Perceived job stress and mental health in precision machine workers of Japan: a 2 year cohort study

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Abstract
Objectives—To determine whether perceived job stress affects mental health in occupational settings.
Methods—A 2 year cohort study was conducted. Initially, a survey including the general health questionnaire (GHQ) and a questionnaire about perceived job stress was carried out. Of 462 workers who initially showed a GHQ score of ≤7 310 were successfully followed up for 2 years. The 2 year risks of developing mental ill health (a GHQ score ≥8) were assessed relative to perceived job stress. To control for potential confounding factors, multiple logistic regression analyses were conducted.
Results—The overall 2 year risk for developing mental ill health was high at 57.7%. Workers who reported aspects of perceived job stress showed a greater 2 year risk than those without stress. Multiple logistic regression analyses showed that some components of perceived job stress were associated with a higher 2 year risk, among which "not allowed to make mistakes" showed the largest adjusted odds ratio (OR) (95% confidence interval (95% CI)) of 2.37 (1.32 to 4.29). "Poor relationship with superior" had a significant effect on mental health only in women, with an adjusted OR (95% CI) of 3.79 (1.65 to 8.73).
Conclusions—Certain specific items of perceived job stress seem to be associated with mental ill health in workers. These could broadly be described as job strain, or job demand items. The type of job stress that predicts mental health may be dependent on the characteristics of the workplace investigated.
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Keywords: job stress; mental health; cohort study

Mental health in the workplace has recently attracted attention, and an appreciable proportion of workers have been reported as having mental disorders.[1] Studies have also shown that mental disorders—such as depression—have a marked economic impact—for example, as assessed by days lost from work.[2 3]

0n the other hand, job stress has been recently regarded as a risk factor for some disorders—for example, cardiovascular diseases.[4] In mental disorders, psychosocial stress—such as life events—has been indicated as a risk factor, and job stress has been included in this.[5] Job stress is therefore likely to be an important risk factor for mental disorders—

such as depression. However, most of these studies did not clarify the nature of the job stress.[6–8] Among studies that did identify individual aspects of job stress associated with mental health, the findings have been inconsistent.[9–16] Also, the study design has usually been cross sectional,[6 7 13 14] which has limits when the cause-effect relation between job stress and mental health is evaluated. In this cohort study, we examined the individual aspects of job stress and evaluated their effects on mental health.

Subjects and methods
SUBJECTS
Of 782 workers at a precision machine production company, those who were mentally healthy at the time of the initiation of this study were included as subjects.

STUDY DESIGN AND MEASUREMENT
The design was a cohort study. At the start of the study, the subjects filled out a questionnaire on the state of mental health, perceived job stress, and other related factors. The questionnaire consisted of the Japanese version of the 30 item general health questionnaire (GHQ-30),[17 18] a 13 item questionnaire covering measurement of perceived job stress,[19] the degree of satisfaction with family life, perceived physical health, sex, and age. The contents of this questionnaire have been described in detail in our previous report.[13] For the subsequent 2 years, the mental health was assessed by a similar questionnaire at 6 month intervals. Consequently, similar questionnaire surveys were conducted 6, 12, 18, and 24 months after the initial survey. Subjects scoring ≤7 on the GHQ were defined as healthy.[20]

Of the 782 workers, 763 (97.6%) satisfactorily replied to the initial questionnaire. Of the 763 workers, the 462 (202 men and 260 women) who were considered to be mentally healthy were used as the subjects of this study. Of the 462 workers, 310 (145 men, 164 women, and one sex unknown) who satisfactorily replied to all four subsequent questionnaires were used as the subjects for analysis. The response rate was, therefore, 67.1% (71.3% in the men; 63.1% in the women).

METHODS OF ANALYSIS
To evaluate the representativeness of the subjects, sex, age, and marital status were first compared between workers who could be followed up and those who were lost, with the χ^2 test.

