

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

An epidemiological study of cognitive stress appraisal and related factors among workers: cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019404
Article Type:	Research
Date Submitted by the Author:	05-Sep-2017
Complete List of Authors:	Tohmiya, Natsuka; Setagaya District Administration Offices,, Public Health Promotion Division; Yokohama Shiritsu Daigaku, Graduate School of Medicine Tadaka, Etsuko; Yokohama City University, Community Health Nursing Arimoto, Azusa; Yokohama Shiritsu Daigaku, Department of Community Health Nursing
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Nursing, Mental health, Public health
Keywords:	cognitive stress appraisal, environmental factor, individual factor, workers

SCHOLARONE™
Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 An epidemiological study of cognitive stress appraisal and related factors among
2 workers: cross-sectional study

6 Corresponding aauthor

7 Natsuka Tohmiya

8 MSN, RN, PHN

9 Public Health Promotion Division, Setagaya District Administration Offices,

10 4-22-33 Setagaya Setagaya-city, Tokyo 154-8504 Japan

11 E-mail: natsuka.dct.ft@gmail.com

12 TEL: +81-3-5432-2896

13 FAX: +81-3-5432-3074

15 Co-author

16 Etsuko Tadaka, Azusa Arimoto

17 Graduate School of Medicine, Yokohama City University, Yokohama, Kanagawa, Japan

20 Word count: 3,613 words

24

25 ABSTRACT

26 **Objective** Stress as a trigger for depression has enormous socioeconomic implications for all
27 spheres of employment, because it affects absenteeism, turnover, productivity, morale, and
28 suicide. Positive or negative cognitive stress appraisal can, however, affect workers' ability to
29 cope with stress as a self-care strategy. This study examined cognitive stress appraisal among
30 workers and identify related individual and environmental factors.

31 **Design** Cross-sectional study using self-administered postal questionnaires.

32 **Participants** 2,311 people working at 48 companies in metropolitan areas in Japan. In total,
33 341 questionnaires were returned (response rate: 14.8%), 337 of which were suitable for
34 analysis (effective response rate: 98.8%).

35 **Primary measures** Cognitive stress appraisal was assessed using the Japanese version of the
36 Perceived Stress Scale (PSS). Potential variables related to stress appraisal included
37 demographic, individual, and environmental factors. Multiple regression analysis was used to
38 identify factors related to cognitive stress appraisal.

39 **Results** The mean age \pm SD was 42.8 ± 11.7 years, and two-thirds were male. The mean PSS
40 score \pm SD was 25.8 ± 6.2 . Multiple regression analysis after controlling for variables of age,
41 sex, and depression indicated that those with poorer economic status ($\beta = 0.161$, $p < 0.001$),
42 lower eHealth literacy ($\beta = -0.116$, $p = 0.009$), higher traditional organizational climate ($\beta =$
43 0.124 , $p = 0.005$), and lower feelings of social support ($\beta = -0.220$, $p < 0.001$) experienced
44 significantly higher negative levels of perceived stress.

45 **Conclusion** The results show the individual and environmental factors related to cognitive
46 stress appraisal among workers. The inter-professional approach of public health nurses and
47 health practitioners, including a spectrum of enhanced self-coping skills using the eHealth
48 literacy of individual workers, improvement of traditional organizational climate at their
49 worksite, and social support in their community, might be an effective strategy to contribute to
50 improved mental health among workers.

51 **Strengths and limitations of this study**

- 52 • First study to examine the individual and environmental factors related to cognitive stress
53 appraisal of healthy and general workers.
- 54 • Simultaneously examine both eHealth literacy, multidimensional perceived social support
55 and traditional organizational climate.
- 56 • This study is cross-sectional design, it could not identify causal relationships between
57 cognitive stress appraisal and related factors.
- 58 • This study's target population is limited to metropolitan areas in Japan.

59
60
61 **keywords:** cognitive stress appraisal, environmental factor, individual factor, workers

INTRODUCTION

Depression is one of the most common psychiatric disorders, affecting about 350 million people worldwide [1]. In Japan, depression is estimated to have affected up to 1.116 million people in 2015 [2]. Certain occupational factors account for up to 8% of cases of depression) [3]. The World Health Organization's comprehensive mental health action plan 2013–2020 was adopted by the 66th World Health Assembly [4] and argues that determinants of mental health and psychiatric disorders include not only individual attributes but also social, cultural, economic, political, and environmental factors [5]. Mental illnesses are associated with a substantial deterioration in individual quality of life and economic loss in the community and the workplace [5, 6]. Therefore, primary prevention of depressive disorders is an important issue nationally and internationally, and not just for individuals.

Stress as a trigger for depression has enormous socioeconomic implications for all spheres of employment, because it affects absenteeism, turnover, productivity, morale, and suicide [7,8,9]. In Japan, the number of employees applying for industrial accident compensation insurance for mental disorders because of stress has increased in recent years [10]. In 2015, the number of applications was 1,515, up from 1,272 in 2011 [11]. The proportion of workers experiencing anxiety, distress, and work stress has progressively increased since 1982 and is now around 60% [12]. Against this background, the Japanese government launched a new occupational health policy in 2015 called "The Stress Check Program" to screen for workers experiencing high psychosocial stress [13]. The law mandates use of the Stress Check Program and its guidelines at least once per year in all workplaces with 50 or more employees in Japan. The program and its guidelines recommends individual checks on perceived stress and sets out four principles of care in the workplace: (1) self-care; (2) line-care; (3) health practitioners' care in the workplace; and (4) health practitioners' care in the community.

Cognitive stress appraisal is the evaluation of how individuals perceive the stressors that cause stress and is a self-care strategy. In primary appraisal, an individual's evaluations are divided into "threat," and "challenge", threat describes anticipated harm/loss, and challenge describes a threat that can be met or overcome [14,15]. Whether something is given a cognitive appraisal of "threat" or "challenge" can affect mental health [15,16]. The stress response and stress coping caused by cognitive appraisal differ among individuals, even in response to the same stressors [17]. For example, people making a positive cognitive appraisal may see stress as a challenging health issue to be resolved, and set themselves challenging goals [14,15]. Those making a negative cognitive appraisal can view the same issues as a health threat, and may believe that resolving tasks and situations is beyond their abilities. Positive or negative cognitive stress appraisal can therefore be an important concept in mental health to improve stress-coping skills and control stress among workers. In an individual, a positive cognitive appraisal contributes to prevention of depression, thus improving quality of

1
2
3 99 life. At the societal level, this is important in controlling the escalation of medical costs and
4 100 increasing corporate and community-wide productivity.

5
6 101 The Perceived Stress Scale (PSS) measures the degree to which situations are
7 102 cognitively appraised as stressful [18]. Many previous studies have measured cognitive
8 103 stress appraisal using the PSS and related factors in students [19-23], medical workers
9 104 [24,25], and patients with chronic disease [26-29]. The scale has not, however, been
10 105 used with healthy adult workers in a wide spectrum of employments. Previous studies
11 106 clarified various individual factors related to the PSS, but varied for different
12 107 participants. Some studies examined the physical and psychological health condition
13 108 of students and conditions in particular groups such as adults with a disease or
14 109 pregnant women [27,30,31]. Others examined the lifestyles of students, pregnant
15 110 women, and medical workers [25,32,33]; job stress among medical workers [24,34,35];
16 111 stressors and coping in adults, such as survivors of suicide and pregnant women
17 112 [30,36]; and health literacy in African-American adults [37]. However, there is limited
18 113 information about the relationship between cognitive stress appraisal and individual
19 114 and environmental factors such as work environment and social support available to
20 115 adult workers [38].

21
22
23
24
25
26
27 116 The purpose of this study was to examine cognitive stress appraisal and identify
28 117 individual and environmental factors among workers. The study can contribute to
29 118 minimizing the effect of one factor that might be associated with an increased risk of
30 119 depression and contribute to the promotion of individual self-care and improvement of
31 120 worksite environments to promote mental health among workers. Furthermore, it can
32 121 be useful for primary prevention of mental health disorders among workers by public
33 122 health nurses and health practitioners at worksites.

34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

124 **METHODS**

125 **Participants and sampling**

126 The study participants were workers at companies in metropolitan areas of Japan. The criteria
127 for participation included being between 18 and 64 years old. An age of 64 years is the upper
128 limit for consideration of retirement and re-employment under the Law Concerning
129 Stabilization of Employment of Older Persons; 18 years is the earliest age for employment
130 immediately after graduating high school in Japan.

131 The study design was a cross-sectional study using self-administered postal questionnaires.
132 Data were collected across two metropolitan areas of Japan (Tokyo and Kanagawa
133 prefectures) from companies registered in the Japan Company Handbook 2016. Questionnaires
134 were sent to employees randomly selected, stratified by the number of employees of each

1
2
3 135 company. In total, 361 of 2,026 companies were selected (17.8%).

4 136

6 7 137 **Ethics**

8
9 138 The questionnaire was unsigned to maintain the anonymity of all personal participant
10 139 information. The Institutional Review Board of the Medical Department of the Yokohama City
11 140 University approved this study on August 9, 2016 (Certification No.A1608008).

12
13
14 141

15 16 17 142 **Measuring instruments**

18 19 143 **Dependent variable: Cognitive stress appraisal**

20
21 144 The dependent variable was cognitive stress appraisal, which was determined using the
22 145 Japanese version of the PSS [39,40]. The PSS consists of 14 items and includes questions such
23 146 as “In the last month, how often have you been upset because of something that happened
24 147 unexpectedly?” and “In the last month, how often have you felt that you were unable to
25 148 control the important things in your life?” The responses were coded for scoring as “Never” =
26 149 0, “Almost Never” = 1, “Sometimes” = 2, “Fairly Often” = 3, and “Very Often” = 4. Possible
27 150 total scores ranged from 0 to 56 with higher scores indicating higher levels of negative
28 151 cognitive stress appraisal. All 14 items are highly intercorrelated in the Japanese version
29 152 (Cronbach’s alpha = 0.74).

30
31
32
33
34
35 153

36 37 38 154 **Demographic characteristics**

39
40 155 Demographic characteristics collected about the participants in this study included age, sex,
41 156 marital status, household membership, educational status, employment status, economic status,
42 157 and depression.

43
44 158 Depression was measured using the Japanese version of the Center for Epidemiologic
45 159 Studies Depression Scale (CES-D) [41,42], which consists of 20 items. Each item is measured
46 160 on a four-point Likert-type scale ranging from 0 to 3. The total score ranges from 0 to 60 with
47 161 higher scores indicating greater levels of depression; scores above 16 on the CES-D indicate a
48 162 depressive state. CES-D was developed for use in epidemiological studies of depressive
49 163 symptomatology in the general population [41,42]. A group with a high average score may be
50 164 interpreted to be “at risk” of depression or in need of treatment [42].

51
52
53
54
55 165

166 **Independent variable**

167 Individual factors of the participants in this study included any disease currently under
168 treatment (e.g., cancer, diabetes), body mass index (BMI), self-rated health, physical
169 complaints, physical demands, lifestyle, perceived health competence, and electronic health
170 literacy (eHealth literacy).

171
172 Self-rated health was measured on a four-point Likert-type scale from 1 (very poor) to 4 (very
173 good). Physical complaints were measured using the Brief Job Stress Questionnaire (BJSQ)
174 [43]. The BJSQ is used in the Japan Stress Check Test by the Ministry of Health, Labour and
175 Welfare [12] and can be easily used in the workplace. It consists of 57 items across 19
176 subscales, from which we drew 11 items (e.g., “I have felt dizzy” and “I have experienced
177 joint pains”). Each item was measured on a four-point Likert-type scale. The total scores
178 ranged from 11 to 44 with higher scores indicating more frequent physical complaints.

179
180 Physical demands were measured using the Job Content Questionnaire (JCQ) [44], which
181 consists of 45 items divided into six subscales. We used three items on physical exertion and
182 two on isometric load. Each item was measured on a five-point Likert-type scale. The total
183 scores for physical exertion ranged from three to 15, and for isometric load from two to 10,
184 with higher scores indicating stronger physical demands and isometric load. The JCQ was
185 developed based on the job demands–control model and has been nationally standardized by
186 occupation in several countries [44-46].

187
188 Lifestyle was measured using seven items based on Breslow’s good health habits [47]. The
189 scale covered smoking, drinking alcohol, eating breakfast every day, physical activity, eating
190 snacks after dinner, skipping breakfast, and sleeping and resting. The responses were coded
191 for scoring as “yes” or “no.”

192
193 Perceived health competence was measured using the Perceived Health Competence Scale,
194 Japanese version (PHCS) [48], which consists of eight items. Each was measured on a
195 five-point Likert-type scale. The total scores ranged from 8 to 40, with higher scores
196 indicating higher perceived health competence. Perceived health competence is related to
197 stress [49]. The PHCS was designed to assess efficacy and competence beliefs about personal
198 health at this intermediate level of domain-specificity [50].

199
200 eHealth literacy was measured using the Japanese version of the eHealth Literacy Scale
201 (eHEALS) [51], which consists of eight items. eHealth literacy is defined as the ability to seek,
202 find, understand, and appraise health information from electronic sources, and apply the

1
2
3 203 knowledge gained from doing so in addressing or solving a health problem [52,53]. Responses
4 204 to the scale were assessed using a five-point Likert-type scale. The total scores ranged from 8
5 205 to 40 with higher scores showing greater health literacy. In Japan, Internet penetration in the
6 206 age group under study is over 90% [54]. eHEALS has been developed to address the need to
7 207 assess eHealth literacy for a wide range of populations and contexts. It is designed to provide
8 208 a general estimate of consumer eHealth-related skills to inform clinical decision-making and
9 209 health promotion planning with individuals or specific populations [53].
10
11
12
13
14

15 211 **Environmental factors: Organizational climate**

16
17 212 Organizational climate was measured using the 12-item Organizational Climate Scale [55],
18 213 which is divided into two six-item subscales: the tradition scale and the organizational
19 214 environment scale. The responses were coded for scoring as “yes” = 2 and “no” = 1. The total
20 215 possible scores ranged from six to 12 for each scale. Higher scores on the tradition scale show
21 216 a more mandatory, injunctive, and feudalistic organizational climate and higher scores on the
22 217 organizational environment scale show a more flexible organizational system. A previous
23 218 study showed that organizational climate could affect occupational stress [56]. This scale
24 219 measures organizational properties based on the model of Healthy Work Organizations at
25 220 NIOSH [55].
26
27
28
29
30

31 221

32 33 34 222 **Social support**

35
36 223 Social support was measured using the short version of the Multidimensional Scale of
37 224 Perceived Social Support (MPSS) in Japanese [57,58], which consists of seven items. Each
38 225 item was examined on a seven-point Likert-type scale with lower scores indicating lower
39 226 feelings of social support. The MPSS specifically addresses the subjective assessment of
40 227 social support adequacy and was designed to assess perceptions of social support adequacy
41 228 from three specific sources: family, friends, and significant others [58].
42
43
44
45

46 229

47 230 **Data collection**

48
49 231 In total, 48 of 361 companies agreed to participate to this study. Prior to sending the
50 232 questionnaire to each company, we identified the sample size from the administrators. A total
51 233 of 2,311 questionnaires were sent to the 48 companies via mail. The potential participants, all
52 234 the employees in each of these companies, were asked to complete the questionnaire
53 235 anonymously and on a voluntary basis, between October 1 and December 9, 2016. The
54 236 anonymity of the workers was maintained throughout the process by using unsigned forms,
55
56
57
58
59
60

1
2
3 237 which they posted back themselves. Returning the document was considered to indicate
4 238 informed consent.

5
6 239

7 8 9 240 **Statistical analysis**

10
11 241 The mean, SD, frequency, and percentage were calculated for demographic characteristics,
12 242 positive or negative cognitive stress appraisal (PSS), and individual and environmental factors.
13 243 Univariate analysis using Spearman's correlation was used to examine correlations between
14 244 the dependent and independent variables. A multiple regression analysis was then used to
15 245 identify factors related to cognitive stress appraisal among workers, using all potentially
16 246 significant predictors identified by the univariate analyses ($P < 0.05$) as independent variables
17 247 via the forced entry (variable reduction) method. The multiple regression model contained
18 248 selected independent variables and all statistical analyses. Sex, age, and depression were
19 249 contained as controlled variables. A previous study reported high correlation between the PSS
20 250 and the CES-D, but both scales still independently predicted symptomatology [18]. The aim of
21 251 this research was primary prevention of poor mental health, specifically depression. We
22 252 therefore assumed that depression was covariate and treated it as a control variable. All
23 253 analyses were performed using IBM SPSS Statistics for Windows version 22.0. The level of
24 254 significance was set at $P < 0.05$.

25 255

26 256 **RESULTS**

27
28 257 Of the 2,311 questionnaires mailed to the companies, 341 were returned (response rate:
29 258 14.8%). Four of the 341 questionnaires were from participants aged over 65 years or who did
30 259 not provide their age. We excluded these questionnaires and were left with 337 questionnaires
31 260 for analysis (effective response rate: 98.8%).

32
33
34
35 261 Participants' background information (demographic characteristics, individual factors,
36 262 environmental factors) is shown in Table 1.

37 263
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1. Background of the participants

Items	Number or Mean±SD	% (Range)
Demographic characteristics		
Age	42.8±11.7	(18-64)
Sex		
Male	228	67.7
Female	109	32.3
Matital status		
Unmarried	110	32.6
Married	203	60.2
Divorced/Widowed	24	7.1
Household membership		
Live alone	76	22.8
Spouse	48	14.4
Spouse and childeren	129	38.6
Parentes	50	15.0
Others	31	9.3
Educational status		
Junior high school/High school	78	23.1
Vocational college/Junior college	53	15.7
College or University/Graduate school	206	61.1
Employment status		
Fulltime worker	301	89.9
Part-time worker	27	8.1
Others	7	2.1
Economic status		
Sufficient	106	31.5
Slightly sufficient	175	51.9
Slightly insufficient	51	15.1
Insufficient	5	1.5
Depression (CES-D)		
Score	12.8±7.6	(0-45)
Depression(CES-D \geq 16; cut-off point)	99	29.5
Dependent variable		
Cognitive stress appraisal (PSS)	25.8±6.2	(6-48)

SD, standard deviation

264

Table 1. Background of the participants (cont.)

