symptoms following exposure to life stressors, because of their impaired ability to cope with environmental changes and stressful situations⁸.¹¹). One stress-management model of job strain (job demand-control model) predicts that mental strain results from the interaction between job demands and job control¹³.¹⁴). The most adverse psychological strain reactions occur when job demand is high and job control is low^{13, 15}), and increase the risk of developing depressive symptoms and depression^{16, 17}). Conversely, high job control was found to be a risk factor for poor health-related quality of life among workers with high autistic trait scores, although high job control was linked preventively to poor health-related quality of life for workers with low autistic trait scores¹⁸). A low job control working environment (i.e., a structured environment with some type of external framework that defines work procedures, work schedules, and workloads) tends to be easier to adapt to than a high job control working environment for individuals with high levels of autistic traits, because the structured environment increases predictability and reduces stress^{18, 19}). Therefore, it is possible that high job control is a risk factor for depression among workers with high levels of autistic traits.

Previous studies on the association of some types of autistic traits with mental health have found that this association differs according to trait. The traits fascination for numbers and patterns, preference for routine, difficulties with social skills, and attention-switching difficulties are independently associated with depressive symptoms; however, the trait difficulty with imagination is not independently associated with depressive symptoms¹⁰). The traits high scores of preference for routine, difficulties with social skills, and attention-switching difficulties are associated with poor student performance²⁰). Individuals with

ASD are at higher risk of developing trauma- and stress-related disorders owing to their proneness to rumination^{21, 22}). The strongest predictors of suicidality score are scores on the autistic trait domains restricted interests and rumination²³). Highly functional adults with less social disability are more likely to be depressed⁵).

Previous studies have reported that individuals with high levels of autistic traits are at a high risk of experiencing depression, and are also vulnerable to job stress. However, it is unclear which combinations of autistic trait and job stress type are related to depression. It is important to address this question so that an environment adapted to the workplace can be created for workers with high autistic trait scores. This study aimed to identify which autistic traits and which type of job stress are related to depressive symptoms in Japanese workers. We attempted to reduce confounding factors by targeting individuals who had graduated from university, were regular staff, and were not currently taking work leave.

Methods

Participants

Participants comprised Japanese workers who completed a self-administered Internet-based questionnaire survey in March 2019. The sample was drawn from a pool of individuals who had previously registered with a Japanese online survey company (Macromill Inc., Tokyo, Japan), comprising approximately 1.2 million registered members across all Japanese prefectures. Of the approximately 450,000 registered workers aged 20 to 69 years, 86,880 workers were randomly selected and were invited by email to participate in the study. Screening was conducted using the following eligibility criteria: aged 20 to 69 years, university graduate or higher, regular staff, and not currently taking leave from work. These criteria were applied to reduce the effects of confounding factors (education level and employment status).

A total of 11,898 workers responded to the screening and 2,658 met the eligibility criteria. Of these, 1,934 workers were randomly selected and given access to the self-report questionnaire. The questionnaire was configured to automatically finish when all responses had been completed. The survey was closed when 1,284 workers had completed the questionnaire, and 1,240 answers were delivered by the survey company. Because this study aimed to identify the association between autistic traits, depressive symptoms, and job stress, the number of each gender and age group were the same to eliminate the influence of gender and age,

which are generally biased. The male:female ratio was 1:1, and there was an equal number of participants in each age group (20–29, 30–39, 40–49, 50–59, and 60–69 years). Since the normal retirement age in Japan is 60 or 65 years, when workers over 60 years old were excluded from the total of 1,240, the final analysis target was 992.

Sociodemographic characteristics

The participants were surveyed using a self-administered questionnaire. Sociodemographic characteristics recorded comprised age, gender, presence of children, socioeconomic status (i.e., occupational position and annual household income), and health-related behaviors (i.e., drinking habits, smoking habits, leisure-time physical activity, and sleep time). Presence of children was classified into two categories, “yes” or “no.” Occupational position was classified into two categories, “president, executive or chief director-level,” and “section chief, chief clerk-level, or no position.” Annual household income was classified into three categories: <6 million yen, 6–10 million yen, and ≥10 million yen (yen = Japanese yen; 100 yen is approximately equal to 1 USD). Smoking habits were classified into two categories, current smoking and non-current smoking. Drinking habits were classified into two categories, almost every day, and rarely or sometimes. Leisure-time physical activity was classified into two categories, “yes” (from light physical activity 1 or more times a week to intense physical activity 3 or more times a week) and “no activity.” Sleep time per day was classified into two categories, <5 hours and ≥5 hours.