Workers who showed a GHQ score ≥8 in at least one of the follow up questionnaires

Table 1 Two year risks of developing psychological ill health in relation to perceived job stress

Perceived job stress item	Two year risk (%)		RR (95% CI)
	Stress group	Non-stress group	
1 Too much competitition	46/85 (54.1)	131/223 (58.7)	0.90 (0.68 to 1.19)
2 Too much work	120/197 (60.9)	58/113 (51.3)	1.25 (0.96 to 1.61)
3 Too little work	40/65 (61.5)	137/241 (56.8)	1.12 (0.80 to 1.58)
4 Schedule is too tight or pressed to work too hard	127/204 (62.3)	52/106 (49.1)	1.35 (1.04 to 1.74)
5 Too much trouble at work	119/182 (65.4)	59/128 (46.1)	1.56 (1.21 to 2.01)
6 Too much responsibility	101/153 (66.0)	76/154 (49.4)	1.49 (1.14 to 1.95)
7 Work hours too long	70/117 (59.8)	107/190 (56.3)	1.09 (0.83 to 1.43)
8 Poor relationships with superiors	57/82 (69.5)	119/224 (53.1)	1.54 (1.07 to 2.19)
9 Feel pressed for time	123/204 (60.3)	55/105 (52.4)	1.20 (0.92 to 1.56)
10 Are not allowed to make mistakes	148/241 (61.4)	29/68 (42.6)	1.49 (1.15 to 1.93)
11 Shortage of workers	88/143 (61.5)	89/165 (53.9)	1.20 (0.92 to 1.56)
12 Labour too strenuous	52/83 (62.7)	125/223 (56.1)	1.18 (0.86 to 1.61)
13 Cannot keep up with new technology	77/114 (67.5)	101/196 (51.5)	1.49 (1.10 to 2.02)

RR=risk ratio.

carried out at 6 month intervals for 2 years were defined as psychologically unhealthy.[20] The 2 year risks of developing this psychological ill health were calculated according to sex and age group. When a score between 8 and 9 and 9 or 10 cut off points were used, the 2 year risks were also calculated. This was done relative to perceived job stress, together with the risk ratio (RR) of the stressed group to the non-stressed group and its 95% confidence interval (95% CI). Each perceived job stress

Table 2 Two year risks of developing psychological ill health by perceived job stress and sex

Perceived job stress item	Two year risk (%)		RR (95% CI)
	Stress group	Non-stress group	
1 Too much competition:			
Male	30/55 (54.5)	55/87 (63.2)	0.81 (0.54 to 1.21)
Female	16/30 (53.3)	74/134 (55.2)	0.96 (0.63 to 1.47)
2 Too much work:			
Male	70/111 (63.1)	16/33 (48.5)	1.39 (0.92 to 2.10)
Female	49/85 (57.6)	41/79 (51.9)	1.14 (0.81 to 1.59)
3 Too little work:			
Male	21/27 (77.8)	65/115 (56.5)	1.95 (0.94 to 4.08)
Female	19/38 (50.0)	70/124 (56.5)	0.87 (0.60 to 1.27)
4 Schedule is too tight or pressed to work too hard:			
Male	80/128 (62.5)	7/16 (43.8)	1.50 (0.92 to 2.44)
Female	45/74 (60.8)	45/90 (50.0)	1.28 (0.90 to 1.81)
5 Too much trouble at work:			
Male	72/112 (64.3)	14/32 (43.8)	1.58 (1.06 to 2.34)
Female	46/69 (66.7)	44/95 (46.3)	1.61 (1.10 to 2.36)
6 Too much responsibility:			
Male	60/87 (69.0)	25/54 (46.3)	1.73 (1.16 to 2.58)
Female	40/65 (61.5)	50/99 (50.5)	1.29 (0.89 to 1.86)
7 Work hours too long:			
Male	44/72 (61.1)	41/70 (58.6)	1.07 (0.71 to 1.59)
Female	24/43 (55.8)	66/120 (55.0)	1.02 (0.69 to 1.50)
8 Poor relations with superiors:			
Male	25/40 (62.5)	60/102 (58.8)	1.10 (0.69 to 1.74)
Female	32/42 (76.2)	57/120 (47.5)	2.21 (1.25 to 3.89)
9 Feel pressed for time:			
Male	72/118 (61.0)	14/25 (56.0)	1.13 (0.69 to 1.85)
Female	49/84 (58.3)	41/80 (51.3)	1.17 (0.83 to 1.64)
10 Are not allowed to make mistakes:			
Male	70/112 (62.5)	15/31 (48.4)	1.38 (0.91 to 2.09)
Female	76/127 (59.8)	14/37 (37.8)	1.55 (1.11 to 2.15)
11 Shortage of workers:			
Male	55/90 (61.1)	30/52 (57.7)	1.09 (0.72 to 1.64)
Female	33/53 (62.3)	57/111 (51.4)	1.29 (0.87 to 1.91)
12 Labour too strenuous:			
Male	24/34 (70.6)	61/107 (57.0)	1.46 (0.83 to 2.57)
Female	28/49 (57.1)	62/114 (54.4)	1.06 (0.73 to 1.56)
13 Cannot keep up with new technology:			
Male	54/81 (66.7)	32/63 (50.8)	1.47 (0.99 to 2.20)
Female	21/31 (67.7)	69/133 (51.9)	1.49 (0.87 to 2.56)