Items	Number or Mean±SD	%(Range)
Individual factors		
Disease currently under treatment		
No	252	75.0
Yes	84	25.0
High blood pressure	25	7.4
Gout	11	3.3
Hyperlipidemia	8	2.4
Respiratory disease	8	2.4
Diabetes	7	2.1
Digestive disease	7	2.1
Mental disease	7	2.1
Others	26	7.7
Body-mass index (BMI)		
Mean	22.0±3.1	(14.5-34.6)
Thin (BMI < 18.5)	32	9.8
Standard (18.5 ≤ BMI < 25)	243	74.8
Obesity (25 ≤ BMI)	50	15.4
Self-rated health		
Very poor	7	2.2
Rather poor	47	14.6
Rather good	216	66.9
Very good	53	16.4
Physical complaint (BJSQ)	19.3±5.1	(11-36)
Physical demands (JCQ)		
Physical exertion	4.9±1.8	(3-11)
Isometric load	3.2±1.3	(2-8)
Life style		
No smoking	255	75.7
Non or sometimes drinking alcohol	256	76.0
Breakfast everyday	241	71.5
More than once a week physical activity	75	22.3
No eating after dinner over 3days per week	246	73.0
No skipping breakfast over 3days per week	248	73.6
Get enough sleep and rest	190	56.5
Perceived health competence (PHCS)	23.4±6.5	(8-40)
eHealth literacy (eHEALS)	22.0±7.5	(3-40)
Environmental factors		
Organizational climate		
Tradition	8.0±1.6	(6-12)
Organizational environment	8.6±1.8	(6-12)
Social support	5.4±1.2	(2-7)

SD, standard deviation

265

266

The mean age ± SD was 42.8 ± 11.7 years, and approximately two-thirds were male and

267 married. Two-fifths lived with their children, and one-quarter lived alone. Two-thirds had
 268 graduated from college or higher. Most participants had regular employment. Four-fifths felt
 269 good about their economic status. The mean CES-D score \pm SD was 12.8 ± 7.6 , and 99
 270 participants (29.5%) were rated as having depression based on the cut-off point. The mean
 271 PSS score \pm SD was 25.8 ± 6.2 . One-quarter of the participants were being treated for a
 272 disease. The mean BMI \pm SD was 22.0 ± 3.1 , and three-quarters were within the healthy range
 273 (over 18.5, less than 25). Four-fifths reported that their self-rated health was good or fairly
 274 good. The mean physical complaint score \pm SD was 19.3 ± 5.1 . The mean scores for physical
 275 exertion and isometric load \pm SD were 4.9 ± 1.8 , and 3.2 ± 1.3 . Most of the healthy lifestyle
 276 options were chosen by at least 50% of the participants, and some by approximately
 277 three-quarters of them. The mean score for PHCS and eHEALS \pm SD were 23.4 ± 6.5 , and
 278 22.0 ± 7.5 . The mean \pm SD for the tradition scale score was 8.0 ± 1.6 , the organizational
 279 environment scale 8.6 ± 1.8 , and the social support scale score 5.4 ± 1.2 .

280 There were correlations among demographic characteristics, individual and environmental
 281 factors, and cognitive stress appraisal. Spearman's correlation coefficients measured the linear
 282 relationship between each factor and PSS among workers (Table 2).

Table 2. Cognitive stress appraisal and related factors

	β	<i>p</i>
Demographic characteristics		
Economic status (1=sufficient, 2=slightly sufficient, 3=slightly insufficient, 4=insufficient)	0.171	0.000
Individual factors		
eHealth literacy (total score)	-0.113	0.012
Environmental factors		
Organizational climate: Tradition (total score)	0.131	0.004
Social support (total score)	-0.205	0.000
Adjusted R ²		0.412

Multiple regression analysis.

Controlled variables: Age, Sex (0=female, 1=male), Depression (0=no, 1=yes).

283
 284 The demographic characteristics showing significant correlations with cognitive stress
 285 appraisal were age ($r = -0.300$, $p < 0.001$), marital status ($r = -0.207$, $p < 0.001$), household
 286 membership ($r = -0.231$, $p < 0.001$), economic status ($r = 0.355$, $p < 0.001$) and depression ($r =$
 287 0.528 , $p < 0.001$). Individual factors showing significant correlations with cognitive stress
 288 appraisal were self-rated health ($r = -0.275$, $p < 0.001$), physical complaints ($r = 0.372$, $p <$
 289 0.001), total scores for physical exertion ($r = 0.109$, $p = 0.048$) and isometric load ($r = 0.183$,

290 $p = 0.001$), physical activity ($r = -0.162$, $p = 0.003$), sleeping and resting ($r = -0.278$, $p <$
291 0.001), perceived health competence ($r = 0.412$, $p < 0.001$), and eHealth literacy ($r = -0.295$, p
292 < 0.001). Environmental factors showing significant correlations with cognitive stress
293 appraisal were total scores for the tradition ($r = 0.197$, $p < 0.001$) and organizational
294 environment scales ($r = -0.182$, $p = 0.001$) and social support ($r = -0.398$, $p < 0.001$).

295 The factors associated with cognitive stress appraisal—marital status, household
296 membership, economic status, physical activity, sleeping, isometric load, eHealth literacy,
297 tradition and organizational environment scales, and social support—were used as
298 independent variables, and age, sex, and depression as control variables in a multiple
299 regression analysis. The results are shown in Table 3. This analysis indicated that those with
300 poorer economic status ($\beta = 0.161$, $p = 0.001$), lower eHealth literacy ($\beta = -0.116$, $p = 0.009$),
301 higher traditional organizational climate ($\beta = 0.124$, $p = 0.005$), and lower feelings of social
302 support ($\beta = -0.220$, $p < 0.001$) experienced a higher level of perceived negative stress. The
303 adjusted R^2 in this analysis was 0.411.

304

305 DISCUSSION

306 The participants in this study were representative of healthy adult workers in a wide spectrum of
307 employments in Japan. Firstly, in terms of demographic characteristics, such as age, sex and the
308 proportion of participants in this study was similar to the national statistics for full-time workers
309 in Japan [59]. Secondly, in terms of the participants' levels of the PSS, the PSS scores in this study
310 were quite similar to those obtained when the PSS was originally developed [18] and from the
311 scores of adults in other countries [60,61]. Therefore this study can be generalized to other
312 workers not only in Japan but also other developed countries.

313 Our study is the first to our knowledge to examine the features of cognitive stress appraisal in
314 workers and identify the associated individual and environmental factors. This study has added to
315 the existing research evidence that individual factors, including eHealth literacy, and
316 environmental factors, such as the organizational climate, are both related to cognitive stress
317 appraisal among workers. This study therefore has important practical implications in promoting
318 stress management and primary prevention of stress-related disease and suicide among workers.

319 The economic status is related to cognitive stress appraisal. It is possible that poor
320 economic status itself is the origin of the stress, and workers with poor economic status
321 therefore cannot cope with their own stress. Cognitive stress appraisal and subjective
322 economic status are related and self-efficacy played an important role as a mediator between
323 cognitive evaluation of stress and life satisfaction [62]. Workers may be unable to appraise
324 challenges and struggle in stressful situations because they feel that their own ability level is
325 low and resources are few.

326 Lower eHealth literacy was related to negative stress appraisal in this study. Health literacy

1
2
3 327 is a cognitive and social skills which determine the motivation and ability of individuals to
4 328 gain access to, understand, and use information in ways which promote and maintain good
5 329 health [63]. Higher health literacy may enable an individual to actively seek support and
6 330 solutions to problems [64]. Good eHealth literacy means people can access health information
7 331 resources and use the information via the Internet. The Internet is increasingly becoming an
8 332 effective information tool for improving self-care behavior [65-67]. There is a considerable
9 333 amount of health information on the Internet, which is helpful for positive cognitive stress
10 334 appraisal. Improving eHealth literacy should empower workers to obtain, understand, and act
11 335 on information that they need for optimal mental health.

12 336 More traditional organizational climates were related to negative cognitive stress appraisal.
13 337 A traditional organizational climate is more directive and feudalistic [55]. Higher tradition
14 338 scores corresponded to higher levels of depressive state, lower job satisfaction, and lower
15 339 levels of mental health [55]. A “traditional” structure or climate implies high levels of
16 340 mandatory working, a lack of respect for individual opinion and pressure from superiors.
17 341 Workers in a traditional organizational climate have less discretion and a more stressful
18 342 environment. They may be unable to ask for help from their supervisor, or make
19 343 improvements to the work environment.

20 344 Lower levels of social support were also related to negative stress appraisal. This is
21 345 consistent with previous studies reporting that the amount of social support was associated
22 346 with levels of depression [68], and that social support buffered adverse effects on mental
23 347 health [69]. Social support also protects from the pathogenic effects of stressful events by
24 348 altering the appraisal of those events or the process by which perceived stress causes illness
25 349 [18]. Those who feel that they have little social support may be unable to buffer stressful
26 350 events, on the other hand, those who feel that they have enough social support may be able to
27 351 buffer stressful events.

28 352 In conclusion, it is suggested that the inter-professional approach of public health nurses
29 353 and health practitioners, including provision of a spectrum of enhanced self-coping skills
30 354 using the eHealth literacy of individual workers, development of a more modern
31 355 organizational climate at their worksite, and social support in their community might be an
32 356 effective strategy to contribute to minimizing the effect of one factor, ‘cognitive stress
33 357 appraisal’ that might be associated with an increased risk of depression and contribute to the
34 358 promotion of mental health in workers.

35 359

360 **Limitations**

361 This study had several limitations. First, it used a cross-sectional design, which means that it
362 could not identify causal relationships between cognitive stress appraisal and related factors.

1
2
3 363 Second, the adjusted R^2 was 0.409 in this study, which was higher than the value of 0.05–0.27
4 364 reported previously [74]. Although this provides an adequate explanation of the factors related
5 365 to cognitive stress appraisal, other factors are also likely to contribute. Future research
6 366 requires longitudinal studies across other areas, widening the scope.
7
8
9

10 367

11 368 **Conclusions**

12
13
14 369 This study aimed to examine the cognitive stress appraisal, and to identify factors related to
15 370 the cognitive stress appraisal in workers. The results indicated that cognitive stress appraisal
16 371 is associated with economic status, depression, eHealth literacy, traditional organizational
17 372 climate, and social support. Thus, it was recommended that public health nurses and health
18 373 practitioners should enhance economic status, eHealth literacy, traditional organizational
19 374 climate, and social support, and improvement depression to encourage workers for better
20 375 cognitive stress appraisal. Furthermore, occupational and community interventions are
21 376 required to create and inform people of the opportunities for cognitive stress appraisal in
22 377 worksite and communities.
23
24
25
26
27

28 378

29 379 **Acknowledgements**

30 380 The authors would like to thank all the employees who agreed to participate in this study.
31
32

33 381

34 382 **Contributors**

35 383 NT, ET and AA contributed to develop the concept and design of this study.
36 384 ET was responsible for acquiring the Institutional Review Board (IRB) approval of this study.
37 385 NT was responsible for data collection and analysis.
38 386 NT and AA were responsible for drafting and revising the manuscript.
39 387 ET is responsible for study supervision and reporting of study results.
40 388 All authors have read and approved the final manuscript.
41
42
43

44 389

45 390 **Competing interests**

46 391 We have read and understood BMJ policy on declaration of interests and declare that we have
47 392 no competing interests.
48
49

50 393

51 394 **Funding**

52 395 This study was supported by University Center of Community (COC) program funded by the
53 396 Ministry of Education, Culture, Sports, Science and Technology, Japan
54 397 (<http://www.mext.go.jp/en/>). The funders had no role in study design, data collection and
55 398 analysis, decision to publish, or preparation of the manuscript.
56
57

1
2
3 399

4 400 **Patient consent**

5 401 Obtained.

6 402

7 403 **Ethics approval**

8 404 The Institutional Review Board of the Medical Department of the Yokohama City University
9 405 approved this study on August 9, 2016 (Certification No.A1608008).

10 406

11 407 **Provenance and peer review**

12 408 Not commissioned; externally peer reviewed.

13 409

14 410 **Data sharing statement**

15 411 There are no additional data available.

16 412

17 413 **REFERENCES**

18 414 1. World Health Organization [Internet]. Genève: Depression; 2016 [cited 26 December 2016].

19 415 Available from:

20 416 <http://www.who.int/mediacentre/factsheets/fs369/en/>.

21 417 2. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Patient Survey; 2015 [cited 12

22 418 December 2016]. Available from:

23 419 <http://www.mhlw.go.jp/toukei/saikin/hw/kanja/14/dl/kanja.pdf> (in Japanese)

24 420 3. World Health Organization [Internet]. Genève: Depression; 2014 [cited 26 December 2016].

25 421 Available from: <http://www.who.int/mediacentre/factsheets/fs389/en/>

26 422 4. World Health Organization [Internet]. Genève: Comprehensive mental health action plan
27 423 2013–2020; 2013 [cited 27 December 2016]. Available from:

28 424 http://www.who.int/mental_health/action_plan_2013/en/

29 425 5. World Health Organization [Internet]. Genève: Mental Health Action Plan 2013-2020; 2013

30 426 [cited 26 December 2016]. Available from:

31 427 http://apps.who.int/iris/bitstream/10665/89966/1/9789241506021_eng.pdf?ua=1

32 428 6. World Economic Forum and the Harvard School of Public Health [Internet]. Genève: The
33 429 global economic burden of non-communicable diseases; 2011 [cited 27 December 2016].

34 430 Available from:

35 431 <http://apps.who.int/medicinedocs/documents/s18806en/s18806en.pdf>

36 432 7. Van den Berg TIJ, Alavinia SM, Bredt FJ, et al. The influence of psychosocial factors at
37 433 work and life style on health and work ability among professional workers. *International*

38 434 *Archives of Occupational and Environmental Health*. 2008;81(8):1029-1036.

39 435 doi:10.1007/s00420-007-0296-7.

- 1
2
3 436 8. Lee YM. Loss of Productivity due to Depression among Korean Employees. *Journal*
4 437 *Occupational Health*. 2010;52(6):389-394.
5
6 438 9. Kim SE, Kim HN, Cho J, et al. Direct and Indirect Effects of Five Factor Personality and
7 439 Gender on Depressive Symptoms Mediated by Perceived Stress. *PLOS ONE*. 2016;11(4):
8 440 e0154140.
9 441 doi: 10.1371/journal.pone.0154140.
10
11 442 10. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Industrial accident compensation
12 443 insurance for mental disorders; 2011 [cited 22 December 2016]. Available from:
13 444 <http://www.mhlw.go.jp/bunya/roudoukijun/rouesaihoken04/dl/120215-01.pdf>. Japanese
14
15 445 11. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Industrial accident compensation
16 446 insurance for mental disorders; 2016 [cited 22 December 2016]. Available from:
17 447 <http://www.mhlw.go.jp/file/04-Houdouhappyou-11402000-Roudoukijunkyokuroudouhoshou>
18 448 [bu-Hoshouka/h27_seishin.pdf](http://www.mhlw.go.jp/file/04-Houdouhappyou-11402000-Roudoukijunkyokuroudouhoshou). Japanese
19
20 449 12. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Basic Survey on Industrial Safety
21 450 and Health; 2013 [cited 23 January 2017]. Available from:
22 451 <http://www.mhlw.go.jp/file/05-Shingikai-11201000-Roudoukijunkyoku-Soumuka/000006140>
23 452 [6.pdf](http://www.mhlw.go.jp/file/05-Shingikai-11201000-Roudoukijunkyoku-Soumuka/000006140). Japanese.
24
25 453 13. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Stress check system; 2015 [cited
26 454 12 December 2016]. Available from:
27 455 <http://www.mhlw.go.jp/bunya/roudoukijun/anzeneisei12/>. Japanese.
28
29 456 14. Lazarus R. Psychological Stress and the Coping Process. New York, McGraw-Hill; 1966.
30 457 15. Lazarus R & Folkman S. Stress, Appraisal, and Coping, New York, Springer; 1984.
31 458 16. Carpenter R. A Review of Instruments on Cognitive Appraisal of Stress. *Archives of*
32 459 *Psychiatric Nursing*. 2016;30(2):271-279.
33 460 doi: <http://dx.doi.org/10.1016/j.apnu.2015.07.002>.
34
35 461 17. Fevre ML, Matheny J, Kolt GS. Eustress, distress, and interpretation in occupational stress.
36 462 *Journal of Managerial Psychology*. 2003;18(7):726-744. doi: 10.1108/02683940310502412
37 463 18. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. *Journal of*
38 464 *Health and Social Behavior*. 1983;24(4):385-396.
39 465 19. Schelle KJ, Olthof BMJ, Reintjes W, et al. A survey of substance use for cognitive
40 466 enhancement by university students in the Netherlands. *Frontiers in Systems*
41 467 *Neuroscience*. 2015;9:10. doi:10.3389/fnsys.2015.00010.
42 468 20. Roberti JW, Harrington LN, Storch EA. Further Psychometric Support for the 10-Item
43 469 Version of the Perceived Stress Scale. *Journal of College Counseling*. 2006;9:135-147. doi:
44 470 10.1002/j.2161-1882.2006.tb00100.x.
45 471 21. Hamaideh SH, Al-ashram SA, Al-modallal H. Premenstrual syndrome and premenstrual
46 472 dysphoric disorder among Jordanian women. *Journal of Psychiatric and Mental Health*
47 473 *Nursing*. 2014;21(1):60-68. doi: 10.1111/jpm.12047.