Autistic traits

The Autism-Spectrum Quotient (AQ), which is used to evaluate autistic traits, is a self-administered test that measures the degree to which an adult with normal intelligence has ASD-associated traits²⁴. The AQ is a 50-item questionnaire on a 4-point Likert scale and measures five different areas (10 items represent each subscale): Social skills, Attention-switching, Attention to detail, Communication, and Imagination. A score of 1 is assigned to the responses “definitely agree” and “slightly agree” and a score of 0 for “slightly disagree” and “definitely disagree” for half the items. To avoid response bias, the remaining items are reverse scored. Total scores could therefore range from 0 to 50; higher scores indicate higher autistic trait levels. A score of 1 for each item indicates mild or strong abnormal or autistic-like behavior (Abnormality = poor social skills, poor attention-switching/strong focus of attention, exceptional attention to detail, poor communication skills, poor

imagination). A psychometric study of the AQ indicated good test–retest reliability and internal consistency²⁴. We used the Japanese version of the AQ, translated by Wakabayashi *et al.*²⁵, for which the validity and reliability have been confirmed. In the present study, the AQ subscale scores were used to assess specific autistic traits. The highest quartile represented highly autistic trait scores/autistic subscale trait scores and the other quartiles represented non-highly autistic trait scores/autistic subscale trait scores; this was based on a previous study²⁶ because we could not find an appropriate study with an AQ subscale cutoff score. The highest quartile in this study had an AQ score ≥26. A cutoff score of 26 was previously reported to have good discriminative validity and screening properties²⁷. A score ≥32 in the original English version²⁴ and a score ≥33 in Japanese version developed by Wakabayashi *et al.*²⁵ was initially suggested to indicate the likely presence of ASD. In this study, we also examined results with a cutoff score ≥33.

Depressive symptoms

Depressive symptoms were measured using the Japanese version of the Kessler Psychological Distress Scale (K6) scale^{28, 29}, which consists of six items assessing the frequency with which respondents had experienced symptoms of psychological distress (e.g., “feeling so sad that nothing can cheer you up”) during the preceding 30 days. The response options range from 0 (none of the time) to 4 (all of the time); total possible scores range from 0 to 24. The reliability and validity of the original K6 versions have been demonstrated repeatedly in the USA and Australia^{30, 31}. The K6 scale has been translated into Japanese and its validity demonstrated for mood and anxiety disorders diagnosed by a lay interviewer in a community sample²⁸. This version demonstrated a screening performance equivalent to that of the original English version³². Depressive symptoms were considered present in subjects with K6 scores ≥ 13³⁰.

Job strain

Job strain was measured using the Job Content Questionnaire (JCQ) scales of job demands and job control^{13–15}. Job demand is assessed using five questions (response range 12–48) and job control is assessed with nine questions (response range 24–96), with four-point response options from 1 (strongly disagree) to 4 (strongly agree). The Japanese version of the scales showed acceptable reliability and validity in a previous study³³. We created four job strain categories according to the job demand-control model described by Karasek. Four job strain quadrants were con-

structured: passive (low job demands and low job control), low strain (low job demands and high job control), high strain (high job demands and low job control) and active (high job demands and high job control). To create “high” and “low” variables for the four quadrants of the demand-control model, scores on the two dimensions (demands and latitude) were divided at the median point of the overall sample distribution.

Sample size

The sample size was estimated based on our previous studies among workers, which were as follows: 6% of workers answered that they had depressive symptoms (K6 scores ≥ 13), and the odds ratio was 3 in the highest autistic trait score quartile (unpublished). Assuming an alpha error of 0.05 and a power of 80%, the required sample size was calculated to be 952 workers. The target number of workers per group was 120, because the required number of workers in each group was calculated to be 119 in a total of 8 groups aged from their 20s to 50s and by gender. Eventually, data collection was stopped when 124 workers in one group answered. The total number of workers in this study was 992.