RR=risk ratio.

was measured at three levels: always present, sometimes present, and absent, and the first two levels were considered to indicate the presence of stress. Similar analyses were performed according to sex. To control the effects of potential confounding factors such as sex, age, the degree of satisfaction with family life, and perceived physical health, multiple logistic regression analysis was performed for stress items in which the 95% CI of the 2 year RR did not include 1: these comprised "schedule is too tight, or pressed to work too hard", "too much trouble at work", "too much responsibility", "poor relationship with superiors", "not allowed to make mistakes", and "cannot keep up with new technology". Mental health over the 2 year period was entered as the criterion variable, and age, sex, satisfaction with family life, perceived physical health, and each perceived job stress were entered as independent variables in the equation. For each of the six stress items the odds ratio (OR) and its 95% CI were calculated; the absence of job stress; men (sex); age <30; being satisfied with family life; and good physical health were used as references.

To avoid multicollinearity with job stress, separate models were fitted for each job stress item. In the evaluation of the RR by sex, there was a single item for which the 95% CI of the RR for men did not include the RR for women (poor relationship with superiors). For this item, multiple logistic regression analysis was performed separately in men and women. These statistical analyses were performed with the statistical software package SPSS 6.1.

Results

REPRESENTATIVENESS OF THE SAMPLE

As the subjects for analysis accounted for only 67.1% of the initial sample, their representativeness was evaluated. Basic characteristics such as sex, age, and marital status were compared between workers who could be followed up and those who were lost to follow up. There were differences in all of these characteristics. Men comprised 46.8% (145/310) in the group that was followed up and 37.5% (57/152) in the group lost to follow up (χ^2=3.6, df=1, p=0.059). The ages in the group that was followed up (n=310), were 43.2% ≤29, 24.2% in their 30s, 29.0% in their 40s, and 3.5% in their 50s, whereas in the group lost to follow up (n=152), the age distribution was 29.6%, 24.3%, 40.1%, and 4.6% respectively (χ^2=9.0, df=3, p=0.029). In the group that was followed up (n=310), 41.9% were single, 55.8% married, and 2.3% divorced or separated, whereas in the group lost to follow up (n=152) the distribution was 22.4%, 73.7%, and 3.9% respectively (χ^2=17.3, df=2, p=0.0002). Therefore, in the group lost to follow up, the proportion of women, of those in their 40s, and of married workers was larger than those in the group that was followed up .

TWO YEAR RISKS FOR DEVELOPING
PSYCHOLOGICAL ILL HEALTH

The 2 year risk for developing psychological ill health in all subjects was 57.7% (179/310) with