- 1
2
3 474 22. Wawrzyniak AJ & Whiteman MCP. Perceived stress, loneliness, and interaction with
4 475 fellow students does not affect innate mucosal immunity in first year university students.
5 476 *Psychological Japanese Research*.2011;53(2):121-132.
6 477 doi: 10.1111/j.1468-5884.2011.00466.x.
7
8 478 23. Gupta R, Singh N, Kumar R. Longitudinal predictive validity of emotional intelligence on first
9 479 year medical students perceived stress. *BMC Medical Education*. 2017;17:139.
10 480 doi:10.1186/s12909-017-0979-z.
11
12 481 24. Li S, Li L, Zhu X, et al. Comparison of characteristics of anxiety sensitivity across career
13 482 stages and its relationship with nursing stress among female nurses in Hunan, China.*BMJ*
14 483 *Open*.2016;6(5):e010829. doi: 10.1136/bmjopen-2015-010829.
15
16 484 25. Györfy Z & Girasek E. Mental Health of Physicians Nationwide Representative Study
17 485 from Hungary. *Ideggyogyaszati szemle-Clinical Neuroscience*. 2015;68(7-8):258-269.
18
19 486 26. Su X, Lau JT, Mak WW, et al. Development of the Perceived Stress Scale for People
20 487 Living with HIV/AIDS in China. *AIDS Patient Care and STDs*. 2008;22(12):989-998. doi:
21 488 10.1089/apc.2008.0095.
22
23 489 27. Kimura T, Yokoyama A, Kohno N, et al. Perceived Stress, Severity of Asthma, and Quality
24 490 of Life in Young Adults with Asthma. *Allergology International*. 2009;58(1):71-79. doi:
25 491 10.2332/allergolint.O-07-531.
26
27 492 28. Hara Y, Hisatomi M, Ito H, et al. Effects of gender, age, family support, and treatment on
28 493 perceived stress and coping of patients with type 2 diabetes mellitus. *BioPsychoSocial*
29 494 *Medicine*.2014;8:16.
30 495 doi: 10.1186/1751-0759-8-16.
31
32 496 29. Lee EH, Chung Y, Suh H, et al. Korean versions of the Perceived Stress Scale (PSS-14, 10
33 497 and 4): psychometric evaluation in patients with chronic disease. *Scand J Caring Sci*.
34 498 2015;29(1):183-192. doi: 10.1111/scs.12131.
35
36 499 30. Mitchell AM, Crane PA, & Kim Y. Perceived Stress in Survivors of Suicide: Psychometric
37 500 Properties of the Perceived Stress Scale. *Research in Nursing & Health*. 2008;31(6):576-85.
38 501 doi: 10.1002/nur.20284.
39
40 502 31. Andreou E, Alexopoulos EC, Lionis C, et al. Perceived Stress Scale: reliability and
41 503 validity study in Greece. *Int J Environ Res Public Health*. 2011;8(8):3287-3298. doi:
42 504 10.3390/ijerph8083287
43
44 505 32. Barrington WE, Ceballos RM, Bishop SK, et al. Perceived Stress, Behavior, and Body
45 506 Mass Index among Adults Participating in a Worksite Obesity Prevention Program, Seattle,
46 507 2005-2007. *Prev Chronic Dis*. 2012;9:E152. doi: 10.5888/pcd9.120001
47
48 508 33. Leung DY, Lam TH, Chan SS. Three versions of Perceived Stress Scale: validation in
49 509 sample of Chinese cardiac patients who smoke. *BMC Public Health*. 2010;25;10:513. doi:
50 510 10.1186/1471-2458-10-513.
51
52 511 34. Willert MV, Wieclaw J, Thulstrup AM. Rehabilitation of individuals on long-term sick
53
54
55
56
57
58
59
60

- 1
2
3 512 leave due to sustained stress-related symptoms: A comparative follow-up study. *Scand J*
4 513 *Public Health*. 2014;42(8):719-27.
5
6 514 doi: 10.1177/1403494814551859.
- 7 515 35. Wiernik E, Nabi H, Pannier B, et al. (2014): Perceived stress, sex, and occupational status
8 516 interact to increase the risk of future high blood pressure: the IPC cohort study. *J Hypertens*.
9 517 2014;32(10):1979-1986.
10 518 doi: 10.1097/HJH.0000000000000288.
- 11 519 36. Horiuchi S, Tsuda A, Kim E, et al. Relationships between stage of change for stress
12 520 management behavior and perceived stress and coping. *Japanese psychological Research*.
13 521 2010;52(4):291-297.
14 522 doi: 10.1111/j.1468-5884.2010.00444.x.
- 15 523 37. Stewart DW, Vidrine JI, Shete S, et al. Health literacy, smoking, and health indicators in
16 524 African American adults. *J Health Commun*. 2015;20 Suppl 2:24-33. doi:
17 525 10.1080/10810730.2015.1066465.
- 18 526 38. Faresjö Å, Theodorsson E, Chatziarzenis M, et al. Higher Perceived Stress but Lower Cortisol
19 527 Levels Found among Young Greek Adults Living in a Stressful Social Environment in
20 528 Comparison with Swedish Young Adults. *PLoS One*. 2013;8(9):e73828.
21 529 doi: 10.1371/journal.pone.0073828
- 22 530 39. Mimura C & Griffiths G. A Japanese version of the perceived stress scale: translation and
23 531 preliminary test. *International Journal of Nursing Studies*. 2004; 41(4): 379-385.
- 24 532 40. Mimura C & Griffiths G. A Japanese version of the Perceived Stress Scale: cross-cultural
25 533 translation and equivalence assessment. *BMC Psychiatry*. 2008;8:85. doi:
26 534 10.1186/1471-244X-8-85.
- 27 535 41. Shima S, Kano T, Kitamura T, et al. Atarashii yokuutsusei jiko hyouka syakudo ni tsuite (A
28 536 new self-report depression scale). *Clinical Psychiatry*, 1985;27: 717-723. Japanese
- 29 537 42. Radloff LS. The CES-D Scale. A self-report depression scale for research in the general
30 538 population. *Applied Psychological Measurement*.1985;1(3):385-401.
31 539 doi: <https://doi.org/10.1177/014662167700100306>
- 32 540 43. Shimomitsu T, & Odagiri Y. The brief job stress questionnaire. *Japanese Journal of*
33 541 *Occupational Mental Health*.2004;12(1):25-36. Japanese
- 34 542 44. Kawakami N & Fujigaki Y. Reliability and Validity of the Japanese Version of Job Content
35 543 Questionnaire: Replication and Extension in Computer Company Employees. *Industrial*
36 544 *Health*.1996;34(4):295-306.
- 37 545 45. Karasek R, Brisson C, Kawakami N, et al. The Job Content Questionnaire (JCQ): an
38 546 instrument for internationally comparative assessments of psychosocial job characteristics. *J*
39 547 *Occup Health Psychol*. 1998;3(4):322-55.
- 40 548 46. Kawakami N, Kobayashi F, Araki S, et al. Assessment of job stress dimensions based on
41 549 the Job Demands-Control model of employees of telecommunication and electric power

- 1
2
3 550 companies in Japan: reliability and validity of the Japanese version of Job Content
4 551 Questionnaire. *Int J Behav Med.* 1995;2(4):358-75.
- 5
6 552 47. Suzuki-Saito T, Yasumura S, Okamura T, et al. Medical care costs and the characteristics
7 553 of higher medical costs among BMI groups in the early-stage elderly Analysis of data
8 554 obtained from a large-scale study of 29,490 elderly. *Japanese Journal of Public
9 555 Health.*2012;59(7);466-473. Japanese.
10 556 doi: http://doi.org/10.11236/jph.59.7_466
- 11
12
13 557 48. Togari T, Yamazaki Y, Koide S, et al. Reliability and validity of the Modified Perceived
14 558 Health Competence Scale (PHCS) Japanese version. *Japanese Journal of Public
15 559 Health.*2006: 53(1); 51-57. Japanese.
16 560 doi:http://doi.org/10.11236/jph.53.1_51
- 17
18
19 561 49. Leon-Perez JM, Antino M, Leon-Rubio JM. The Role of Psychological Capital and
20 562 Intragroup Conflict on Employees' Burnout and Quality of Service: A Multilevel Approach.
21 563 *Front Psychol.* 2016; 7: 1755. doi: 10.3389/fpsyg.2016.01755
- 22
23 564 50. Smith MS, Wallston KA, Smith CA. The development and validation of the Perceived
24 565 Health Competence Scale. *Health Educ Res.* 1995 Mar;10(1):51-64.
- 25
26 566 51. Mitsutake S, Shibata A, Ishii K, et al. Developing Japanese version of the eHealth Literacy
27 567 Scale (eHEALS). *Japanese Journal of Public Health.*2011;58(5):361-371. Japanese. doi:
28 568 http://doi.org/10.11236/jph.58.5_361
- 29
30 569 52. Norman CD & Skinner HA. eHealth Literacy: Essential Skills for Consumer Health in a
31 570 Networked World. *J Med Internet Res.* 2006; 8(2): e9. doi: 10.2196/jmir.8.2.e9
- 32
33 571 53. Norman CD & Skinner HA. eHEALS: The eHealth Literacy Scale. *J Med Internet Res.*
34 572 2006 Oct-Dec; 8(4): e27. doi: 10.2196/jmir.8.4.e27
- 35
36 573 54. Ministry of Internal Affairs and Communications [Internet] Tokyo: White Paper on
37 574 Information and Communications in Japan; 2016 [cited 28 January 2017. Available from:
38 575 <http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2016/chapter-5.pdf#page=1>
- 39
40 576 55. Fukui S, Haratani T, Toshima Y, et al. Measuring Workplace Climate: Reliability and
41 577 Validity of the 12-item Organizational Climate Scale (OCS-12). *Japan Society for
42 578 Occupational Health.* 2004;46(6):213-222.
43
44 579 Japanese. doi:<http://doi.org/10.1539/sangyoisei.46.213>
- 45
46 580 56. Hemingway MA & Smith CS. Organizational climate and occupational stressors as
47 581 predictors of withdrawal behaviors and injuries in nurses. *Journal of Occupational and
48 582 Organizational Psychology.* 1999;72(3):285-299.
49 583 doi:10.1348/096317999166680
- 50
51
52 584 57. Iwasa H, Gondo Y, Masui Y, et al. Reliability and validity of “Social Support Scale”,
53 585 Japanese language edition: Investigation targeting middle and old age. *Indicators of social
54 586 welfare.*2007 54(6), 26-33. Japanese.
- 55
56 587 58. Zimet GD, Dahlem NW, Zimet SG, Farley GK. The Multidimensional Scale of Perceived
57
58
59

- 1
2
3 588 Social Support. *Journal of Personality Assessment*. 1988;52(1):30-41. doi:
4 589 10.1207/s15327752jpa5201_2
5
6 590 59. Japan Institute for Labour Policy and Training [Internet] Tokyo: Labour statistics data
7 591 retrieval system (Basic Survey on Wage Structure); 2015 [cited 19 December 2016].
8
9 592 http://stat.jil.go.jp/jil63/plsql/JTK0400?P_TYOUSU=R1&P_HYOUJI=C0010&P_KITYOU=0
10 593 60. Katsarou A, PANagiotakos D, Zafeiropoulou A, et al. Validation of a Greek Version of
11 594 PSS-14: A global measure of perceived stress. *Cent Eur J Public Health*.
12 595 2012;20(2):104-109.
13
14 596 61. Remor E. Psychometric properties of a European Spanish version of the Perceived Stress
15 597 Scale (PSS). *Span J Psychol*. 2006; 9(1); 86-93.
16
17 598 62. Lee J, Kim EY, Wachholtz A. The effect of perceived stress on life satisfaction: The
18 599 mediating effect of self-efficacy. *Chongsonyonghak Yonku*. 2016;23(10):29-47.
19
20 600 63. Nutbeam D. Health promotion glossary. *Health Promotion International*.
21 601 1998;13(4):349-364.
22
23 602 64. Ishikawa H, Nomura K, Sato M, et al. Developing a measure of communicative and critical
24 603 health literacy: a pilot study of Japanese office workers. *Health Promotion International*.
25 604 *Health Promot Int*. 2008;23(3):269-274.
26 605 doi: 10.1093/heapro/dan017.
27
28 606 65. Ministry of Economy, Trade and Industry [Internet]. Tokyo: Employment Status Survey;
29 607 2012 [cited 24 December 2016] Available from:
30 608 <http://www.stat.go.jp/english/data/shugyou/pdf/sum2012.pdf>. Japanese
31
32 609 66. Ritterband LM & Palermo T. Introduction to the Special Issue: eHealth in Pediatric
33 610 Psychology. *Journal of Pediatric Psychology*. 2009;34(5):453-456.
34 611 doi: 10.1093/jpepsy/jsp008
35
36 612 67. Mitsutake S, Shibata A, Ishii K, et al. Associations of eHealth Literacy With Health
37 613 Behavior Among Adult Internet Users. *J Med Internet Res*. 2016;18(7):e192.
38 614 doi: 10.2196/jmir.5413.
39
40 615 68. Koizumi Y, Awata S, Kuriyama S, et al. Association between social support and depression
41 616 status in the elderly: results of a 1-year community-based prospective cohort study in Japan.
42 617 *Psychiatry Clin Neurosci*. 2005;59(5):563-569.
43
44 618 69. Frasure-Smith N, Lesperance F, Gravel G, et al. Social Support, depression, and mortality
45 619 during the first year after myocardial infarction. *Circulation*. 2000;101(16):1919-1924.
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4-5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	-
		(c) Explain how missing data were addressed	-
		(d) If applicable, describe analytical methods taking account of sampling strategy	7-8
		(e) Describe any sensitivity analyses	8
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	9-11
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(b) Report category boundaries when continuous variables were categorized	-
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

An epidemiological study of cognitive stress appraisal and related factors among workers: cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019404.R1
Article Type:	Research
Date Submitted by the Author:	28-Dec-2017
Complete List of Authors:	Tohmiya, Natsuka; Setagaya District Administration Offices,, Public Health Promotion Division; Yokohama Shiritsu Daigaku, Graduate School of Medicine Tadaka, Etsuko; Yokohama City University, Community Health Nursing Arimoto, Azusa; Yokohama Shiritsu Daigaku, Department of Community Health Nursing
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Epidemiology, Mental health, Nursing, Public health, Occupational and environmental medicine
Keywords:	cognitive stress appraisal, environmental factor, individual factor, workers

SCHOLARONE™
Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 An epidemiological study of cognitive stress appraisal and related factors among
2 workers: cross-sectional study

6 Corresponding aauthor

7 Natsuka Tohmiya

8 MSN, RN, PHN

9 Public Health Promotion Division, Setagaya District Administration Offices,

10 4-22-33 Setagaya Setagaya-city, Tokyo 154-8504 Japan

11 E-mail: natsuka.dct.ft@gmail.com

12 TEL: +81-3-5432-2896

13 FAX: +81-3-5432-3074

15 Co-author

16 Etsuko Tadaka, Azusa Arimoto

17 Graduate School of Medicine, Yokohama City University, Yokohama, Kanagawa, Japan

20 Word count: 4,283 words

25 ABSTRACT

26 **Objective** Stress as a trigger for depression has enormous socioeconomic implications for all
27 spheres of employment, because it affects absenteeism, turnover, productivity, morale, and
28 suicide. Positive or negative cognitive stress appraisal can, however, affect workers' ability to
29 cope with stress as a self-care strategy. This study examined cognitive stress appraisal among
30 workers and identify related individual and environmental factors.

31 **Design** Cross-sectional study using self-administered postal questionnaires.

32 **Participants** 2,311 people working at 48 companies in metropolitan areas in Japan. In total,
33 341 questionnaires were returned (response rate: 14.8%), 337 of which were suitable for
34 analysis (effective response rate: 98.8%).

35 **Primary measures** Cognitive stress appraisal was assessed using the Japanese version of the
36 Perceived Stress Scale (PSS). Potential variables related to stress appraisal included
37 demographic, individual, and environmental factors. Multiple regression analysis was used to
38 identify factors related to cognitive stress appraisal.

39 **Results** The mean age \pm SD was 42.8 ± 11.7 years, and two-thirds were male. The mean PSS
40 score \pm SD was 25.8 ± 6.2 . Multiple regression analysis after controlling for variables of age,
41 sex, and depression indicated that those with poorer economic status ($\beta = 0.161$, $p < 0.001$),
42 lower eHealth literacy ($\beta = -0.116$, $p = 0.009$), higher traditional organizational climate ($\beta =$
43 0.124 , $p = 0.005$), and lower feelings of social support ($\beta = -0.220$, $p < 0.001$) experienced
44 significantly higher negative levels of perceived stress.

45 **Conclusion** The results show the individual and environmental factors related to cognitive
46 stress appraisal among workers. The inter-professional approach of public health nurses and
47 health practitioners, including a spectrum of enhanced self-coping skills using the eHealth
48 literacy of individual workers, improvement of traditional organizational climate at their
49 worksite, and social support in their community, might be an effective strategy to contribute to
50 improved mental health among workers.

51 **Strengths and limitations of this study**

- 52 • First study to examine the individual and environmental factors related to cognitive stress
53 appraisal of healthy and general workers.
- 54 • Simultaneously examine both eHealth literacy, multidimensional perceived social support
55 and traditional organizational climate.
- 56 • This study is cross-sectional design, it could not identify causal relationships between
57 cognitive stress appraisal and related factors.
- 58 • This study's target population is limited to metropolitan areas in Japan.

59
60
61 **keywords:** cognitive stress appraisal, environmental factor, individual factor, workers

INTRODUCTION

Depression is one of the most common psychiatric disorders, affecting about 350 million people worldwide [1]. In Japan, depression is estimated to have affected up to 1.116 million people in 2015 [2]. Certain occupational factors account for up to 8% of cases of depression) [3]. The World Health Organization's comprehensive mental health action plan 2013–2020 was adopted by the 66th World Health Assembly [4] and argues that determinants of mental health and psychiatric disorders include not only individual attributes but also social, cultural, economic, political, and environmental factors [5]. Mental illnesses are associated with a substantial deterioration in individual quality of life and economic loss in the community and the workplace [5, 6]. Therefore, primary prevention of depressive disorders is an important issue nationally and internationally, and not just for individuals.

Stress as a trigger for depression has enormous socioeconomic implications for all spheres of employment, because it affects absenteeism, turnover, productivity, morale, and suicide [7,8,9]. In Japan, the number of employees applying for industrial accident compensation insurance for mental disorders because of stress has increased in recent years [10]. In 2015, the number of applications was 1,515, up from 1,272 in 2011 [11]. The proportion of workers experiencing anxiety, distress, and work stress has progressively increased since 1982 and is now around 60% [12]. Against this background, the Japanese government launched a new occupational health policy in 2015 called "The Stress Check Program" to screen for workers experiencing high psychosocial stress [13]. The law mandates use of the Stress Check Program and its guidelines at least once per year in all workplaces with 50 or more employees in Japan. The program and its guidelines recommends individual checks on perceived stress and sets out four principles of care in the workplace: (1) self-care; (2) line-care; (3) health practitioners' care in the workplace; and (4) health practitioners' care in the community.