Statistical analysis

Categorical variables are presented as percentages. The χ^2 -test was used to compare subjects with depressive symptoms (K6 ≥ 13) with those without depressive symptoms. Variables that were significant in the comparisons between the presence or absence of depressive symptoms, age, and gender were used as adjusting factors in the multivariate analysis. Logistic regression was performed to estimate the odds ratio (OR) and 95% confidence interval (CI) of depressive symptoms for the highest quartile of the autistic traits or autistic trait subscale scores, taking the other quartiles of the autistic traits or autistic trait subscale scores as the reference. If the OR is greater than 1, it means that there are more reports of depressive symptoms compared to the reference. Univariate analysis was first performed, and then the multivariate-adjusted model was adjusted for age, gender, children (with vs. without), annual household income (<6 million yen, 6–10 million yen, and ≥ 10 million yen), and sleep time (<5 hours a day). Additionally, all five autistic trait subscales were entered simultaneously into the model to check if the traits were independently associated with depressive symptoms for each subscale analysis. Two-tailed *p* values of <0.05 were considered statistically significant. All analyses were conducted using SPSS (version 24 for Windows, IBM Inc., New York, USA).

Ethics statement

Ethical approval was obtained from the International University of Health and Welfare Ethics Committee (No. 18-Im-017). The study was conducted in accordance with the standards specified in the 1964 Declaration of Helsinki. Participant responses implied voluntary consent for participation. Individuals who agreed to participate were then directed to complete an anonymous online questionnaire. International University of Health and Welfare Ethics Committee waived the need for written informed consent from the participants.

Results

Participant demographics are shown in Table 1. A total of 992 workers participated in this study, and nearly half had children. The most common occupational position was section chief, chief clerk-level, or no position, and annual household income for almost half the workers was <6 million yen. Regarding lifestyle factors, one-sixth of workers were currently smoking, one-sixth drank almost every day, over half of workers reported no leisure-time physical activity, and less than one-tenth slept <5 hours a day.

Table 2 shows participant characteristics dichotomized according to the presence or absence of depressive symptoms (K6 ≥ 13). Compared with participants who did not report depressive symptoms, those with depressive symptoms were likely to have no children, to have lower annual household income, and to sleep <5 hours a day. Regarding mental health factors, participants with depressive symptoms were more likely to be stressed at work (passive, active, and high strain, $p=0.042$), and were likely to have high scores of any autistic traits or autistic trait subscales (Attention to detail trait: $p=0.005$, Autistic traits and the other autistic trait subscales were all $p<0.001$).

Table 3 shows the ORs for depressive symptoms (K6 ≥ 13) according to the autistic trait scores and job stress, taking non-high autistic trait scores/autistic trait subscale scores with low strain as the reference. The results of the analysis of autistic trait scores (AQ cutoff score of 26) after adjustment for possible confounding factors were as follows. For workers with non-high autistic trait scores, there was no significant difference in depressive symptoms for any job stress type (although the significance was borderline for active job stress). However, workers with high autistic trait scores reported 3.69 to 7.97 times more depressive symptoms for all job stress types, even low strain, compared with the reference (low strain: OR=3.69, 95% CI: 1.27–

Table 1. Participant sociodemographic characteristics (n=992)

		n (%)
Age range (years)	20–29	248 (25.0)
	30–39	248 (25.0)
	40–49	248 (25.0)
	50–59	248 (25.0)
Gender	Male	496 (50.0)
Presence of children	Yes	425 (42.8)
Occupational position	President, executive or Chief director-level	107 (10.8)
	Section chief, chief clerk-level or no position	885 (89.2)
Annual household income (yen)	<6 million	447 (45.1)
	6–10 million	341 (34.4)
	≥10 million	204 (20.6)
Smoking habit	Current smoking	165 (16.6)
Drinking habits	Almost everyday	175 (17.6)
Leisure-time physical activity	No	539 (54.3)
Sleeping time (hours a day)	<5	84 (8.5)

10.76, passive: OR=4.82, 95% CI: 1.88–12.33, active: OR=7.97, 95% CI: 3.06–20.78, and high strain: OR=7.14, 95% CI: 2.79–18.28). Furthermore, the ORs increased in the order of low strain, passive, and active/high strain, and the OR for active stress type was approximately 1.7 times higher than that for passive.