Table 3   Results of multiple logistic regression analysis

Stress number	Odds ratio (95% CI)					
	4	*5*	*6*	*8*	*10*	*13*
Stress:						
No	Referent					
Yes	1.53 (0.88 to 2.68)	2.14 (1.27 to 3.61)	2.07 (1.26 to 3.42)	2.08 (1.18 to 3.68)	2.37 (1.32 to 4.29)	1.97 (1.13 to 3.42)
Sex:						
Male	Referent					
Female	0.84 (0.48 to 1.49)	0.94 (0.54 to 1.63)	0.85 (0.50 to 1.45)	0.71 (0.42 to 1.20)	0.72 (0.43 to 1.20)	0.90 (0.52 to 1.56)
Age:						
-29	Referent					
30-	0.83 (0.42 to 1.53)	0.75 (0.39 to 1.46)	0.83 (0.43 to 1.61)	0.72 (0.37 to 1.39)	0.75 (0.39 to 1.45)	0.77 (0.40 to 1.49)
40-	0.93 (0.53 to 1.64)	0.84 (0.47 to 1.50)	0.87 (0.49 to 1.56)	0.86 (0.48 to 1.53)	0.78 (0.44 to 1.40)	0.82 (0.46 to 1.46)
50-	0.73 (0.19 to 2.80)	0.62 (0.17 to 2.32)	0.75 (0.19 to 2.92)	0.77 (0.20 to 2.95)	0.57 (0.15 to 2.12)	0.52 (0.14 to 1.95)
Family life satisfaction:						
Yes	Referent					
Partly	1.62 (0.84 to 3.11)	1.69 (0.87 to 3.29)	1.70 (0.88 to 3.30)	1.61 (0.83 to 3.13)	1.86 (0.95 to 3.64)	1.74 (0.90 to 3.37)
No	2.36 (0.93 to 5.97)	2.25 (0.88 to 5.75)	2.25 (0.88 to 5.74)	2.37 (0.93 to 6.02)	2.63 (1.02 to 6.78)	2.29 (0.90 to 5.82)
Physical health state:						
Good	Referent					
Partly	1.46 (0.86 to 2.48)	1.43 (0.84 to 2.45)	1.53 (0.90 to 2.62)	1.52 (0.89 to 2.59)	1.42 (0.84 to 2.43)	1.36 (0.80 to 2.32)
Bad	2.90 (1.35 to 6.23)	2.92 (1.36 to 6.29)	3.16 (1.46 to 6.82)	3.17 (1.47 to 6.84)	3.00 (1.39 to 6.46)	2.97 (1.38 to 6.38)
-2 log likelihood	393	387	383	384	386	390
Model χ^2 (p value)*	20.1 (0.018)	26.7 (0.002)	26.0 (0.002)	24.1 (0.004)	27.0 (0.001)	24.3 (0.004)

*df=9.

the cut off point between scores of 7 and 8. The risks were 60.4% (87/144) in men and 54.9% (90/164) in women, not significantly different. There was also no significant difference by age. When we used the cut off point between scores of 8 and 9 or 9 and 10, the 2 year risks were 54.5% (188/345) and 50.1% (183/365). In later analyses, the cut off point between 7 and 8 was used.

TWO YEAR RISKS IN RELATION TO PERCEIVED JOB STRESS

To evaluate the association between perceived job stress and psychological ill health, we calculated the 2 year risk associated with each job stress item (table 1). The RR was >1—that is, the risk was higher in the stress group—for all items but two. The stress items significantly associated with risk were, in decreasing order: too much trouble at work; poor relationship with superiors; too much responsibility; not allowed to make mistakes; cannot keep up with new technology; and schedule is too tight, or pressed to work too hard. The same perceived job stress items were related to the 2 year risk of ill health when higher, score between 8 and 9 or 9 and 10, cut off points were used for the GHQ-30.

TWO YEAR RISKS IN RELATION TO PERCEIVED JOB STRESS AND SEX

Table 2 compares 2 year risks broken down by sex. The stress items significantly associated with the development of mental ill health were: too much responsibility and too much trouble at work among men and too much trouble at work, poor relationship with superiors, and not allowed to make mistakes among women. In particular, for poor relationship with superiors, the RR in women was 2.2 and its 95% CI did not include the point estimate of the RR in men. Thus, this stress item was related to mental health only in the women.

MULTIPLE LOGISTIC REGRESSION ANALYSIS

To exclude the effects of confounding factors on the relation between perceived job stress and mental health, multiple logistic regression analysis was carried out as shown in table 3. After adjustment for the effects of these factors, the OR for developing psychological ill health for the stress group was about 2, and the 95% CI was >1 for too much trouble at work, too much responsibility, poor relationship with superiors, not allowed to make mistakes, and cannot keep up with technology. However, the stress item, schedule is too tight or pressed to work too hard, was not significantly associated with mental ill health. The OR of the group unsatisfied with family life and that of the group with poor physical health were >2.