Cognitive stress appraisal is the evaluation of how individuals perceive the stressors that cause stress and is a self-care strategy. In primary appraisal, an individual's evaluations are divided into "threat," and "challenge", threat describes anticipated harm/loss, and challenge describes a threat that can be met or overcome [14,15]. Whether something is given a cognitive appraisal of "threat" or "challenge" can affect mental health [15,16]. The stress response and stress coping caused by cognitive appraisal differ among individuals, even in response to the same stressors [17]. For example, people making a positive cognitive appraisal may see stress as a challenging health issue to be resolved, and set themselves challenging goals [14,15]. Those making a negative cognitive appraisal can view the same issues as a health threat, and may believe that resolving tasks and situations is beyond their abilities. Positive or negative cognitive stress appraisal can therefore be an important concept in mental health to improve stress-coping skills and control stress among workers. In an individual, a positive cognitive appraisal contributes to prevention of depression, thus improving quality of

1
2
3 99 life. At the societal level, this is important in controlling the escalation of medical costs and
4 100 increasing corporate and community-wide productivity.

5
6 101 The Perceived Stress Scale (PSS) measures the degree to which situations are
7 102 cognitively appraised as stressful [18]. Cohen said that PSS is a measure of the degree
8 103 to which situations in one's life are appraised as stressful. In addition, items of PSS
9 104 were designed to tap how unpredictable, uncontrollable, and overloaded respondents
10 105 find their lives and these issues have been repeatedly found to be central components
11 106 of the experience of stress. (Perceptions of stress and negative affect are necessary for
12 107 stressful life events to influence disease risk.) [18] Also, Cohen said PSS can be used to
13 108 determine whether "appraised" stress is an etiological (or risk) factor in behavioral
14 109 disorders or disease. [18,19] Thus, we interpreted PSS can continuously measure
15 110 negative cognitive stress appraisal. Many previous studies have measured cognitive
16 111 stress appraisal using the PSS and related factors in students [20-24], medical workers
17 112 [25,26], and patients with chronic disease [27-30]. The scale has not, however, been
18 113 used with healthy adult workers in a wide spectrum of employments. Previous studies
19 114 clarified various individual factors related to the PSS, but varied for different
20 115 participants. Some studies examined the physical and psychological health condition
21 116 of students and conditions in particular groups such as adults with a disease or
22 117 pregnant women [28,31,32]. Others examined the lifestyles of students, pregnant
23 118 women, and medical workers [26,33,34]; job stress among medical workers [25,35,36];
24 119 stressors and coping in adults, such as survivors of suicide and pregnant women
25 120 [31,37]; and health literacy in African-American adults [38]. However, there is limited
26 121 information about the relationship between cognitive stress appraisal and individual
27 122 and environmental factors such as work environment and social support available to
28 123 adult workers [39].

29 124 The purpose of this study was to examine cognitive stress appraisal and identify
30 125 individual and environmental factors among workers. The study can contribute to
31 126 minimizing the effect of one factor that might be associated with an increased risk of
32 127 depression and contribute to the promotion of individual self-care and improvement of
33 128 worksite environments to promote mental health among workers. Furthermore, it can
34 129 be useful for primary prevention of mental health disorders among workers by public
35 130 health nurses and health practitioners at worksites.

36 131

37 132 **METHODS**

38 133 **Participants and sampling**

39 134 The study participants were workers at companies in metropolitan areas of Japan. The criteria

1
2
3 135 for participation included being between 18 and 64 years old. An age of 64 years is the upper
4 136 limit for consideration of retirement and re-employment under the Law Concerning
5 137 Stabilization of Employment of Older Persons; 18 years is the earliest age for employment
6 138 immediately after graduating high school in Japan. We selected companies stratified number
7 139 of employees based on Industrial Safety and Health Act. Moreover, we clarified that there is
8 140 no biased type of industry.

9
10
11 141 The study design was a cross-sectional study using self-administered postal questionnaires.
12 142 Data were collected across two metropolitan areas of Japan (Tokyo and Kanagawa
13 143 prefectures) from companies registered in the Japan Company Handbook 2016. Questionnaires
14 144 were sent to employees randomly selected, stratified by the number of employees of each
15 145 company. In total, 361 of 2,026 companies were selected (17.8%).
16 146

17 147 **Measuring instruments**

18 148 **Dependent variable: Cognitive stress appraisal**

19
20
21 149 The dependent variable was cognitive stress appraisal, which was determined using the
22 150 Japanese version of the PSS [40,41]. The PSS consists of 14 items and includes questions such
23 151 as “In the last month, how often have you been upset because of something that happened
24 152 unexpectedly?” and “In the last month, how often have you felt that you were unable to
25 153 control the important things in your life?” The responses were coded for scoring as “Never” =
26 154 0, “Almost Never” = 1, “Sometimes” = 2, “Fairly Often” = 3, and “Very Often” = 4. Possible
27 155 total scores ranged from 0 to 56 with higher scores indicating higher levels of negative
28 156 cognitive stress appraisal. All 14 items are highly intercorrelated in the Japanese version
29 157 (Cronbach’s alpha = 0.74).

30 158 **Demographic characteristics**

31 159 Demographic characteristics collected about the participants in this study included age, sex
32 160 (“Male”=1, “Female”=2), marital status (“Unmarried” and “Divorced/Widowed” =1,
33 161 “Married”=2), household membership (“Live alone”=1, “Spouse”=2, “Spouse and
34 162 Children”=3, “Parents”=4, “Others”=5), educational status (“Junior high school/High
35 163 school”=1, “Vocational college/Junior college”=2, “College or University/Graduate
36 164 school”=3), employment status (“Fulltime worker”=1, “Part-time worker”=2, “Others”=3),
37 165 economic status (“Sufficient”=1, “Slightly sufficient”=2, “slightly insufficient”
38 166 =3, “Insufficient”=4) and depression. We asked standard questions generally used in
39 167 previous study for workers and deliberated about items of national survey for workers.

40 168 Depression was measured using the Japanese version of the Center for Epidemiologic
41 169 Studies Depression Scale (CES-D) [42,43], which consists of 20 items. Each item is measured

1
2
3 170 on a four-point Likert-type scale ranging from 0 to 3. The total score ranges from 0 to 60 with
4 171 higher scores indicating greater levels of depression; scores above 16 on the CES-D indicate a
5 172 depressive state. CES-D was developed for use in epidemiological studies of depressive
6 173 symptomatology in the general population [42,43]. A group with a higher score may be
7 174 interpreted to be depressive state or in need of treatment [43]. Cognitive stress appraisal is
8 175 affected by participants' mental condition at that time. Depression is basic mental condition of
9 176 participants. The psychometric properties of CES-D were confirmed reliability and
10 177 validity. CES-D had high internal consistency, acceptable test-retest stability, and
11 178 excellent concurrent validity by clinical and self-report criteria and substantial
12 179 evidence of construct validity. When CES-D designed, internal consistency was high in
13 180 the general population (0.77-0.87) and even higher in the patient sample (0.85-0.92).
14 181 And the test-retest correlations were in the moderate range (between 0.45 and 0.70). In
15 182 addition, the correlations of the CES-D with the Hamilton Clinician's Rating scale and
16 183 with the Raskin Rating scale were moderate (0.44-0.54) at admission.[42,43]
17
18
19
20
21
22
23
24
25
26
27

28 186 **Independent variable**

29
30 187 Conceptual framework of this study was to examine cognitive stress appraisal and
31 188 identify individual and environmental factors. According to Lazarus's theory,
32 189 individual and environment mutually affect in cognitive stress appraisal process. So,
33 190 we thought both individual and environmental factors were important. When we
34 191 selected independent variables, we referred previous studies.

35
36 192 Individual factors of the participants in this study included any disease currently under
37 193 treatment (e.g., cancer, diabetes), body mass index (BMI), self-rated health, physical
38 194 complaints, physical demands, lifestyle, perceived health competence, and electronic health
39 195 literacy (eHealth literacy).
40
41
42
43
44

45 197 BMI is calculated from self-reported weight and height.
46
47

48 199 Self-rated health was measured on a four-point Likert-type scale from 1 (very poor) to 4 (very
49 200 good). Physical complaints were measured using the Brief Job Stress Questionnaire (BJSQ)
50 201 [44]. The BJSQ is used in the Japan Stress Check Test by the Ministry of Health, Labour and
51 202 Welfare [12] and can be easily used in the workplace. It consists of 57 items across 19
52 203 subscales, from which we drew 11 items (e.g., "I have felt dizzy" and "I have experienced
53 204 joint pains"). Each item was measured on a four-point Likert-type scale. The total scores
54 205 ranged from 11 to 44 with higher scores indicating more frequent physical complaints.
55
56
57
58
59
60

206

207 Physical demands were measured using the Job Content Questionnaire (JCQ) [45], which
208 consists of 45 items divided into six subscales. We used three items on physical exertion and
209 two on isometric load. Each item was measured on a five-point Likert-type scale. The total
210 scores for physical exertion ranged from three to 15, and for isometric load from two to 10,
211 with higher scores indicating stronger physical demands and isometric load. The JCQ was
212 developed based on the job demands–control model and has been nationally standardized by
213 occupation in several countries [45-47].

214

215 Lifestyle was measured using seven items based on Breslow’s good health habits [48]. The
216 scale covered smoking, drinking alcohol, eating breakfast every day, physical activity, eating
217 snacks after dinner, skipping breakfast, and sleeping and resting. The responses were coded
218 for scoring as “yes” or “no.”

219

220 Perceived health competence was measured using the Perceived Health Competence Scale,
221 Japanese version (PHCS) [49], which consists of eight items. Each was measured on a
222 five-point Likert-type scale. The total scores ranged from 8 to 40, with higher scores
223 indicating higher perceived health competence. Perceived health competence is related to
224 stress [50]. The PHCS was designed to assess efficacy and competence beliefs about personal
225 health at this intermediate level of domain-specificity [51].

226

227 eHealth literacy was measured using the Japanese version of the eHealth Literacy Scale
228 (eHEALS) [52], which consists of eight items. eHealth literacy is defined as the ability to seek,
229 find, understand, and appraise health information from electronic sources, and apply the
230 knowledge gained from doing so in addressing or solving a health problem [53,54]. Responses
231 to the scale were assessed using a five-point Likert-type scale. The total scores ranged from 8
232 to 40 with higher scores showing greater health literacy. In Japan, Internet penetration in the
233 age group under study is over 90% [55]. eHEALS has been developed to address the need to
234 assess eHealth literacy for a wide range of populations and contexts. It is designed to provide
235 a general estimate of consumer eHealth-related skills to inform clinical decision-making and
236 health promotion planning with individuals or specific populations [54].

237

238 **Environmental factors: Organizational climate**

239 Organizational climate was measured using the 12-item Organizational Climate Scale [56],
240 which is divided into two six-item subscales: the tradition scale and the organizational
241 environment scale. The responses were coded for scoring as “yes” = 2 and “no” = 1. The total
242 possible scores ranged from six to 12 for each scale. Higher scores on the tradition scale show

1
2
3 243 a more mandatory, injunctive, and feudalistic organizational climate and higher scores on the
4 244 organizational environment scale show a more flexible organizational system. A previous
5 245 study showed that organizational climate could affect occupational stress [57]. This scale
6 246 measures organizational properties based on the model of Healthy Work Organizations at
7 247 NIOSH [56].
8
9

10 248
11
12

13 249 **Social support**

14
15
16 250 Social support was measured using the short version of the Multidimensional Scale of
17 251 Perceived Social Support (MPSS) in Japanese [58,59], which consists of seven items. Each
18 252 item was examined on a seven-point Likert-type scale with lower scores indicating lower
19 253 feelings of social support. The MPSS specifically addresses the subjective assessment of
20 254 social support adequacy and was designed to assess perceptions of social support adequacy
21 255 from three specific sources: family, friends, and significant others [59].
22
23
24
25

26 256

27 257 **Data collection**

28
29 258 In total, 48 of 361 companies agreed to participate to this study. Prior to sending the
30 259 questionnaire to each company, we identified the sample size from the administrators. A total
31 260 of 2,311 questionnaires were sent to the 48 companies via mail. Of the 2,311 questionnaires
32 261 mailed to the companies, 341 were returned (response rate: 14.8%). The potential participants,
33 262 all the employees in each of these companies, were asked to complete the questionnaire
34 263 anonymously and on a voluntary basis, between October 1 and December 9, 2016. The
35 264 anonymity of the workers was maintained throughout the process by using unsigned forms,
36 265 which they posted back themselves. Returning the document was considered to indicate
37 266 informed consent.
38
39
40
41
42

43 267
44

45 268 **Statistical analysis**

46
47 269 The mean, SD, frequency, and percentage were calculated for demographic characteristics,
48 270 positive or negative cognitive stress appraisal (PSS), and individual and environmental factors.
49 271 Univariate analysis using Spearman's correlation was used to examine correlations between
50 272 the dependent and independent variables. A multiple regression analysis was then used to
51 273 identify factors related to cognitive stress appraisal among workers, using all potentially
52 274 significant predictors identified by the univariate analyses ($P < 0.05$) considering
53 275 multicollinearity as independent variables via the forced entry (variable reduction) method.
54
55
56
57
58

1
2
3 276 The multiple regression model contained selected independent variables and all statistical
4 277 analyses. We performed with step 1 have the control variables, step 2 having the
5 278 demographics, and step 3 having the remaining predictors. Sex, age, and depression were
6 279 contained as controlled variables. A previous study reported high correlation between the PSS
7 280 and the CES-D, but both scales still independently predicted symptomatology [18]. The aim of
8 281 this research was primary prevention of poor mental health, specifically depression. We
9 282 therefore assumed that depression was covariate and treated it as a control variable. All
10 283 analyses were performed using IBM SPSS Statistics for Windows version 22.0. Sample size
11 284 was calculated using sample-size calculating software G*Power version 3.0.10. [60]
12 285 With power of 80 %, 0.05 statistical level of significance, effect size of 0.15[61] and
13 286 number of predictors of 13, sample size for multiple regression model was calculated to
14 287 be 131. We converted a missing data into a median value of this study sample. The level of
15 288 significance was set at $P < 0.05$.

16 289

25 290 **RESULTS**

26 291 Returned questionnaires were 341. Four of the 341 questionnaires were from participants aged
27 292 over 65 years or who did not provide their age. We excluded these questionnaires and were
28 293 left with 337 questionnaires for analysis (effective response rate: 98.8%).

29 294 Participants' background information (demographic characteristics, individual factors,
30 295 environmental factors) is shown in Table 1.

31 296 The mean age \pm SD was 42.8 ± 11.7 years, and approximately two-thirds were male and
32 297 married. Two-fifths lived with their children, and one-quarter lived alone. Two-thirds had
33 298 graduated from college or higher. Most participants had regular employment. Four-fifths felt
34 299 good about their economic status. The mean CES-D score \pm SD was 12.8 ± 7.6 , and 99
35 300 participants (29.5%) were rated as having depression based on the cut-off point. The mean
36 301 PSS score \pm SD was 25.8 ± 6.2 . One-quarter of the participants were being treated for a
37 302 disease. The mean BMI \pm SD was 22.0 ± 3.1 , and three-quarters were within the healthy range
38 303 (over 18.5, less than 25). Four-fifths reported that their self-rated health was good or fairly
39 304 good. The mean physical complaint score \pm SD was 19.3 ± 5.1 . The mean scores for physical
40 305 exertion and isometric load \pm SD were 4.9 ± 1.8 , and 3.2 ± 1.3 . Most of the healthy lifestyle
41 306 options were chosen by at least 50% of the participants, and some by approximately
42 307 three-quarters of them. The mean score for PHCS and eHEALS \pm SD were 23.4 ± 6.5 , and
43 308 22.0 ± 7.5 . The mean \pm SD for the tradition scale score was 8.0 ± 1.6 , the organizational
44 309 environment scale 8.6 ± 1.8 , and the social support scale score 5.4 ± 1.2 .

45 310

56 **Table 1. Background of the participants**

Items	Number or Mean±SD	% (Range)
Demographic characteristics		
Age	42.8±11.7	(18-64)
Sex		
Male	228	67.7
Female	109	32.3
Matital status		
Unmarried	110	32.6
Married	203	60.2
Divorced/Widowed	24	7.1
Household membership		
Live alone	76	22.8
Spouse	48	14.4
Spouse and children	129	38.6
Parentes	50	15.0
Others	31	9.3
Educational status		
Junior high school/High school	78	23.1
Vocational college/Junior college	53	15.7
College or University/Graduate school	206	61.1
Employment status		
Fulltime worker	301	89.9
Part-time worker	27	8.1
Others	7	2.1
Economic status		
Sufficient	106	31.5
Slightly sufficient	175	51.9
Slightly insufficient	51	15.1
Insufficient	5	1.5
Depression (CES-D)		
Score	12.8±7.6	(0-45)
Depression(CES-D ≥ 16; cut-off point)	99	29.5
Dependent variable		
Cognitive stress appraisal (PSS)	25.8±6.2	(6-48)

SD, standard deviation

311

312

313

Table 1. Background of the participants (cont.)