Using an AQ cutoff score of 33 after adjustment for possible confounding factors, workers with non-high autistic trait scores reported 1.86 to 2.25 times more depressive symptoms for all job stress types compared with the reference group (low strain), although there was no significant association for passive job stress. Workers with high autistic trait scores reported 2.79 to 15.79 times more depressive symptoms for all job stress types (although this was not significant for low strain and high strain), and the OR for active stress type was approximately 3.3 times higher than that for passive stress type.

The results of the autistic trait subscale analysis after adjustment for possible confounding factors, entering all five autistic trait subscales simultaneously, were as follows. Regarding the Social skills trait, for workers with non-high autistic trait scores, there was no significant difference in depressive symptoms for any job stress type. However, workers with high autistic trait scores reported significantly more depressive symptoms for all job stress types, except low strain. Regarding the Attention-switching trait, both workers with non-high and those with high trait scores reported significantly more depressive symptoms for all job stress types compared with the reference. Regarding the Attention to detail trait, for workers with non-high trait scores, no significant difference in depressive symptoms

was reported for passive or active stress types, although workers with high strain reported significantly more depressive symptoms. However, workers with high trait scores reported significantly more depressive symptoms for all job stress types, except low strain. Furthermore, the OR for active stress type was approximately 2 times higher than that for high strain. Regarding the Communication trait, for workers with non-high trait scores, no significant difference in depressive symptoms was reported for passive stress types, although workers with active and high strain reported significantly more depressive symptoms. However, workers with high trait scores reported significantly more depressive symptoms for all job stress types, except high strain. Regarding the Imagination trait, for workers with non-high trait scores, no significant difference in depressive symptoms was reported for any job stress type. For workers with high trait scores, no significant difference in depressive symptoms was reported at low strain or passive stress types, although workers with active and high strain types reported significantly more depressive symptoms.

Discussion

We examined the vulnerability to depressive symptoms in 992 regular workers (who were sampled from across Japan and had a university education or higher) with high autistic traits or autistic trait subscale scores according to job stress type. Workers with non-high autistic trait scores (AQ score <26) reported no significant difference in depressive symptoms for any job stress type. However, work-

Table 2. Participant sociodemographic characteristics according to presence/absence of depressive symptoms (n=992)

		Depressive symptoms		<i>p</i>
		Yes (K6≥13)	No (K6<13)	
		113 (11.4)	879 (88.6)	
Age range (years)	20–29	36 (14.5)	212 (85.5)	0.131
	30–39	32 (12.9)	216 (87.1)	
	40–49	23 (9.3)	225 (90.7)	
	50–59	22 (8.9)	226 (91.1)	
Gender	Male	60 (12.1)	436 (87.9)	0.484
	Female	53 (10.7)	443 (89.3)	
Presence of children	Yes	38 (8.9)	387 (91.1)	0.035
	No	75 (13.2)	492 (86.8)	
Occupational position	President, executive or Chief director-level	7 (6.5)	100 (93.5)	0.095
	Section chief, chief clerk-level or no position	106 (12.0)	779 (88.0)	
Annual household income (yen)	< 6 million	62 (13.9)	385 (86.1)	0.012
	6–10 million	39 (11.4)	302 (88.6)	
	≥ 10 million	12 (5.9)	192 (94.1)	
Smoking habit	Current smoking	21 (12.7)	144 (87.3)	0.554
	Other	92 (11.1)	735 (88.9)	
Drinking habits	Almost everyday	18 (10.3)	157 (89.7)	0.612
	Other	95 (11.6)	722 (88.4)	
Leisure-time physical activity	Yes	43 (9.5)	410 (90.5)	0.084
	No	70 (13.0)	469 (87.0)	
Sleeping time (hours a day)	<5	17 (20.2)	67 (79.8)	0.008
	≥5	96 (10.6)	812 (89.4)	
Stress factor	Low strain	15 (6.4)	221 (93.6)	0.042
	Passive	31 (12.0)	228 (88.0)	
	Active	36 (13.2)	236 (86.8)	
	High strain	31 (13.8)	194 (86.2)	
Autistic trait scores	High (≥26)	58 (20.5)	225 (79.5)	<0.001
	Non-high (<26)	55 (7.8)	654 (92.2)	
	High (≥33)	14 (28.0)	36 (72.0)	<0.001
	Non-high (<33)	99 (10.5)	843 (89.5)	
Autistic trait subscale scores				
Social skill trait	High (≥7)	51 (17.4)	242 (82.6)	<0.001
	Non-high (<7)	62 (8.9)	637 (91.1)	
Attention switching trait	High (≥6)	53 (18.0)	241 (82.0)	<0.001
	Non-high (<6)	60 (8.6)	638 (91.4)	
Attention to detail trait	High (≥6)	47 (15.7)	252 (84.3)	0.005
	Non-high (<6)	66 (9.5)	627 (90.5)	
Communication trait	High (≥7)	43 (19.8)	174 (80.2)	<0.001
	Non-high (<7)	70 (9.0)	705 (91.0)	
Imagination trait	High (≥7)	42 (18.8)	182 (81.3)	<0.001
	Non-high (<7)	71 (9.2)	697 (90.8)	