Evaluation of the RR according to sex showed definite differences between the men and women. For poor relationship with superiors, multiple logistic regression analysis was performed separately in men and women. As shown in table 4, the OR (95%CI) was 3.8 (1.7 to 8.7) in women, but 0.96 (0.4 to 2.3) in men. Thus, a poor relationship with superiors seemed to be related to mental health only in women.

Table 4   Results of multiple logisitic regression analysis by sex

	Odds ratio (95% CI)	
	Male	*Female*
Poor relation with superiors:		
No	Referent	
Yes	0.96 (0.41 to 2.26)	3.79 (1.65 to 8.73)
Age (y):		
<29	Referent	
≥30	0.82 (0.34 to 2.01)	1.05 (0.35 to 3.17)
≥40	1.33 (0.46 to 3.90)	0.76 (0.37 to 1.57)
≥50	0.59 (0.13 to 2.64)	NA
Family life satisfaction:		
Yes	Referent	
Partly	1.18 (0.44 to 3.17)	2.17 (0.84 to 5.60)
No	7.42 (0.90 to 61.3)	1.52 (0.47 to 4.94)
Physical health state:		
Good	Referent	
Partly	1.27 (0.56 to 2.87)	1.90 (0.89 to 4.07)
Bad	3.86 (1.10 to 13.6)	3.19 (1.11 to 9.13)
-2 Log likelihood	174	198
Model χ^2* (p value)	14.1 (0.08)	20.9 (0.007)

*df=8.
NA=not applicable.

Discussion

This study had several limitations. Firstly, mental health was followed up at 6 month intervals. If workers developed a disorder and recovered within 6 months, the disorder could not be identified. It is therefore possible that the 2 year risk was underestimated.

Secondly, the state of mental health was measured with the Japanese version of GHQ-30,[17 18] and the cut off point was set between 7 and 8. The GHQ-30 is used throughout the world, and its validity has been evaluated with operational diagnostic criteria as a gold standard. The Japanese version of GHQ-30 has also been widely used, but there have been few studies of validity. In this study, the cut off point of between 7 and 8 was chosen, based on the study by Kitamura *et al*.[20] However, their study used gynaecological outpatients as subjects, and the application of their cut off point to workers may be problematic. In the current study, the 2 year risk of the development of mental health problems was 57.7%, which was higher than the values seen elsewhere. However, when we used the higher cut off points of between 8 and 9 or 9 and 10, the 2 year risk remained strikingly high at 54.5% and 50.1%, respectively. For example, Henderson *et al*[21] reported that, out of 169 Australian subjects who were ≤4 on GHQ-30, only 38 (22.5%) had at least one episode in which their GHQ score rose to >4 during 1 year. Theoretically, if a higher cut off point is used, sensitivity becomes smaller and specificity becomes larger, and the proportion of those over the cut off point becomes smaller. Despite the difference of the observation period between this study and that of Henderson *et al*, the risk in the current study was more than twice as great. It is, therefore, possible that the use of the Japanese version of GHQ overestimated the risk in this study. Studies that used operational diagnostic criteria are necessary to determine an appropriate cut off point in the Japanese version of GHQ-30. However, the same perceived job stress items were significantly related to the 2 year risk, even when higher GHQ cut off points were used. This might mean that the association between perceived job stress and future mental health found in the current study is valid.

Thirdly, a self administered questionnaire consisting of 13 items[19] was used for evaluating perceived job stress. The appropriateness or accuracy of this questionnaire had not previously been evaluated. It is doubtful whether all perceived stresses in Japanese workers would be generally and accurately covered by this questionnaire. However, before using the questionnaire, we consulted with workers in charge of health management at the company investigated, and confirmed that it consisted of appropriate questions that covered all likely stresses at that workplace. Thus, the face validity of the questionnaire was supported to certain extent.

Fourthly, there was a relatively large group of workers lost to follow up. Married women aged 40–49 were often lost in this study. It therefore remains a problem to assess whether our study is representative.

There have been other studies on perceived job stress and mental health. These studies can be classified according to the study design into cross sectional studies, case-control studies, and cohort studies.