Items	Number or Mean±SD	%(Range)
Individual factors		
Disease currently under treatment		
No	252	75.0
Yes	84	25.0
High blood pressure	25	7.4
Gout	11	3.3
Hyperlipidemia	8	2.4
Respiratory disease	8	2.4
Diabetes	7	2.1
Digestive disease	7	2.1
Mental disease	7	2.1
Others	26	7.7
Body-mass index (BMI)		
Mean	22.0±3.1	(14.5-34.6)
Thin (BMI < 18.5)	32	9.8
Standard (18.5 ≤ BMI < 25)	243	74.8
Obesity (25 ≤ BMI)	50	15.4
Self-rated health		
Very poor	7	2.2
Rather poor	47	14.6
Rather good	216	66.9
Very good	53	16.4
Brief Job Stress (BJSQ)		
Physical complaint	19.3±5.1	(11-36)
Physical demands (Job Content: JCQ)		
Physical exertion	4.9±1.8	(3-11)
Isometric load	3.2±1.3	(2-8)
Life style		
No smoking	255	75.7
Non or sometimes drinking alcohol	256	76.0
Breakfast everyday	241	71.5
More than once a week physical activity	75	22.3
No eating after dinner over 3days per week	246	73.0
No skipping breakfast over 3days per week	248	73.6
Get enough sleep and rest	190	56.5
Perceived health competence (PHCS)	23.4±6.5	(8-40)
eHealth literacy (eHEALS)	22.0±7.5	(3-40)
Environmental factors		
Organizational climate		
Tradition	8.0±1.6	(6-12)
Organizational environment	8.6±1.8	(6-12)
Social support	5.4±1.2	(2-7)

SD, standard deviation

314

315

316 There were correlations among demographic characteristics, individual and environmental
 317 factors, and cognitive stress appraisal. Spearman's correlation coefficients measured the linear
 318 relationship between each factor and PSS among workers.

319 The demographic characteristics showing significant correlations with cognitive stress
 320 appraisal were age ($r = -0.300, p < 0.001$), marital status ($r = -0.207, p < 0.001$), household
 321 membership ($r = -0.231, p < 0.001$), economic status ($r = 0.355, p < 0.001$) and depression ($r =$
 322 $0.528, p < 0.001$). Individual factors showing significant correlations with cognitive stress
 323 appraisal were self-rated health ($r = -0.275, p < 0.001$), physical complaints ($r = 0.372, p <$
 324 0.001), total scores for physical exertion ($r = 0.109, p = 0.048$) and isometric load ($r = 0.183,$
 325 $p = 0.001$), physical activity ($r = -0.162, p = 0.003$), sleeping and resting ($r = -0.278, p <$
 326 0.001), perceived health competence ($r = 0.412, p < 0.001$), and eHealth literacy ($r = -0.295, p$
 327 < 0.001). Environmental factors showing significant correlations with cognitive stress
 328 appraisal were total scores for the tradition ($r = 0.197, p < 0.001$) and organizational
 329 environment scales ($r = -0.182, p = 0.001$) and social support ($r = -0.398, p < 0.001$).

330 The factors associated with cognitive stress appraisal—marital status, household
 331 membership, economic status, physical activity, sleeping, isometric load, eHealth literacy,
 332 tradition and organizational environment scales, and social support—were used as
 333 independent variables, and age, sex, and depression as control variables in a multiple
 334 regression analysis. The results are shown in Table 2. This analysis indicated that those with
 335 poorer economic status ($\beta = 0.161, p = 0.001$), lower eHealth literacy ($\beta = -0.116, p = 0.009$),
 336 higher traditional organizational climate ($\beta = 0.124, p = 0.005$), and lower feelings of social
 337 support ($\beta = -0.220, p < 0.001$) experienced a higher level of perceived negative stress. The
 338 adjusted R^2 in this analysis was 0.412.

Table 2. Cognitive stress appraisal and related factors

	β	p
Demographic characteristics		
Economic status (1=sufficient, 2=slightly sufficient, 3=slightly insufficient, 4=insufficient)	0.171	0.000
Individual factors		
eHealth literacy (total score)	-0.113	0.012
Environmental factors		
Organizational climate: Tradition (total score)	0.131	0.004
Social support (total score)	-0.205	0.000
Adjusted R^2		0.412

Multiple regression analysis.

Controlled variables: Age, Sex (0=female, 1=male), Depression (0=no, 1=yes).

DISCUSSION

The participants in this study were representative of healthy adult workers in a wide spectrum of employments in Japan. Firstly, in terms of demographic characteristics, such as age, sex and the proportion of participants in this study was similar to the national statistics for full-time workers in Japan [62]. Secondly, in terms of the participants' levels of the PSS, the PSS scores in this study were quite similar to those obtained when the PSS was originally developed [18] and from the scores of adults in other countries [63,64]. Therefore this study can be generalized to other workers not only in Japan but also other developed countries.

Our study is the first to our knowledge to examine the features of cognitive stress appraisal in workers and identify the associated individual and environmental factors. This study has added to the existing research evidence that individual factors, including eHealth literacy, and environmental factors, such as the organizational climate, are both related to cognitive stress appraisal among workers. This study therefore has important practical implications in promoting stress management and primary prevention of stress-related disease and suicide among workers.

The economic status is related to cognitive stress appraisal. It is possible that poor economic status itself is the origin of the stress, and workers with poor economic status therefore cannot cope with their own stress. Cognitive stress appraisal and subjective economic status are related and self-efficacy played an important role as a mediator between cognitive evaluation of stress and life satisfaction [65]. Workers may be unable to appraise challenges and struggle in stressful situations because they feel that their own ability level is low and resources are few.

Lower eHealth literacy was related to negative stress appraisal in this study. Health literacy is a cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand, and use information in ways which promote and maintain good health [66]. Higher health literacy may enable an individual to actively seek support and solutions to problems [67]. Good eHealth literacy means people can access health information resources and use the information via the Internet. The Internet is increasingly becoming an effective information tool for improving self-care behavior [68-70]. There is a considerable amount of health information on the Internet, which is helpful for positive cognitive stress appraisal. Improving eHealth literacy should empower workers to obtain, understand, and act on information that they need for optimal mental health.

More traditional organizational climates were related to negative cognitive stress appraisal. A traditional organizational climate is more directive and feudalistic [56]. Higher tradition scores corresponded to higher levels of depressive state, lower job satisfaction, and lower levels of mental health [56]. A "traditional" structure or climate implies high levels of mandatory working, a lack of respect for individual opinion and pressure from superiors. Workers in a traditional organizational climate have less discretion and a more stressful

environment. They may be unable to ask for help from their supervisor, or make improvements to the work environment. The relation between organizational climate and worker's performance can be explained using the Social Exchange Theory. This theory is based upon the assumption that social exchanges involve several actions that create obligations, and that relationships evolve over time into trusting, loyal, and mutual commitments [71]. Organizational climate can be changed when employers establish an organizational climate that is perceived as positive by their employees with their good relationships, and this can result in better organizational performance and higher levels of motivation in workers.

Lower levels of social support were also related to negative stress appraisal. This is consistent with previous studies reporting that the amount of social support was associated with levels of depression [72], and that social support buffered adverse effects on mental health [73]. Social support also protects from the pathogenic effects of stressful events by altering the appraisal of those events or the process by which perceived stress causes illness [18]. Those who feel that they have little social support may be unable to buffer stressful events, on the other hand, those who feel that they have enough social support may be able to buffer stressful events.

In conclusion, it is suggested that the inter-professional approach of public health nurses and health practitioners, including provision of a spectrum of enhanced self-coping skills using the eHealth literacy of individual workers, development of a more modern organizational climate at their worksite, and social support in their community might be an effective strategy to contribute to minimizing the effect of one factor, 'cognitive stress appraisal' that might be associated with an increased risk of depression and contribute to the promotion of mental health in workers.

400

401 **Limitations**

402 This study had several limitations. First, it used a cross-sectional design, which means that it
403 could not identify causal relationships between cognitive stress appraisal and related factors.
404 Second, it was low response rate, which may be a lot of instrument. So we should consider the
405 number of questions, and collection method of questionnaires. Third, the adjusted R^2 was
406 0.412 in this study, which was higher than the value of 0.05–0.27 reported previously [65].
407 Although this provides an adequate explanation of the factors related to cognitive stress
408 appraisal, other factors are also likely to contribute. Future research requires longitudinal
409 studies across other areas, widening the scope.

410

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

411 **Conclusions**

412 This study aimed to examine the cognitive stress appraisal, and to identify factors related to
413 the cognitive stress appraisal in workers. The results indicated that cognitive stress appraisal
414 is associated with economic status, depression, eHealth literacy, traditional organizational
415 climate, and social support. Thus, it was recommended that public health nurses and health
416 practitioners should enhance economic status, eHealth literacy, traditional organizational
417 climate, and social support, and improvement depression to encourage workers for better
418 cognitive stress appraisal. Furthermore, occupational and community interventions are
419 required to create and inform people of the opportunities for cognitive stress appraisal in
420 worksite and communities.

423 **Acknowledgements**

424 The authors would like to thank all the employees who agreed to participate in this study.

427 **Footnotes**

428 **Contributors**

429 NT, ET and AA contributed to develop the concept and design of this study.
430 ET was responsible for acquiring the Institutional Review Board (IRB) approval of this study.
431 NT was responsible for data collection and analysis.
432 NT and AA were responsible for drafting and revising the manuscript.
433 ET is responsible for study supervision and reporting of study results.
434 All authors have read and approved the final manuscript.

436 **Competing interests**

437 We have read and understood BMJ policy on declaration of interests and declare that we have
438 no competing interests.

440 **Funding**

441 This study was supported by University Center of Community (COC) program funded by the
442 Ministry of Education, Culture, Sports, Science and Technology, Japan
443 (<http://www.mext.go.jp/en/>). The funders had no role in study design, data collection and
444 analysis, decision to publish, or preparation of the manuscript.

446 **Ethics**

447 The questionnaire was unsigned to maintain the anonymity of all personal participant

1
2
3 448 information. The Institutional Review Board of the Medical Department of the Yokohama City
4 449 University approved this study on August 9, 2016 (Certification No.A1608008 ; PI: Dr.Etsuko
5 450 Tadaka).
6 451

7 452 **Data sharing statement**

8
9 453 No additional unpublished data from the study are available at the moment.
10 454
11 455

12 456 **REFERENCES**

- 13 457 1. World Health Organization [Internet]. Genève: Depression; 2016 [cited 26 December 2016].
14 458 Available from:
15 459 <http://www.who.int/mediacentre/factsheets/fs369/en/>.
16 460 2. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Patient Survey; 2015 [cited 12
17 461 December 2016]. Available from:
18 462 <http://www.mhlw.go.jp/toukei/saikin/hw/kanja/14/dl/kanja.pdf> (in Japanese)
19 463 3. World Health Organization [Internet]. Genève: Depression; 2014 [cited 26 December 2016].
20 464 Available from: <http://www.who.int/mediacentre/factsheets/fs389/en/>
21 465 4. World Health Organization [Internet]. Genève: Comprehensive mental health action plan
22 466 2013–2020; 2013 [cited 27 December 2016]. Available from:
23 467 http://www.who.int/mental_health/action_plan_2013/en/
24 468 5. World Health Organization [Internet]. Genève: Mental Health Action Plan 2013-2020; 2013
25 469 [cited 26 December 2016]. Available from:
26 470 http://apps.who.int/iris/bitstream/10665/89966/1/9789241506021_eng.pdf?ua=1
27 471 6. World Economic Forum and the Harvard School of Public Health [Internet]. Genève: The
28 472 global economic burden of non-communicable diseases; 2011 [cited 27 December 2016].
29 473 Available from:
30 474 <http://apps.who.int/medicinedocs/documents/s18806en/s18806en.pdf>
31 475 7. Van den Berg TIJ, Alavinia SM, Bredt FJ, et al. The influence of psychosocial factors at
32 476 work and life style on health and work ability among professional workers. *International*
33 477 *Archives of Occupational and Environmental Health*. 2008;81(8):1029-1036.
34 478 doi:10.1007/s00420-007-0296-7.
35 479 8. Lee YM. Loss of Productivity due to Depression among Korean Employees. *Journal*
36 480 *Occupational Health*. 2010;52(6):389-394.
37 481 9. Kim SE, Kim HN, Cho J, et al. Direct and Indirect Effects of Five Factor Personality and
38 482 Gender on Depressive Symptoms Mediated by Perceived Stress. *PLOS ONE*. 2016;11(4):
39 483 e0154140.
40 484 doi: 10.1371/journal.pone.0154140.

- 1
2
3 485 10. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Industrial accident compensation
4 486 insurance for mental disorders; 2011 [cited 22 December 2016]. Available from:
5 487 <http://www.mhlw.go.jp/bunya/roudoukijun/rousaihoken04/dl/120215-01.pdf>. Japanese
6
7 488 11. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Industrial accident compensation
8 489 insurance for mental disorders; 2016 [cited 22 December 2016]. Available from:
9 490 <http://www.mhlw.go.jp/file/04-Houdouhappyou-11402000-Roudoukijunkyokuroudouhoshou>
10 491 [bu-Hoshouka/h27_seishin.pdf](http://www.mhlw.go.jp/file/04-Houdouhappyou-11402000-Roudoukijunkyokuroudouhoshou). Japanese
11
12 492 12. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Basic Survey on Industrial Safety
13 493 and Health; 2013 [cited 23 January 2017]. Available from:
14 494 <http://www.mhlw.go.jp/file/05-Shingikai-11201000-Roudoukijunkyoku-Soumuka/000006140>
15 495 6.pdf. Japanese.
16
17 496 13. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Stress check system; 2015 [cited
18 497 12 December 2016]. Available from:
19 498 <http://www.mhlw.go.jp/bunya/roudoukijun/anzeneisei12/>. Japanese.
20
21 499 14. Lazarus R. Psychological Stress and the Coping Process. New York, McGraw-Hill; 1966.
22
23 500 15. Lazarus R & Folkman S. Stress, Appraisal, and Coping, New York, Springer; 1984.
24
25 501 16. Carpenter R. A Review of Instruments on Cognitive Appraisal of Stress. *Archives of*
26 502 *Psychiatric Nursing*. 2016;30(2):271-279.
27
28 503 doi: <http://dx.doi.org/10.1016/j.apnu.2015.07.002>.
29
30 504 17. Fevre ML, Matheny J, Kolt GS. Eustress, distress, and interpretation in occupational stress.
31 505 *Journal of Managerial Psychology*. 2003;18(7):726-744. doi: 10.1108/02683940310502412
32
33 506 18. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. *Journal of*
34 507 *Health and Social Behavior*. 1983;24(4):385-396.
35
36 508 19.
37
38 509 20. Schelle KJ, Olthof BMJ, Reintjes W, et al. A survey of substance use for cognitive
39 510 enhancement by university students in the Netherlands. *Frontiers in Systems*
40 511 *Neuroscience*. 2015;9:10. doi:10.3389/fnsys.2015.00010.
41
42 512 21. Roberti JW, Harrington LN, Storch EA. Further Psychometric Support for the 10-Item
43 513 Version of the Perceived Stress Scale. *Journal of College Counseling*. 2006;9:135-147. doi:
44 514 10.1002/j.2161-1882.2006.tb00100.x.
45
46 515 22. Hamaideh SH, Al-ashram SA, Al-modallal H. Premenstrual syndrome and premenstrual
47 516 dysphoric disorder among Jordanian women. *Journal of Psychiatric and Mental Health*
48 517 *Nursing*. 2014;21(1):60-68. doi: 10.1111/jpm.12047.
49
50 518 23. Wawrzyniak AJ & Whiteman MCP. Perceived stress, loneliness, and interaction with
51 519 fellow students does not affect innate mucosal immunity in first year university students.
52 520 *Psychological Japanese Research*. 2011;53(2):121-132.
53
54 521 doi: 10.1111/j.1468-5884.2011.00466.x.
55
56 522 24. Gupta R, Singh N, Kumar R. Longitudinal predictive validity of emotional intelligence on first
57
58
59
60

- 1
2
3 523 year medical students perceived stress. *BMC Medical Education*. 2017;17:139.
4 524 doi:10.1186/s12909-017-0979-z.
- 5
6 525 25. Li S, Li L, Zhu X, et al. Comparison of characteristics of anxiety sensitivity across career
7 526 stages and its relationship with nursing stress among female nurses in Hunan, China. *BMJ*
8 527 *Open*. 2016;6(5):e010829. doi: 10.1136/bmjopen-2015-010829.
- 9
10 528 26. Györfy Z & Girasek E. Mental Health of Physicians Nationwide Representative Study
11 529 from Hungary. *Ideggyogyaszati szemle-Clinical Neuroscience*. 2015;68(7-8):258-269.
- 12
13 530 27. Su X, Lau JT, Mak WW, et al. Development of the Perceived Stress Scale for People
14 531 Living with HIV/AIDS in China. *AIDS Patient Care and STDs*. 2008;22(12):989-998. doi:
15 532 10.1089/apc.2008.0095.
- 16
17 533 28. Kimura T, Yokoyama A, Kohno N, et al. Perceived Stress, Severity of Asthma, and Quality
18 534 of Life in Young Adults with Asthma. *Allergology International*. 2009;58(1):71-79. doi:
19 535 10.2332/allergolint.O-07-531.
- 20
21 536 29. Hara Y, Hisatomi M, Ito H, et al. Effects of gender, age, family support, and treatment on
22 537 perceived stress and coping of patients with type 2 diabetes mellitus. *BioPsychoSocial*
23 538 *Medicine*. 2014;8:16.
24
25 539 doi: 10.1186/1751-0759-8-16.
- 26
27 540 30. Lee EH, Chung Y, Suh H, et al. Korean versions of the Perceived Stress Scale (PSS-14, 10
28 541 and 4): psychometric evaluation in patients with chronic disease. *Scand J Caring Sci*.
29 542 2015;29(1):183-192. doi: 10.1111/scs.12131.
- 30
31 543 31. Mitchell AM, Crane PA, & Kim Y. Perceived Stress in Survivors of Suicide: Psychometric
32 544 Properties of the Perceived Stress Scale. *Research in Nursing & Health*. 2008;31(6):576-85.
33 545 doi: 10.1002/nur.20284.
- 34
35 546 32. Andreou E, Alexopoulos EC, Lionis C, et al. Perceived Stress Scale: reliability and
36 547 validity study in Greece. *Int J Environ Res Public Health*. 2011;8(8):3287-3298. doi:
37 548 10.3390/ijerph8083287
- 38
39 549 33. Barrington WE, Ceballos RM, Bishop SK, et al. Perceived Stress, Behavior, and Body
40 550 Mass Index among Adults Participating in a Worksite Obesity Prevention Program, Seattle,
41 551 2005-2007. *Prev Chronic Dis*. 2012;9:E152. doi: 10.5888/pcd9.120001
- 42
43 552 34. Leung DY, Lam TH, Chan SS. Three versions of Perceived Stress Scale: validation in
44 553 sample of Chinese cardiac patients who smoke. *BMC Public Health*. 2010;25;10:513. doi:
45 554 10.1186/1471-2458-10-513.
- 46
47 555 35. Willert MV, Wieclaw J, Thulstrup AM. Rehabilitation of individuals on long-term sick
48 556 leave due to sustained stress-related symptoms: A comparative follow-up study. *Scand J*
49 557 *Public Health*. 2014;42(8):719-27.
50
51 558 doi: 10.1177/1403494814551859.
- 52
53 559 36. Wiernik E, Nabi H, Pannier B, et al. (2014): Perceived stress, sex, and occupational status
54 560 interact to increase the risk of future high blood pressure: the IPC cohort study. *J Hypertens*.