n (%); Inequalities in parentheses indicate the range; Difference in proportions was assessed using the χ^2 test; Abnormal response on each autistic trait subscale (Social skills: poor social skills, Attention switching: poor attention-switching/strong focus of attention, Attention to detail: exceptional attention to detail, Communication: poor communication skills, Imagination: poor imagination).
High: highest autistic trait (subscale) score quartile; Non-high: others.

Table 3. Odds ratios for depressive symptoms (K6 \geq 13) according to autistic trait scores and job stress type (n=992)

Autistic trait scores	Job stress	Crude		Multivariate-adjusted		
		OR (95%CI)	<i>p</i>	OR (95%CI)	<i>p</i>	
Autistic traits						
Non-high (<26)	Low strain	ref.		ref.		
	Passive	2.29 (0.91–5.78)	0.078	2.13 (0.84–5.40)	0.111	
	Active	2.50 (1.03–6.06)	0.043	2.45 (1.00–5.97)	0.050	
High (\geq 26)	High strain	2.22 (0.86–5.71)	0.099	1.96 (0.76–5.10)	0.166	
	Low strain	3.53 (1.23–10.20)	0.020	3.69 (1.27–10.76)	0.017	
	Passive	5.30 (2.09–13.44)	<0.001	4.82 (1.88–12.33)	0.001	
Non-high (<33)	Active	8.48 (3.29–21.87)	<0.001	7.97 (3.06–20.78)	<0.001	
	High strain	7.95 (3.15–20.06)	<0.001	7.14 (2.79–18.28)	<0.001	
	Low strain	ref.		ref.		
High (\geq 33)	Passive	2.01 (1.01–4.00)	0.047	1.86 (0.93–3.73)	0.080	
	Active	2.11 (1.07–4.15)	0.031	2.00 (1.01–3.97)	0.047	
	High strain	2.52 (1.27–4.99)	0.008	2.25 (1.12–4.49)	0.022	
High (\geq 33)	Low strain	2.94 (0.59–14.66)	0.189	2.79 (0.55–14.18)	0.215	
	Passive	5.87 (1.64–21.00)	0.006	4.75 (1.30–17.33)	0.018	
	Active	16.15 (4.57–57.10)	<0.001	15.79 (4.40–56.64)	<0.001	
High (\geq 33)	High strain	4.04 (0.78–20.98)	0.097	3.11 (0.58–16.64)	0.185	
	Autistic trait subscales					
	Social skill traits					
Non-high (<7)	Low strain	ref.		ref.		
	Passive	1.86 (0.77–4.52)	0.168	1.50 (0.61–3.72)	0.380	
	Active	2.27 (0.98–5.26)	0.056	2.26 (0.95–5.37)	0.064	
High (\geq 7)	High strain	2.67 (1.13–6.33)	0.026	2.29 (0.94–5.56)	0.067	
	Low strain	2.24 (0.78–6.45)	0.134	1.85 (0.62–5.53)	0.269	
	Passive	4.68 (1.91–11.44)	0.001	3.46 (1.35–8.91)	0.010	
High (\geq 7)	Active	5.73 (2.30–14.29)	<0.001	4.32 (1.65–11.25)	0.003	
	High strain	4.31 (1.70–10.91)	0.002	3.17 (1.20–8.35)	0.020	
	Attention switching traits					
Non-high (<6)	Low strain	ref.		ref.		
	Passive	3.14 (1.21–8.16)	0.019	2.82 (1.07–7.43)	0.036	
	Active	3.35 (1.32–8.55)	0.011	3.48 (1.34–9.01)	0.010	