CROSS SECTIONAL STUDIES

Ilfeld[6] clarified the relation between job stress and depression, but did not describe his measure of job stress. Among various job stresses, Margolis *et al*[14] reported a close association between mental health and a lack of say in decisions affecting a person's job. Billing and Moos[9] suggested that four job stresses, high work pressure, high supervisor control, lack of autonomy, and lack of clarity, are associated with mental symptoms such as anxiety and depression. Iwata *et al*[7] found an association between perceived job stress and the GHQ score in their survey. After adjustment for confounding factors, Shigemi *et al*[13] reported an association between mental health and four complaints related to subjective job stress (too much trouble, too much responsibility, not allowed to make mistakes, poor relationship with superiors, and cannot keep up with new technology).

CASE-CONTROL STUDIES

Chevalier *et al*[8] carried out a case-control study in electricity and gas companies in France and suggested recent occupational changes and having a supervisory position as risk factors.

COHORT STUDIES

Karasek[15] carried out a cohort study for 6 years and reported that job strain increases depressive symptoms. Bromet *et al*[10] performed a 1 year cohort study and suggested that job demand is a risk factor for affective disorder, and the interaction between job demand and coworker support is an important factor predicting mental symptoms. Kawakami *et al*[16] followed up 3000 workers for 3 years and compared 15 patients with major depression and 75 controls. They performed multiple logistic regression analysis to adjust for confounding factors, and reported an association between the development of major depression and stress due to being in an unsuitable job. Kawakami *et al*[11] also carried out a cohort study by following up 468 blue collar workers at 1 year intervals for 3 years, and suggested that job unsuitability and poor human relations at the workplace are risk factors even after adjustment for confounding factors and the initial depressive symptoms.

Thus, our present study confirmed the relation found by previous studies between job stress and mental health, suggesting that job stress causes mental health problems. Previous studies have sometimes not clarified the precise nature of the job stress closely associated with mental ill health. In our study, some job stress items did seem to be significantly related to mental health. However, the specific job stresses that seemed important are not consistent with those found previously.[14 16] The perceived job stress items in the current study

could broadly be described as job strain[15] or job demand.[10] The type of job stress that predicts mental health may be associated with the characteristics of the workplace investigated. We investigated a factory that develops and produces precision machines. Work at this factory requires meticulous care and patience. When there is a mistake, the production line stops, causing a problem. Such working conditions may be responsible for the relation between mental ill health and the variables: schedule is too tight or pressed to work too hard; too much trouble at work; and too much responsibility. These job stresses are associated with the job demands and job strains that have been suggested to be related to psychiatric symptoms. Also, the technological innovation constantly required in the production of precision machines may have caused the relation between mental health and the stress item "cannot keep up with new technology". Studies, therefore, are necessary to determine whether the findings obtained in this study are applicable to other countries or workplaces.

The stress item "poor relationship with superior" was related to mental health only in the women. Although some previous studies have also suggested the association between personal relationships in workplaces and mental health—such as depression[11]—this study is the first to show this association only in women. Since the second world war, the position of women in workplaces in Japan has improved. However, there are only a few women holding managerial positions. Some people still consider that the position of women in the workplace is inadequate. In the workplace investigated in this study, most managerial positions (superiors in this stress item) were held by men, and this may have contributed to the result. However, given the amount of sexual harassment of women in the workplaces in the west, careful studies directed specifically at job stress in women[22] including that from personal relationships are also necessary in western countries.

Other than perceived job stress, perceived physical health and satisfaction with family life were significantly related to mental health after controlling for other confounding factors (table 3). Physical health has been found to be related to mental health in previous studies,[23] [24] and this is supported in the current study. Family environment is thought to be crucial in mental health[5] and this was also found in this study. Family life should receive more attention in occupational mental health. However even after controlling for these confounding factors, our study confirmed that perceived job stress is an important predictor of future mental health.

Our findings have implications for the prevention of mental disorders. Thus, the use of work manuals for preventing mistakes,

adequate training, and carefully designed production lines are important. For women, especially in subordinate roles, particular importance should be attached to smooth personal relations at work. These procedures could all reduce the perceived job stress associated with increased risk of mental ill health in this study, and as a result, could contribute to mental health in an occupational setting.

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