- 1
2
3 561 2014;32(10):1979-1986.
4 562 doi: 10.1097/HJH.0000000000000288.
5
6 563 37. Horiuchi S, Tsuda A, Kim E, et al. Relationships between stage of change for stress
7 564 management behavior and perceived stress and coping. *Japanese psychological Research*.
8 565 2010;52(4):291-297.
9 566 doi: 10.1111/j.1468-5884.2010.00444.x.
10
11 567 38. Stewart DW, Vidrine JI, Shete S, et al. Health literacy, smoking, and health indicators in
12 568 African American adults. *J Health Commun*. 2015;20 Suppl 2:24-33. doi:
13 569 10.1080/10810730.2015.1066465.
14
15 570 39. Faresjö Å, Theodorsson E, Chatziarzenis M, et al. Higher Perceived Stress but Lower Cortisol
16 571 Levels Found among Young Greek Adults Living in a Stressful Social Environment in
17 572 Comparison with Swedish Young Adults. *PLoS One*. 2013;8(9):e73828.
18 573 doi: 10.1371/journal.pone.0073828
19
20 574 40. Mimura C & Griffiths G. A Japanese version of the perceived stress scale: translation and
21 575 preliminary test. *International Journal of Nursing Studies*. 2004; 41(4): 379-385.
22
23 576 41. Mimura C & Griffiths G. A Japanese version of the Perceived Stress Scale: cross-cultural
24 577 translation and equivalence assessment. *BMC Psychiatry*. 2008;8:85. doi:
25 578 10.1186/1471-244X-8-85.
26
27 579 42. Shima S, Kano T, Kitamura T, et al. Atarashii yokuutsusei jiko hyouka syakudo ni tsuite (A
28 580 new self-report depression scale). *Clinical Psychiatry*, 1985;27; 717-723. Japanese
29
30 581 43. Radloff LS. The CES-D Scale. A self-report depression scale for research in the general
31 582 population. *Applied Psychological Measurement*. 1985;1(3):385-401.
32 583 doi: <https://doi.org/10.1177/014662167700100306>
33
34 584 44. Shimomitsu T, & Odagiri Y. The brief job stress questionnaire. *Japanese Journal of*
35 585 *Occupational Mental Health*. 2004;12(1):25-36. Japanese
36
37 586 45. Kawakami N & Fujigaki Y. Reliability and Validity of the Japanese Version of Job Content
38 587 Questionnaire: Replication and Extension in Computer Company Employees. *Industrial*
39 588 *Health*. 1996;34(4):295-306.
40
41 589 46. Karasek R, Brisson C, Kawakami N, et al. The Job Content Questionnaire (JCQ): an
42 590 instrument for internationally comparative assessments of psychosocial job characteristics. *J*
43 591 *Occup Health Psychol*. 1998;3(4):322-55.
44
45 592 47. Kawakami N, Kobayashi F, Araki S, et al. Assessment of job stress dimensions based on
46 593 the Job Demands-Control model of employees of telecommunication and electric power
47 594 companies in Japan: reliability and validity of the Japanese version of Job Content
48 595 Questionnaire. *Int J Behav Med*. 1995;2(4):358-75.
49
50 596 48. Suzuki-Saito T, Yasumura S, Okamura T, et al. Medical care costs and the characteristics
51 597 of higher medical costs among BMI groups in the early-stage elderly Analysis of data
52 598 obtained from a large-scale study of 29,490 elderly. *Japanese Journal of Public*
53
54
55
56
57
58
59
60

- 1
2
3 599 *Health*.2012;59(7);466-473. Japanese.
4 600 doi: http://doi.org/10.11236/jph.59.7_466
5
6 601 49. Togari T, Yamazaki Y, Koide S, et al. Reliability and validity of the Modified Perceived
7 602 Health Competence Scale (PHCS) Japanese version. *Japanese Journal of Public*
8 603 *Health*.2006; 53(1); 51-57. Japanese.
9 604 doi:http://doi.org/10.11236/jph.53.1_51
10
11 605 50. Leon-Perez JM, Antino M, Leon-Rubio JM. The Role of Psychological Capital and
12 606 Intragroup Conflict on Employees' Burnout and Quality of Service: A Multilevel Approach.
13 607 *Front Psychol*. 2016; 7: 1755. doi: 10.3389/fpsyg.2016.01755
14
15 608 51. Smith MS, Wallston KA, Smith CA. The development and validation of the Perceived
16 609 Health Competence Scale. *Health Educ Res*. 1995 Mar;10(1):51-64.
17
18 610 52. Mitsutake S, Shibata A, Ishii K, et al. Developing Japanese version of the eHealth Literacy
19 611 Scale (eHEALS). *Japanese Journal of Public Health*.2011;58(5):361-371. Japanese. doi:
20 612 http://doi.org/10.11236/jph.58.5_361
21
22 613 53. Norman CD & Skinner HA. eHealth Literacy: Essential Skills for Consumer Health in a
23 614 Networked World. *J Med Internet Res*. 2006; 8(2): e9. doi: 10.2196/jmir.8.2.e9
24
25 615 54. Norman CD & Skinner HA. eHEALS: The eHealth Literacy Scale. *J Med Internet Res*.
26 616 2006 Oct-Dec; 8(4): e27. doi: 10.2196/jmir.8.4.e27
27
28 617 55. Ministry of Internal Affairs and Communications [Internet] Tokyo: White Paper on
29 618 Information and Communications in Japan; 2016 [cited 28 January 2017. Available from:
30 619 <http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2016/chapter-5.pdf#page=1>
31
32 620 56. Fukui S, Haratani T, Toshima Y, et al. Measuring Workplace Climate: Reliability and
33 621 Validity of the 12-item Organizational Climate Scale (OCS-12). *Japan Society for*
34 622 *Occupational Health*. 2004;46(6):213-222.
35
36 623 Japanese. doi:<http://doi.org/10.1539/sangyoisei.46.213>
37
38 624 57. Hemingway MA & Smith CS. Organizational climate and occupational stressors as
39 625 predictors of withdrawal behaviors and injuries in nurses. *Journal of Occupational and*
40 626 *Organizational Psychology*. 1999;72(3):285-299.
41 627 doi:10.1348/096317999166680
42
43 628 58. Iwasa H, Gondo Y, Masui Y, et al. Reliability and validity of “Social Support Scale”,
44 629 Japanese language edition: Investigation targeting middle and old age. *Indicators of social*
45 630 *welfare*.2007 54(6), 26-33. Japanese.
46
47 631 59. Zimet GD, Dahlem NW, Zimet SG, Farley GK. The Multidimensional Scale of Perceived
48 632 Social Support. *Journal of Personality Assessment*. 1988;52(1):30-41. doi:
49 633 10.1207/s15327752jpa5201_2
50
51 634 60. Cohen J. A Power Primer. *Psychological Bulletin*. 1992; 112(1): 155-159.
52
53 635 61. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power
54 636 analysis program for the social, behavioral, and biomedical sciences. *Behav Res*

- 1
2
3 637 *Methods*. 2007;3:175-91.
- 4 638 62. Japan Institute for Labour Policy and Training [Internet] Tokyo: Labour statistics data
5 639 retrieval system (Basic Survey on Wage Structure); 2015 [cited 19 December 2016].
6 640 http://stat.jil.go.jp/jil63/plsql/JTK0400?P_TYOUSHA=R1&P_HYOUJI=C0010&P_KITYOU=0
7
8 641 63. Katsarou A, PANagiotakos D, Zafeiropoulou A, et al. Validation of a Greek Version of
9 642 PSS-14: A global measure of perceived stress. *Cent Eur J Public Health*.
10 643 2012;20(2):104-109.
- 11 644 64. Remor E. Psychometric properties of a European Spanish version of the Perceived Stress
12 645 Scale (PSS). *Span J Psychol*. 2006; 9(1); 86-93.
- 13 646 65. Lee J, Kim EY, Wachholtz A. The effect of perceived stress on life satisfaction: The
14 647 mediating effect of self-efficacy. *Chongsonyonghak Yongu*. 2016;23(10):29-47.
- 15 648 66. Nutbeam D. Health promotion glossary. *Health Promotion International*.
16 649 1998;13(4):349-364.
- 17 650 67. Ishikawa H, Nomura K, Sato M, et al. Developing a measure of communicative and critical
18 651 health literacy: a pilot study of Japanese office workers. *Health Promotion International*.
19 652 *Health Promot Int*. 2008;23(3):269-274.
20 653 doi: 10.1093/heapro/dan017.
- 21 654 68. Ministry of Economy, Trade and Industry [Internet]. Tokyo: Employment Status Survey;
22 655 2012 [cited 24 December 2016] Available from:
23 656 <http://www.stat.go.jp/english/data/shugyou/pdf/sum2012.pdf>. Japanese
- 24 657 69. Ritterband LM & Palermo T. Introduction to the Special Issue: eHealth in Pediatric
25 658 Psychology. *Journal of Pediatric Psychology*. 2009;34(5):453-456.
26 659 doi: 10.1093/jpepsy/jsp008
- 27 660 70. Mitsutake S, Shibata A, Ishii K, et al. Associations of eHealth Literacy With Health
28 661 Behavior Among Adult Internet Users. *J Med Internet Res*. 2016;18(7):e192.
29 662 doi: 10.2196/jmir.5413.
- 30 663 71. Cropanzano R & Mitchell MS. Social Exchange Theory: An Interdisciplinary Review.
31 664 *Journal of Management*. 2005;31(6): 874-900
- 32 665 72. Koizumi Y, Awata S, Kuriyama S, et al. Association between social support and depression
33 666 status in the elderly: results of a 1-year community-based prospective cohort study in Japan.
34 667 *Psychiatry Clin Neurosci*. 2005;59(5):563-569.
- 35 668 73. Frasure-Smith N, Lesperance F, Gravel G, et al. Social Support, depression, and mortality
36 669 during the first year after myocardial infarction. *Circulation*. 2000;101(16):1919-1924.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4-5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-8
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8-9
		(b) Describe any methods used to examine subgroups and interactions	-
		(c) Explain how missing data were addressed	9
		(d) If applicable, describe analytical methods taking account of sampling strategy	7-8
		(e) Describe any sensitivity analyses	8-9
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4-5
		(b) Give reasons for non-participation at each stage	4-5
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	9-11
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(b) Report category boundaries when continuous variables were categorized	-
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

A cross-sectional study of cognitive stress appraisal and related factors among workers in metropolitan areas of Japan.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019404.R2
Article Type:	Research
Date Submitted by the Author:	09-Mar-2018
Complete List of Authors:	Tohmiya, Natsuka; Setagaya District Administration Offices,, Public Health Promotion Division; Yokohama Shiritsu Daigaku, Graduate School of Medicine Tadaka, Etsuko; Yokohama City University, Community Health Nursing Arimoto, Azusa; Yokohama Shiritsu Daigaku, Department of Community Health Nursing
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Epidemiology, Mental health, Nursing, Public health, Occupational and environmental medicine
Keywords:	cognitive stress appraisal, environmental factor, individual factor, workers

SCHOLARONE™
Manuscripts

Only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 A cross-sectional study of cognitive stress appraisal and related factors among
2 workers in metropolitan areas of Japan

3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

6 Corresponding author
7 Natsuka Tohmiya
8 MSN, RN, PHN
9 Public Health Promotion Division, Setagaya District Administration Offices,
10 4-22-33 Setagaya Setagaya-city, Tokyo 154-8504 Japan
11 Email: natsuka.dct.ft@gmail.com
12 TEL: +81-3-5432-2896
13 FAX: +81-3-5432-3074

15 Co-authors
16 Etsuko Tadaka, Azusa Arimoto
17 Graduate School of Medicine, Yokohama City University, Yokohama, Kanagawa, Japan

20 Word count: 4,013words

25 ABSTRACT

26 **Objective:** Stress has major socioeconomic implications for all spheres of employment. It is a
27 trigger for depression, and affects absenteeism, turnover, productivity, morale, and suicide.
28 Positive or negative cognitive stress appraisal can be a self-care strategy that affects workers'
29 ability to cope with stress. This study examined cognitive stress appraisal among workers and
30 identified related individual and environmental factors.

31 **Design:** Cross-sectional study using self-administered postal questionnaires.

32 **Setting:** Companies located in two metropolitan areas of Japan (Tokyo and Kanagawa
33 prefectures)

34 **Participants:** 2,311 employees of 48 companies in metropolitan areas in Japan. In total, 341
35 questionnaires were returned (response rate: 14.8%), 337 of which were suitable for analysis
36 (effective response rate: 98.8%).

37 **Primary measures:** Cognitive stress appraisal was assessed using the Japanese version of the
38 Perceived Stress Scale (PSS). Potential variables related to stress appraisal included
39 demographic, individual, and environmental factors. Multiple regression analysis was used to
40 identify factors related to cognitive stress appraisal.

41 **Results:** Participants' mean \pm standard deviation [SD] age was 42.8 ± 11.7 years, and
42 two-thirds were male. The mean \pm SD PSS score was 25.8 ± 6.2 . The multiple regression
43 analysis controlled for age, sex, and depression showed that those with poorer economic status
44 ($\beta = 0.161$, $p < 0.001$), lower eHealth literacy ($\beta = -0.116$, $p = 0.009$), higher traditional
45 organizational climate ($\beta = 0.124$, $p = 0.005$), and lower perceived social support ($\beta = -0.220$,
46 $p < 0.001$) experienced significantly higher levels of negatively perceived stress.

47 **Conclusions:** The results show individual and environmental factors related to cognitive
48 stress appraisal among workers. An effective strategy to improve mental health among
49 workers may involve an inter-professional approach by public health nurses and health
50 practitioners that includes enhanced self-coping skills using individual workers' eHealth
51 literacy, improvement of organizational climates in workplaces, and community-based social
52 support.

53

54 **Strengths and limitations of this study**

- 55 • This study is the first to examine individual and environmental factors related to cognitive
56 stress appraisal among healthy workers.
- 57 • We simultaneously examined eHealth literacy, multidimensional perceived social support,
58 and traditional organizational climates.
- 59 • This study used a cross-sectional design, and could not identify causal relationships between
60 cognitive stress appraisal and related factors.
- 61 • The target population of this study was limited to metropolitan areas in Japan.

62 **keywords:** cognitive stress appraisal, environmental factor, individual factor, workers

INTRODUCTION

Depression is a common psychiatric disorder, affecting about 350 million people worldwide and is a major contributor to the overall global burden of disease.[1] In Japan, depression is estimated to have affected up to 1.116 million people in 2015.[2] Depression is different from usual mood fluctuations and short-lived emotional responses to challenges in everyday life. Especially when long-lasting and with moderate or severe intensity, depression may become a serious health condition. In particular, depression caused by occupational stress result in increasing rates of long-term illness and absence from work among workers.[3] The World Health Organization's Comprehensive Mental Health Action Plan 2013–2020 adopted by the 66th World Health Assembly[4] argues that determinants of mental health and psychiatric disorders include individual attributes and social, cultural, economic, political, and environmental factors for protecting workers' health.[5] Mental illnesses are associated with a substantial deterioration in individual quality of life, and economic loss in the community and workplace.[5,6] Therefore, primary prevention of depressive disorders is important nationally and internationally, as well as for individuals.

Stress has major socioeconomic implications for all spheres of employment. It is a trigger for depression and affects absenteeism, turnover, productivity, morale, and suicide.[7,8,9] In Japan, the number of employees that applied for industrial accident compensation insurance for mental disorders because of stress has increased in recent years.[10] There was 1,515 applications in 2015, which was up from 1,272 in 2011.[11] The proportion of workers experiencing anxiety, distress, and work stress has progressively increased since 1982, and is now estimated at 60%.[12] In this context, the Japanese government launched "The Stress Check Program" in 2015, a new occupational health policy to screen for workers experiencing high psychosocial stress.[13] The law mandates use of the Stress Check Program and its guidelines at least once each year in all workplaces in Japan with 50 or more employees. The program and guidelines recommend individual checks for perceived stress, and sets out four principles of care in the workplace: 1) self-care; 2) line-care; 3) health practitioners' care in the workplace; and 4) health practitioners' care in the community.

Cognitive stress appraisal is a self-care strategy based on individuals' evaluation of how they perceive stressors. In primary appraisal, an individual's evaluations are divided into "threat" and "challenge"; threat describes anticipated harm/loss, and challenge describes a threat that can be met or overcome.[14,15] The cognitive appraisal of something as a "threat" or "challenge" can affect mental health.[15,16] The stress response and stress coping following cognitive appraisal differ among individuals, even in response to the same stressors.[17] For example, people making a positive cognitive appraisal may perceive stress as a challenging health issue to be resolved, and set themselves challenging goals.[14,15] Those making a negative cognitive appraisal may view the same issue as a health threat, and

1
2
3 100 believe that resolving the issue is beyond their abilities. Positive or negative cognitive stress
4 101 appraisal can therefore be an important mental health concept to improve stress-coping skills
5 102 and control stress among workers. For individuals, positive cognitive appraisal contributes to
6 103 prevention of depression, thereby improving quality of life. At the societal level, this is
7 104 important in controlling the escalation of medical costs and increasing corporate and
8 105 community-wide productivity.