High (\geq 6)	High strain	3.79 (1.45–9.86)	0.006	3.29 (1.24–8.71)	0.017	
	Low strain	5.71 (1.93–16.85)	0.002	3.58 (1.17–11.00)	0.026	
	Passive	5.83 (2.16–15.79)	0.001	3.19 (1.13–9.03)	0.028	
High (\geq 6)	Active	7.53 (2.82–20.09)	<0.001	5.01 (1.83–13.74)	0.002	
	High strain	6.48 (2.39–17.60)	<0.001	4.10 (1.46–11.54)	0.007	
	Attention to detail traits					
Non-high (<6)	Low strain	ref.		ref.		
	Passive	1.83 (0.80–4.20)	0.152	1.54 (0.66–3.60)	0.320	
	Active	1.79 (0.77–4.12)	0.175	1.82 (0.77–4.32)	0.172	
High (\geq 6)	High strain	2.65 (1.18–5.95)	0.018	2.32 (1.01–5.32)	0.047	
	Low strain	1.53 (0.53–4.48)	0.435	1.88 (0.62–5.67)	0.262	
	Passive	3.71 (1.51–9.13)	0.004	3.52 (1.37–9.04)	0.009	
High (\geq 6)	Active	4.45 (1.92–10.32)	<0.001	5.64 (2.35–13.57)	<0.001	
	High strain	2.96 (1.12–7.86)	0.029	2.77 (1.01–7.65)	0.049	
	Communication traits					
Non-high (<7)	Low strain	ref.		ref.		
	Passive	2.03 (0.80–5.16)	0.135	1.77 (0.69–4.54)	0.237	
	Active	3.26 (1.38–7.69)	0.007	3.21 (1.34–7.69)	0.009	
High (\geq 7)	High strain	3.93 (1.64–9.40)	0.002	3.22 (1.32–7.85)	0.010	
	Low strain	4.73 (1.63–13.76)	0.004	3.21 (1.06–9.69)	0.039	
	Passive	8.16 (3.21–20.72)	<0.001	4.79 (1.81–12.67)	0.002	
High (\geq 7)	Active	7.71 (2.74–21.69)	<0.001	4.17 (1.41–12.32)	0.010	
	High strain	4.52 (1.56–13.12)	0.006	2.86 (0.94–8.73)	0.065	

Table 3. Continued

Autistic trait scores	Job stress	Crude		Multivariate-adjusted	
		OR (95%CI)	<i>p</i>	OR (95%CI)	<i>p</i>
Imagination traits					
Non-high (<7)	Low strain	ref.		ref.	
	Passive	1.76 (0.81–3.80)	0.152	1.56 (0.71–3.45)	0.269
	Active	1.93 (0.92–4.03)	0.081	1.91 (0.90–4.09)	0.094
High (≥7)	High strain	1.68 (0.76–3.73)	0.204	1.51 (0.67–3.43)	0.320
	Low strain	1.31 (0.40–4.30)	0.655	1.03 (0.30–3.52)	0.962
	Passive	3.25 (1.36–7.77)	0.008	2.09 (0.84–5.23)	0.115
	Active	5.41 (2.16–13.52)	<0.001	3.59 (1.37–9.42)	0.009
	High strain	5.36 (2.30–12.49)	<0.001	3.66 (1.50–8.92)	0.004

Abnormal response on each autistic trait subscale (Social skills: poor social skills, Attention switching: poor attention-switching/strong focus of attention, Attention to detail: exceptional attention to detail, Communication: poor communication skills, Imagination: poor imagination); OR: odds ratio; CI: confidence interval; High: highest autistic trait scores/autistic trait subscale scores quartile; Non-high: other autistic trait scores/autistic trait subscale scores quartiles.

Logistic regression was performed to estimate the OR and 95% CI of depressive symptoms (K6≥13) taking as the reference the other autistic traits scores/autistic trait subscale scores quartiles with low strain.

The multivariate-adjusted model was adjusted for age, gender, children (with vs. without), annual household income (<6 million yen, 6–10 million yen, and ≥10 million yen), and sleep time (<5 hours a day). Five autistic trait subscales were entered simultaneously for each subscale analysis.

ers with high autistic trait scores (AQ score ≥26) reported significantly more depressive symptoms at all job stress types, even low strain, compared with the reference of non-high autistic trait scores and low strain job stress. Furthermore, greater job stress was associated with a greater risk of depressive symptoms, especially when job demand was high (active and high strain types). Depressive symptoms differed according to the type and scores of autistic traits and job stress, classified into six patterns. A distinctive characteristic among the patterns was that workers with active stress reported more depressive symptoms than those with high strain in workers with high autistic trait scores, especially for the Attention to detail and Communication traits (but not for the Imagination trait), contrary to previous reports^{13, 15)} that the active stress type is generally less associated with depressive symptoms than the high-strain stress type.

Workers with non-high autistic trait scores (AQ score <26) seemed to be stress resistant, because no significant difference in depressive symptoms was reported for any job stress types. However, workers with high autistic trait scores (AQ score ≥26) seemed to be at high risk of depressive symptoms, even in less stressful workplaces (i.e., low strain job stress type), because such workers reported significantly more depressive symptoms for all job stress types. Therefore, it can be assumed that workers with high autistic trait scores need to be careful even in a less stressful

workplace. Additionally, workers with high autistic trait scores appear to be more vulnerable to stress than those with low autistic trait scores. Our results support previous study findings that individuals with high levels of autistic traits are more likely to have depressive symptoms/depression^{8–10)}, and that individuals with high autistic trait levels are susceptible to the effects of stress^{8, 11)}. Furthermore, workers with high autistic trait scores seemed to experience active and high strain job stress types as more stressful than the passive job stress type. A previous report indicated that high job control was a risk factor for poor health-related quality of life among workers with high autistic trait scores¹⁸⁾, although the most adverse psychological strain reactions occur when job demand is high and job control is low^{13, 15)}. Therefore, the active stress type (high job demand and high job control) is likely to be more adverse than the passive stress type (low job demand and low job control), and likely to be slightly more adverse than the high strain stress type (high job demand and low job control) in workers with high autistic trait scores. Our finding that the active stress type was likely to be more adverse than the passive stress type and high strain stress type in workers with high autistic trait scores appeared to be considerably stronger when an AQ cutoff score of 33 was used compared with an AQ cutoff score of 26.

The results of the autistic trait subscale analysis can be classified into six patterns. First, workers with the active

stress type reported more depressive symptoms than workers with high strain when the autistic trait scores were high, especially for the Attention to detail trait and Communication trait (but not for the Imagination trait). Generally, the active stress type is less associated with depression than the high strain stress type^{13, 15}. However, the present results were the opposite: the active stress type had a greater effect on depressive symptoms than the high strain stress type. Workers with high autistic traits scores appear less stressed and less at risk of depressive symptoms in workplaces with low job control (high strain stress type) compared with high job control (active stress type) when the workplace job demand is high. Conversely, a previous report suggested that high job control is stressful in workers with high autistic trait scores, as high job control is associated with poor physical health-related quality of life among workers with high autistic trait scores¹⁸. High job control scores on the JCQ indicate skill discretion (i.e., the flexibility that enables a worker to decide what type of skills and creativity to use) and decision authority (i.e., a worker's ability to make decisions about their work)^{13, 15}. Workers with high autistic trait scores tend to do better in a lower job control working environment, such as a structured environment (e.g., fixed work procedures and fixed work schedules)¹⁸.

Second, no significant difference in depressive symptoms was reported for any job stress types at non-high scores in the Social skills trait and Imagination trait. These results indicate that workers with low scores in these traits are stress resistant, because there was no significant difference in the risk of depressive symptoms between high stress and low stress types as a reference (low strain).