9
10
11 106 The Perceived Stress Scale (PSS) measures the degree to which situations are cognitively
12 107 appraised as stressful.[18] Cohen explained the PSS as a measure of the degree to which
13 108 situations in one's life are appraised as stressful. PSS items were designed to capture how
14 109 unpredictable, uncontrollable, and overloaded respondents perceive their lives. These issues
15 110 have been repeatedly found to be central components of the experience of stress. In addition,
16 111 stressful life events influence disease risk through an individual's perceptions of stress and
17 112 negative affect.[18] Cohen also noted that the PSS can be used to determine whether
18 113 "appraised" stress is an etiological (or risk) factor in behavioral disorders or disease.[18,19]
19 114 Therefore, we considered that the PSS can continuously measure negative cognitive stress
20 115 appraisal. Previous studies have measured cognitive stress appraisal using the PSS and
21 116 investigated related factors with students,[20-24] medical professionals,[25,26] and patients
22 117 with chronic diseases.[27-30] However, the scale has not previously been used with healthy
23 118 adult workers in a range of employment types. Previous studies clarified various individual
24 119 factors related to the PSS, but these varied for different participants. Some studies examined
25 120 the physical and psychological health conditions among students or conditions in particular
26 121 populations (e.g., adults with a disease or pregnant women).[28,31,32] Other studies
27 122 examined lifestyle factors among students, pregnant women, and medical
28 123 professionals;[26,33,34] job stress among medical professionals;[25,35,36] stressors and
29 124 coping in adult survivors of suicide and pregnant women;[31,37] and health literacy in
30 125 African-American adults.[38] However, there is limited information about the relationship
31 126 between cognitive stress appraisal and individual and environmental factors (e.g., work
32 127 environment and available social support) among adult workers.[39]

33 128 This study aimed to examine cognitive stress appraisal among workers and identify
34 129 associated individual and environmental factors. The findings may contribute to minimizing
35 130 the effect of factors associated with an increased risk for depression, and contribute to
36 131 promoting individual self-care and improving workplace environments to promote mental
37 132 health among workers. Furthermore, the findings may be useful for public health nurses and
38 133 health practitioners at worksites engaged in primary prevention of mental health disorders
39 134 among workers.

40 135

41 136 **METHODS**

137 **Participants and sampling**

138 Study participants were employees of companies located in metropolitan areas of Japan. The
139 inclusion criterion was employees aged 18–64 years. The age of 64 years is the upper limit for
140 consideration of retirement and re-employment under the Japanese Law Concerning
141 Stabilization of Employment of Older Persons, and 18 years is the youngest age for
142 employment immediately after graduating high school in Japan.

143 This study used a cross-sectional design with self-administered postal questionnaires. Data
144 were collected from employees of companies registered in the Japan Company Handbook
145 2016 across two metropolitan areas of Japan (Tokyo and Kanagawa prefectures). We stratified
146 companies by size and type of industry, and selected companies randomly within that
147 stratification; 361 of a total 2,026 companies were selected (17.8%). The questionnaire did not
148 collect details about company name, number of employees and type of industry to safeguard
149 participant anonymity.

151 **Data collection**

152 Forty-eight of 361 companies agreed to participate in this study. Before sending the
153 questionnaires to each company, we identified the relevant sample size from company
154 administrators. In total, 2,311 questionnaires were mailed to the 48 companies. Of these, 341
155 questionnaires were returned (response rate: 14.8%). Potential participants (all employees of
156 the participating companies) were invited to complete the questionnaire anonymously on a
157 voluntary basis, between October 1 and December 9, 2016. Participant anonymity was
158 maintained throughout data collection as the questionnaires did not collect any identifying
159 information. In addition, participants returned completed questionnaires by mail to the
160 researchers themselves. Returning a completed questionnaire was considered to indicate
161 provision of informed consent.

163 **Instruments**

164 **Dependent variable: cognitive stress appraisal**

165 The dependent variable was cognitive stress appraisal, which was determined using the
166 Japanese version of the PSS [40,41]. The PSS comprises 14 items and includes questions such
167 as, “In the last month, how often have you been upset because of something that happened
168 unexpectedly?” and “In the last month, how often have you felt that you were unable to
169 control the important things in your life?” Responses were coded for scoring as Never = 0,
170 Almost Never = 1, Sometimes = 2, Fairly Often = 3, and Very Often = 4. Possible total scores

171 ranged from 0–56, with higher scores indicating higher levels of negative cognitive stress
172 appraisal. All 14 items in the Japanese version of the scale are highly intercorrelated
173 (Cronbach’s alpha = 0.74).

175 **Demographic characteristics**

176 Participants’ demographic characteristics included age, sex (Male = 1, Female = 2), marital
177 status (Unmarried and Divorced/Widowed = 1, Married = 2), household membership (Live
178 alone = 1, Spouse = 2, Spouse and Children = 3, Parents = 4, Others = 5), educational status
179 (Junior high school/High school = 1, Vocational college/Junior college = 2, College or
180 University/Graduate school = 3), employment status (Fulltime= 1, Part-time = 2, Others = 3),
181 economic status (Sufficient = 1, Slightly Sufficient = 2, Slightly Insufficient = 3, Insufficient
182 = 4), and depression. Items were based on standard questions generally used in previous
183 studies involving workers and items used in a recent national survey for workers.

184 Depression was measured using the Japanese version of the Center for Epidemiologic
185 Studies Depression Scale (CES-D),[42,43] which comprises 20 items. Each item is measured
186 on a four-point Likert-type scale from 0–3. Total scores range from 0–60, with higher scores
187 indicating greater levels of depression. CES-D scores above 16 indicate a depressive state.
188 The CES-D was developed for use in epidemiological studies of depressive symptomatology
189 in the general population.[42,43] A specific group with a higher mean score may be
190 interpreted to be at risk for a depressive state or in need of intervention.[43] Cognitive stress
191 appraisal is affected by participants’ mental condition at that particular time, which includes
192 depression. The psychometric properties of the CES-D have been investigated, and the scale
193 showed high internal consistency, acceptable test-retest stability, excellent concurrent validity
194 for clinical and self-report criteria, and substantial evidence of construct validity. When the
195 CES-D was designed, the internal consistency was high in the general population (0.77–0.87)
196 and higher in the patient sample (0.85–0.92), and test-retest correlations were in the moderate
197 range (0.45–0.70). In addition, the CES-D showed moderate correlations with the Hamilton
198 Clinician’s Rating scale and the Raskin Rating scale (0.44–0.54) at admission.[42,43]

200 **Independent variables**

201 The conceptual framework of this study was to examine cognitive stress appraisal and identify
202 related individual and environmental factors. According to Lazarus’s theory, individual and
203 environmental factors mutually affect the cognitive stress appraisal process. Therefore, we
204 considered both individual and environmental factors to be important. Independent variables
205 were selected based on previous studies[20-37].

206 Individual factors included any disease currently under treatment (e.g., cancer, diabetes),

207 body mass index (BMI), self-rated health, physical complaints, physical demands, lifestyle,
208 perceived health competence, and electronic health (eHealth) literacy. BMI was calculated
209 from self-reported weight and height. Self-rated health was measured on a four-point
210 Likert-type scale from 1 (very poor) to 4 (very good).

211 Physical complaints were measured using the Brief Job Stress Questionnaire (BJSQ).[44]
212 The BJSQ is used in the Japan Stress Check Test by the Ministry of Health, Labour and
213 Welfare,[12] and can be easily used in the workplace. It comprises 57 items on 19 subscales,
214 from which we drew 11 items (e.g., “I have felt dizzy” and “I have experienced joint pains”).
215 Each item was measured on a four-point Likert-type scale. Total scores ranged from 11–44,
216 with higher scores indicating more frequent physical complaints. Physical demands were
217 measured using the Job Content Questionnaire (JCQ),[45] which comprises 45 items on six
218 subscales. We used three items for physical exertion and two for isometric load. Items were
219 measured on a five-point Likert-type scale. Total scores for physical exertion ranged from 3–
220 15, and for isometric load from 2–10, with higher scores indicating stronger physical
221 demands/isometric load. The JCQ was developed based on the job demands–control model,
222 and has been nationally standardized by occupation in several countries.[45-47]

223 Lifestyle was measured using seven items based on Breslow’s good health habits.[48]
224 These items covered smoking, drinking alcohol, eating breakfast every day, physical activity,
225 eating snacks after dinner, skipping breakfast, and sleeping and resting. Responses were coded
226 for scoring as “yes” or “no.” Perceived health competence was measured using the Japanese
227 version of the Perceived Health Competence Scale (PHCS).[49] The PHCS comprises eight
228 items measured on a five-point Likert-type scale. Total scores ranged from 8–40, with higher
229 scores indicating higher perceived health competence. Perceived health competence is related
230 to stress,[50] and the PHCS was designed to assess efficacy and competence beliefs about
231 personal health at an intermediate level of domain-specificity.[51]

232 Finally, eHealth literacy was measured using the Japanese version of the eight-item eHealth
233 Literacy Scale (eHEALS).[52] eHealth literacy is defined as the ability to seek, find,
234 understand, and appraise health information from electronic sources, and apply that
235 knowledge in addressing or solving a health problem.[53,54] Responses were assessed using a
236 five-point Likert-type scale. Total scores ranged from 8–40, with higher scores indicating
237 greater eHealth literacy. In Japan, Internet penetration in the studied age group is over
238 90%.[55]. eHEALS was developed to address the need to assess eHealth literacy for a range of
239 populations and contexts. It is designed to provide a general estimate of consumer
240 eHealth-related skills to inform clinical decision-making and health promotion planning for
241 individuals or specific populations.[54]

242

243 **Environmental factors: Organizational climate**

1
2
3 244 Organizational climate was measured using the 12-item Organizational Climate Scale,[56]
4 245 which is divided into two six-item subscales: a tradition scale and an organizational
5 246 environment scale. Responses were coded for scoring as Yes = 2 and No = 1. The total
6 247 possible scores ranged from 6–12 for each subscale. Higher scores on the tradition scale
7 248 indicate a more mandatory, injunctive, and feudalistic organizational climate. Higher scores
8 249 on the organizational environment scale indicate a more flexible organizational system. A
9 250 previous study showed that organizational climate may affect occupational stress.[57] This
10 251 scale measures organizational properties based on the model of Healthy Work Organizations at
11 252 the National Institute for Occupational Safety and Health (NIOSH) of U.S. Department of
12 253 Labor.[56]
13 254

19 255 **Social support**

20
21 256 Social support was measured using the short version of the Multidimensional Scale of
22 257 Perceived Social Support (MPSS) in Japanese,[58,59] which comprises seven items.
23 258 Responses were on a seven-point Likert-type scale, with lower scores indicating lower
24 259 perceived social support. The MPSS specifically addresses the subjective assessment of social
25 260 support adequacy, and was designed to assess perceptions of social support adequacy from
26 261 three sources: family, friends, and significant others.[59]
27 262

32 263 **Statistical analysis**

33
34 264 Means, SDs, frequencies, and percentages were calculated for demographic characteristics,
35 265 positive or negative cognitive stress appraisal (PSS scores), and individual and environmental
36 266 factors. Univariate analysis using Spearman's correlation was used to examine correlations
37 267 between the dependent and independent variables. A multiple regression analysis was then
38 268 used to identify factors related to cognitive stress appraisal among workers, using all
39 269 potentially significant predictors identified by the univariate analyses ($p < 0.05$).
40 270 Multicollinearity of independent variables was considered via the forced entry (variable
41 271 reduction) method. The multiple regression model included selected independent variables
42 272 and all statistical analyses. In the model, step 1 included the control variables, step 2 the
43 273 demographic characteristics, and step 3 the remaining predictors. Sex, age, and depression
44 274 were entered as control variables. A previous study reported high correlation between the PSS
45 275 and the CES-D, but both scales still independently predicted symptomatology.[18] Because
46 276 the aim of this study was primary prevention of poor mental health, specifically depression,
47 277 we assumed that depression was a covariate and treated it as a control variable. Of the 337
48 278 effective response, data was missing for; BMI (n=2, 0.59%), self-rated health (n=14, 4.15%),
49 279 household membership (n=3, 0.89%), employment status (n=2, 0.59%), and CES-D (n=10,

3.20%), therefore, these cases were excluded from the multiple regression models. The sample size was calculated using G*Power version 3.0.10.[60] With power of 80%, a 0.05 level of statistical significance, an effect size of 0.15[61] and the number of predictors as 13, the required sample size for the multiple regression model was calculated as 131. The level of significance was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics for Windows version 22.0.

Patient and Public Involvement

Patients and or public were not involved in developing the hypothesis, the aim, nor were they involved in developing plans for study design or implementation of the study.

RESULTS

In total, 341 questionnaires were returned. Four questionnaires were from participants aged over 65 years or who did not provide their age. We excluded these questionnaires, which left 337 questionnaires for analysis (effective response rate: 98.8%). Participants' background information (demographic characteristics, individual factors, environmental factors) is shown in Table 1. Results are reported below as means \pm SD.

Participants mean age was 42.8 ± 11.7 years. Approximately 67.7% were male and 60.2% were married. 38.6% lived with their spouse and children, and 22.8% lived alone. 61.1% had graduated with a college education or higher, and most participants had regular employment. 83.4% felt good about their economic status. The mean CES-D score was 12.8 ± 7.6 , with 99 participants (29.5%) rated as having depression based on the cut-off point. The mean PSS score was 25.8 ± 6.2 , with one-quarter of participants being treated for a disease. The mean BMI was 22.0 ± 3.1 ; 74.8% of participants were in the healthy range (over 18.5, less than 25). 83.3% reported their self-rated health as good or fairly good. The mean physical complaint score was 19.3 ± 5.1 , and mean scores for physical exertion and isometric load were 4.9 ± 1.8 and 3.2 ± 1.3 , respectively. At least 50% of participants chose most of the healthy lifestyle options, and approximately 75% chose some health options. The mean PHCS and eHEALS scores were 23.4 ± 6.5 and 22.0 ± 7.5 , respectively. The mean tradition subscale score was 8.0 ± 1.6 and that of the organizational environment scale was 8.6 ± 1.8 . The mean social support scale score was 5.4 ± 1.2 .

Table 1. Background of the participants

Items	Number or Mean \pm SD	% (Range)
Demographic characteristics		
Age	42.8 \pm 11.7	(18-64)
Sex		

Male	228	67.7
Female	109	32.3
Matital status		
Unmarried	110	32.6
Married	203	60.2
Divorced/Widowed	24	7.1
Household membership		
Live alone	76	22.8
Spouse	48	14.4
Spouse and children	129	38.6
Parentes	50	15.0
Others	31	9.3
Educational status		
Junior high school/High school	78	23.1
Vocational college/Junior college	53	15.7
College or University/Graduate school	206	61.1
Employment status		
Fulltime worker	301	89.9
Part-time worker	27	8.1
Others	7	2.1
Economic status		
Sufficient	106	31.5
Slightly sufficient	175	51.9
Slightly insufficient	51	15.1
Insufficient	5	1.5
Depression (CES-D)		
Score	12.8±7.6	(0-45)
Depression(CES-D ≥ 16; cut-off point)	99	29.5
Dependent variable		
Cognitive stress appraisal (PSS)	25.8±6.2	(6-48)

SD, standard deviation

312

Table 1. Background of the participants (cont.)

Items	Number or Mean±SD	% (Range)
Individual factors		
Disease currently under treatment		
No	252	75.0
Yes	84	25.0
High blood pressure	25	7.4
Gout	11	3.3
Hyperlipidemia	8	2.4
Respiratory disease	8	2.4
Diabetes	7	2.1
Digestive disease	7	2.1
Mental disease	7	2.1
Others	26	7.7
Body-mass index (BMI)		
Mean	22.0±3.1	(14.5-34.6)

Thin (BMI < 18.5)	32	9.8
Standard (18.5 ≤ BMI < 25)	243	74.8
Obesity (25 ≤ BMI)	50	15.4
Self-rated health		
Very poor	7	2.2
Rather poor	47	14.6
Rather good	216	66.9
Very good	53	16.4
Brief Job Stress (BJSQ)		
Physical complaint	19.3±5.1	(11-36)
Physical demands (Job Content: JCQ)		
Physical exertion	4.9±1.8	(3-11)
Isometric load	3.2±1.3	(2-8)
Life style		
No smoking	255	75.7
Non or sometimes drinking alcohol	256	76.0
Breakfast everyday	241	71.5
More than once a week physical activity	75	22.3
No eating after dinner over 3 days per week	246	73.0
No skipping breakfast over 3 days per week	248	73.6
Get enough sleep and rest	190	56.5
Perceived health competence (PHCS)	23.4±6.5	(8-40)
eHealth literacy (eHEALS)	22.0±7.5	(3-40)
Environmental factors		
Organizational climate		
Tradition	8.0±1.6	(6-12)
Organizational environment	8.6±1.8	(6-12)
Social support	5.4±1.2	(2-7)

SD, standard deviation

313

314 There were correlations among demographic characteristics, individual and environmental
 315 factors, and cognitive stress appraisal. Spearman's correlation coefficients were used to
 316 measure the linear relationship between each factor and PSS among workers. The
 317 demographic characteristics showing significant correlations with cognitive stress appraisal
 318 were: age ($r = -0.300$, $p < 0.001$), marital status ($r = -0.207$, $p < 0.001$), household
 319 membership ($r = -0.231$, $p < 0.001$), economic status ($r = 0.355$, $p < 0.001$), and depression (r
 320 $= 0.528$, $p < 0.001$). Individual factors showing significant correlations with cognitive stress
 321 appraisal were: self-rated health ($r = -0.275$, $p < 0.001$), physical complaints ($r = 0.372$, $p <$
 322 0.001), total scores for physical exertion ($r = 0.109$, $p = 0.048$) and isometric load ($r = 0.183$,
 323 $p = 0.001$), physical activity ($r = -0.162$, $p = 0.003$), sleeping and resting ($r = -0.278$, $p <$
 324 0.001), perceived health competence ($r = 0.412$, $p < 0.001$), and eHealth literacy ($r = -0.295$, p
 325 < 0.001). Environmental factors showing significant correlations with cognitive stress
 326 appraisal were: total scores for the tradition ($r = 0.197$, $p < 0.001$) and organizational
 327 environment scales ($r = -0.182$, $p = 0.001$), and social support ($r = -0.398$, $p < 0.001$).