Third, workers with high Attention-switching and Communication trait scores reported significantly more depressive symptoms, even at low strain. This indicates that workers with high scores in these traits, even in less stressful workplaces, are at higher risk of depressive symptoms than workers with low scores in these traits. Therefore, such workers must be careful even in a less stressful workplace.

Fourth, workers with high Social skills and Attention to detail trait scores reported significantly more depressive symptoms for all job stress types, except low strain, compared with workers with low scores in these traits. These results indicate that workers with high scores in these traits are vulnerable to stress and prone to depressive symptoms under stress.

Fifth, in workers with high autistic trait subscale scores (except for the Communication trait), those who experienced active stress reported more depressive symptoms

than those who experienced passive stress. This suggests that job demand affects the risk of depressive symptoms more than job control.

Sixth, workers with high Imagination trait scores reported significantly more depressive symptoms only for the active or high strain stress types, and both stress types showed similar ORs. These results indicate that workers with a high Imagination trait scores are resistant to passive stress types, but vulnerable to active or high strain stress types. This is unaffected by job control but vulnerable to job demand. These results are slightly inconsistent with our previous findings that the Imagination trait score was not independently associated with depressive symptoms¹⁰. The autistic trait symptom of imagination impairment involves an impairment of the ability to imagine others' thoughts, or to identify appropriate behavior in a situation¹¹. Individuals who lack such skills may be free from interpersonal conflicts and/or relationship stress, which are major stressors that can induce depressive symptoms¹⁰. Although our previous results did not take job stress into account, it seems that low job demand does not affect depressive symptoms, but high job demand is associated with a greater risk of depressive symptoms.

The study implications are that depressive symptoms differ according to job stress type and type of autistic trait. It is important for workers with high autistic scores to be aware of which combination of autistic trait and job stress type lead to a greater risk of depressive symptoms, so that an environment that can be adapted to the workplace can be created. Creating an appropriate work environment that suits each different pattern of high autistic trait scores could prevent depressive symptoms, and a suitable work environment with less risk of depressive symptoms would make it easier for workers to demonstrate their abilities. Workplace improvements, such as conducting AQ screening and creating work routines, are conceivable. Autistic traits could be evaluated using AQ screening, and managers could consult workers with high autistic trait scores in the concerned subscales who are suspected of having depressive symptoms. If the workers are stressed by an active job, especially with a high job latitude, then managers could add more routine to reduce job latitude (job control).

Limitations

There were some potential study limitations that must be considered. First, the questionnaire was online, so the sample may have been biased toward individuals more familiar with the Internet. Second, our questionnaire may be less

appropriate for participants with a low IQ, as it required a certain degree of reading comprehension skills. The participants in our study therefore, presumably comprised those with typical intelligence levels.

Conclusions

The effect of high autistic trait scores on depressive symptoms differed according to the type of job stress among Japanese regular workers with university education. Workers with non-high autistic trait scores reported no significant difference in depressive symptoms for any job stress type. However, workers with high autistic trait scores reported significantly more depressive symptoms for all job stress types, even low strain. Furthermore, greater job stress was associated with a greater risk of depressive symptoms, especially when job demand was high. Autistic trait subscale analysis showed that depressive symptoms reports differed according to the type and scores of autistic traits and job stress, which could be classified into six patterns. Of these, workers with the active stress type reported more depressive symptoms than workers with high strain when the autistic trait subscale scores were high (except for the Imagination trait), contrary to previous reports that the active stress type is generally less associated with depressive symptoms than the high-strain stress type. To prevent mental health problems, it is important for workers with high autistic trait scores to know which combination of autistic trait and job stress type are associated with a greater risk of depressive symptoms.

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Conflict of Interest

YY declares no direct conflict of interest related to this article. On behalf of all authors, the corresponding author states that there is no conflict of interest.

Author Contributions

TS conceived the study. TS, SI, KW, MN, and TO designed the protocol. TS enrolled participants, and participated in data collection. TS was responsible for the statistical analysis and drafting of the manuscript. KW, TO, SI, and MN were the advisors for the whole study and completed the manuscript. YY, BA, JK, NC, and AG gave valuable advice and revised the manuscript for important intellectual content. All authors were involved in the data interpretation and contributed to preparing the manuscript.

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