328 In the multiple regression analysis, Factors associated with cognitive stress appraisal,

(marital status, household membership, economic status, physical activity, sleeping, isometric load, eHealth literacy, tradition and organizational environment scales, and social support) were used as independent variables, and age, sex, and depression as control variables (Table 2). This analysis indicated that those with poorer economic status ($\beta = 0.161$, $p = 0.001$), lower eHealth literacy ($\beta = -0.116$, $p = 0.009$), higher traditional organizational climate ($\beta = 0.124$, $p = 0.005$), and lower perceived social support ($\beta = -0.220$, $p < 0.001$) experienced a higher level of perceived negative stress. The adjusted R^2 in this analysis was 0.412.

Table 2. Cognitive stress appraisal and related factors

	β	p
Demographic characteristics		
Economic status (1=sufficient, 2=slightly sufficient, 3=slightly insufficient, 4=insufficient)	0.171	0.000
Individual factors		
eHealth literacy (total score)	-0.113	0.012
Environmental factors		
Organizational climate: Tradition (total score)	0.131	0.004
Social support (total score)	-0.205	0.000
Adjusted R^2		0.412

Multiple regression analysis.

Controlled variables: Age, Sex (0=female, 1=male), Depression (0=no, 1=yes).

DISCUSSION

Participants in this study were representative of healthy adult workers in a range of employment types in Japan. First, in terms of demographic characteristics (e.g., age, sex) and proportion of participants, this study was similar to the reported national statistics for full-time workers in Japan.[62] Second, the PSS scores in this study were similar to those obtained when the PSS was originally developed[18] and those of adults in other countries.[63,64] Therefore this study can be generalized to other workers in Japan and to other developed countries.

Our study is the first to examine the features of cognitive stress appraisal in workers and identify associated individual and environmental factors. This study adds to existing research evidence that both individual factors (including eHealth literacy) and environmental factors (such as organizational climate) are related to cognitive stress appraisal among workers. Therefore, this study has important practical implications in promoting stress management and primary prevention of stress-related disease and suicide among workers.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

351 Economic status was related to cognitive stress appraisal. It is possible that poor economic
352 status in itself is the origin of stress, and workers with poor economic status have difficulty
353 coping with their own stress. Cognitive stress appraisal and subjective economic status are
354 related, and self-efficacy plays an important role as a mediator between cognitive evaluation
355 of stress and life satisfaction.[65] Workers may be unable to appraise challenges and struggle
356 in stressful situations because they feel that their own ability level is low and they have
357 limited resources.

358 We found that lower eHealth literacy was related to negative stress appraisal. Health
359 literacy is a cognitive and social skill that determines individuals' motivation and ability to
360 gain access to, understand, and use information in ways that promote and maintain good
361 health.[66] Higher health literacy may enable an individual to actively seek support and
362 solutions to problems.[67] Good eHealth literacy means people can access health information
363 resources via the Internet. The Internet is increasingly becoming an effective information tool
364 for improving self-care behavior.[68-70] In addition, the Internet holds a considerable amount
365 of health information, which is helpful for positive cognitive stress appraisal. Improving
366 eHealth literacy may empower workers to obtain, understand, and act on information they
367 need for optimal mental health.

368 We also found that more traditional organizational climates were related to negative
369 cognitive stress appraisal. A traditional organizational climate is more directive and
370 feudalistic.[56] Higher tradition scores correspond to higher levels of depressive state, lower
371 job satisfaction, and lower levels of mental health.[56] A traditional structure or climate
372 implies high levels of mandatory working, a lack of respect for individual opinion, and
373 pressure from superiors. Workers in traditional organizational climates have less discretion
374 and a more stressful environment. They may be unable to ask for help from their supervisor, or
375 make improvements to the work environment. The relationship between organizational climate
376 and workers' performance may be explained using the social exchange theory. This theory is
377 based on the assumption that social exchanges involve several actions that create obligations,
378 and that relationships evolve over time into trusting, loyal, and mutual commitments.[71]
379 Organizational climate can be changed when employers establish a climate that is perceived as
380 positive by their employees with good relationships, and this can result in better
381 organizational performance and higher levels of motivation in workers.

382 In addition, lower levels of social support were related to negative stress appraisal. This is
383 consistent with previous studies that reported the amount of social support was associated
384 with levels of depression,[72] and that social support buffered adverse effects on mental
385 health.[73] Social support also protects individuals from the pathogenic effects of stressful
386 events by altering the appraisal of those events or the process by which perceived stress
387 causes illness.[18] Those who feel that they have little social support may be unable to buffer
388 stressful events, whereas those who feel that they have sufficient social support may be able to

1
2
3 389 buffer stressful events.

4 390 Our findings suggested that an inter-professional approach involving public health nurses
5 391 and health practitioners that includes provision of enhanced self-coping skills using individual
6 392 workers' eHealth literacy, along with development of more modern organizational climates in
7 393 workplaces and social support in communities may be effective in minimizing the effect
8 394 negative cognitive stress appraisal that may be associated with an increased risk of depression.
9 395 This would contribute to the overall promotion of mental health among workers.

10
11
12
13
14 396

15 16 397 **Limitations**

17
18 398 This study had several limitations. First, we used a cross-sectional design, meaning that we
19 399 could not identify causal relationships between cognitive stress appraisal and related factors.
20 400 Second, the response rate was low, which might be explained by the number of instruments
21 401 included in the questionnaire. Future studies should consider the number of included questions
22 402 and collection method for questionnaires. Third, the adjusted R^2 was 0.412, which was higher
23 403 than the values of 0.05–0.27 previously reported.[65] Although this provides an adequate
24 404 explanation of factors related to cognitive stress appraisal, other factors are also likely to have
25 405 contributed. In future, longitudinal studies should be conducted across other areas to widen
26 406 the scope of investigation.

27
28
29
30
31
32 407

33 34 35 408 **Conclusions**

36
37 409 This study examined cognitive stress appraisal and identified factors related to cognitive
38 410 stress appraisal among workers. The results indicated that cognitive stress appraisal is
39 411 associated with economic status, depression, eHealth literacy, traditional organizational
40 412 climates, and social support. Therefore, it is recommended that public health nurses and health
41 413 practitioners enhance eHealth literacy, and improve organizational climates and social support,
42 414 to help improve depression and support workers to develop better cognitive stress appraisal.
43 415 Furthermore, occupational and community interventions are required to create and inform
44 416 people of opportunities for cognitive stress appraisal in the workplace and the community.

45
46
47
48
49 417

50 51 418 **Acknowledgements**

52
53 419 The authors would like to thank all the employees who agreed to participate in this study.
54 420 We thank Audrey Holmes, MA, from Edanz Group (www.edanzediting.com/ac) for editing a
55 421 draft of this manuscript.

1
2
3 422

4 423 Footnotes

5 424 **Contributors**

6 425 NT, ET and AA contributed to develop the concept and design of this study. ET was
7 426 responsible for acquiring the Institutional Review Board (IRB) approval of this study. NT was
8 427 responsible for data collection and analysis. NT and AA were responsible for drafting and
9 428 revising the manuscript. ET is responsible for study supervision and reporting of study results.
10 429 All authors have read and approved the final manuscript.

11 430

12 431 **Competing interests**

13 432 We have read and understood BMJ policy on declaration of interests and declare that we have
14 433 no competing interests.

15 434

16 435 **Funding**

17 436 This study was supported by University Center of Community (COC) program funded by the
18 437 Ministry of Education, Culture, Sports, Science and Technology, Japan
19 438 (<http://www.mext.go.jp/en/>)(PI:Etsuko Tadaka). The funders had no role in study design, data
20 439 collection and analysis, decision to publish, or preparation of the manuscript.

21 440

22 441 **Ethics**

23 442 The questionnaire was unsigned to maintain the anonymity of all personal participant
24 443 information. The Institutional Review Board of the Medical Department of the Yokohama City
25 444 University approved this study on August 9, 2016 (Certification No.A1608008 ; PI: Dr.Etsuko
26 445 Tadaka).

27 446

28 447 **Data sharing statement**

29 448 No additional unpublished data from the study are available at the moment.

30 449

31 450

32 451 **REFERENCES**

- 33 452 1. World Health Organization [Internet]. Genève: Depression; 2016 [cited 22 February 2018].
34 453 Available from: <http://www.who.int/mediacentre/factsheets/fs369/en/>
- 35 454 2. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Patient Survey; 2015 [cited 22
36 455 February 2018]. Available from:
37 456 <http://www.mhlw.go.jp/toukei/saikin/hw/kanja/14/dl/kanja.pdf> (in Japanese)
- 38 457 3. World Health Organization [Internet]. Genève: Protecting workers' health; 2017 [cited 22
39 458 February 2018]. Available from: <http://www.who.int/mediacentre/factsheets/fs389/en/>

- 459 4. World Health Organization [Internet]. Genève: Comprehensive mental health action plan
460 2013–2020; 2013 [cited 22 February 2018]. Available from:
461 http://www.who.int/mental_health/action_plan_2013/en/
- 462 5. World Health Organization [Internet]. Genève: Mental Health Action Plan 2013-2020; 2013
463 [cited 22 February 2018]. Available from:
464 http://apps.who.int/iris/bitstream/10665/89966/1/9789241506021_eng.pdf?ua=1
- 465 6. World Economic Forum and the Harvard School of Public Health [Internet]. Genève: The
466 global economic burden of non-communicable diseases; 2011 [cited 22 February 2018].
467 Available from:
468 <http://apps.who.int/medicinedocs/documents/s18806en/s18806en.pdf>
- 469 7. Van den Berg TIJ, Alavinia SM, Bredt FJ, et al. The influence of psychosocial factors at
470 work and life style on health and work ability among professional workers. *International*
471 *Archives of Occupational and Environmental Health*. 2008;81(8):1029-1036.
472 doi:10.1007/s00420-007-0296-7.
- 473 8. Lee YM. Loss of Productivity due to Depression among Korean Employees. *Journal*
474 *Occupational Health*. 2010;52(6):389-394.
- 475 9. Kim SE, Kim HN, Cho J, et al. Direct and Indirect Effects of Five Factor Personality and
476 Gender on Depressive Symptoms Mediated by Perceived Stress. *PLOS ONE*. 2016;11(4):
477 e0154140.
478 doi: 10.1371/journal.pone.0154140.
- 479 10. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Industrial accident compensation
480 insurance for mental disorders; 2011 [cited 22 February 2018]. Available from:
481 <http://www.mhlw.go.jp/bunya/roudoukijun/rousaihoken04/dl/120215-01.pdf> (in Japanese)
- 482 11. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Industrial accident compensation
483 insurance for mental disorders; 2016 [cited 22 February 2018]. Available from:
484 <http://www.mhlw.go.jp/file/04-Houdouhappyou-11402000-Roudoukijunkyokuroudouhoshou>
485 [bu-Hoshouka/h27_seishin.pdf](http://www.mhlw.go.jp/file/04-Houdouhappyou-11402000-Roudoukijunkyokuroudouhoshou-bu-Hoshouka/h27_seishin.pdf) (in Japanese)
- 486 12. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Basic Survey on Industrial Safety
487 and Health; 2013 [cited 22 February 2018]. Available from:
488 <http://www.mhlw.go.jp/file/05-Shingikai-11201000-Roudoukijunkyoku-Soumuka/000006140>
489 [6.pdf](http://www.mhlw.go.jp/file/05-Shingikai-11201000-Roudoukijunkyoku-Soumuka/0000061406.pdf) (in Japanese)
- 490 13. Ministry of Health, Labor and Welfare [Internet]. Tokyo: Stress check system; 2015 [cited
491 22 February 2018]. Available from:
492 <http://www.mhlw.go.jp/bunya/roudoukijun/anzeneisei12/> (in Japanese)
- 493 14. Lazarus R. Psychological Stress and the Coping Process. New York, McGraw-Hill; 1966.
- 494 15. Lazarus R & Folkman S. Stress, Appraisal, and Coping, New York, Springer; 1984.
- 495 16. Carpenter R. A Review of Instruments on Cognitive Appraisal of Stress. *Archives of*
496 *Psychiatric Nursing*. 2016;30(2):271-279.

- 1
2
3 497 doi: <http://dx.doi.org/10.1016/j.apnu.2015.07.002>.
- 4 498 17. Fevre ML, Matheny J, Kolt GS. Eustress, distress, and interpretation in occupational stress.
5 499 *Journal of Managerial Psychology*.2003;18(7):726-744. doi: 10.1108/02683940310502412
- 6 500 18. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. *Journal of*
7 501 *Health and Social Behavior*. 1983;24(4):385-396.
- 8 502 19. Cohen S, Williamson G. Perceived stress in a probability sample of the United States. In:
9 503 Spacapan S, Oskamp S, eds. *The social psychology of health*. Newbury Park, Calif.: Sage,
10 504 1988:31-67.
- 11 505 20. Schelle KJ, Olthof BMJ, Reintjes W, et al. A survey of substance use for cognitive enhancement
12 506 by university students in the Netherlands. *Frontiers in Systems Neuroscience*.2015;9:10.
13 507 doi:10.3389/fnsys.2015.00010.
- 14 508 21. Roberti JW, Harrington LN, Storch EA. Further Psychometric Support for the 10-Item
15 509 Version of the Perceived Stress Scale. *Journal of College Counseling*. 2006;9:135-147. doi:
16 510 10.1002/j.2161-1882.2006.tb00100.x.
- 17 511 22. Hamaideh SH, Al-ashram SA, Al-modallal H. Premenstrual syndrome and premenstrual
18 512 dysphoric disorder among Jordanian women. *Journal of Psychiatric and Mental Health*
19 513 *Nursing*. 2014;21(1):60-68. doi: 10.1111/jpm.12047.
- 20 514 23. Wawrzyniak AJ & Whiteman MCP. Perceived stress, loneliness, and interaction with
21 515 fellow students does not affect innate mucosal immunity in first year university students.
22 516 *Psychological Japanese Research*.2011;53(2):121-132.
23 517 doi: 10.1111/j.1468-5884.2011.00466.x.
- 24 518 24. Gupta R, Singh N, Kumar R. Longitudinal predictive validity of emotional intelligence on first
25 519 year medical students perceived stress. *BMC Medical Education*. 2017;17:139.
26 520 doi:10.1186/s12909-017-0979-z.
- 27 521 25. Li S, Li L, Zhu X, et al. Comparison of characteristics of anxiety sensitivity across career
28 522 stages and its relationship with nursing stress among female nurses in Hunan, China. *BMJ*
29 523 *Open*.2016;6(5):e010829. doi: 10.1136/bmjopen-2015-010829.
- 30 524 26. Györfy Z & Girasek E. Mental Health of Physicians Nationwide Representative Study
31 525 from Hungary. *Ideggyogyaszati szemle-Clinical Neuroscience*. 2015;68(7-8):258-269.
- 32 526 27. Su X, Lau JT, Mak WW, et al. Development of the Perceived Stress Scale for People
33 527 Living with HIV/AIDS in China. *AIDS Patient Care and STDs*. 2008;22(12):989-998. doi:
34 528 10.1089/apc.2008.0095.
- 35 529 28. Kimura T, Yokoyama A, Kohno N, et al. Perceived Stress, Severity of Asthma, and Quality
36 530 of Life in Young Adults with Asthma. *Allergology International*. 2009;58(1):71-79. doi:
37 531 10.2332/allergolint.O-07-531.
- 38 532 29. Hara Y, Hisatomi M, Ito H, et al. Effects of gender, age, family support, and treatment on
39 533 perceived stress and coping of patients with type 2 diabetes mellitus. *BioPsychoSocial*
40 534 *Medicine*.2014;8:16.

- 1
2
3 535 doi: 10.1186/1751-0759-8-16.
- 4 536 30. Lee EH, Chung Y, Suh H, et al. Korean versions of the Perceived Stress Scale (PSS-14, 10
5 537 and 4): psychometric evaluation in patients with chronic disease. *Scand J Caring Sci.*
6 538 2015;29(1):183-192. doi: 10.1111/scs.12131.
- 7
8 539 31. Mitchell AM, Crane PA, & Kim Y. Perceived Stress in Survivors of Suicide: Psychometric
9 540 Properties of the Perceived Stress Scale. *Research in Nursing & Health.* 2008;31(6):576-85.
10 541 doi: 10.1002/nur.20284.
- 11
12 542 32. Andreou E, Alexopoulos EC, Lionis C, et al. Perceived Stress Scale: reliability and
13 543 validity study in Greece. *Int J Environ Res Public Health.* 2011;8(8):3287-3298. doi:
14 544 10.3390/ijerph8083287
- 15
16 545 33. Barrington WE, Ceballos RM, Bishop SK, et al. Perceived Stress, Behavior, and Body
17 546 Mass Index among Adults Participating in a Worksite Obesity Prevention Program, Seattle,
18 547 2005-2007. *Prev Chronic Dis.* 2012;9:E152. doi: 10.5888/pcd9.120001
- 19
20 548 34. Leung DY, Lam TH, Chan SS. Three versions of Perceived Stress Scale: validation in
21 549 sample of Chinese cardiac patients who smoke. *BMC Public Health.* 2010;25;10:513. doi:
22 550 10.1186/1471-2458-10-513.
- 23
24 551 35. Willert MV, Wieclaw J, Thulstrup AM. Rehabilitation of individuals on long-term sick
25 552 leave due to sustained stress-related symptoms: A comparative follow-up study. *Scand J*
26 553 *Public Health.* 2014;42(8):719-27.
27 554 doi: 10.1177/1403494814551859.
- 28
29 555 36. Wiernik E, Nabi H, Pannier B, et al. (2014): Perceived stress, sex, and occupational status
30 556 interact to increase the risk of future high blood pressure: the IPC cohort study. *J Hypertens.*
31 557 2014;32(10):1979-1986.
32 558 doi: 10.1097/HJH.0000000000000288.
- 33
34 559 37. Horiuchi S, Tsuda A, Kim E, et al. Relationships between stage of change for stress
35 560 management behavior and perceived stress and coping. *Japanese psychological Research.*
36 561 2010;52(4):291-297.
37 562 doi: 10.1111/j.1468-5884.2010.00444.x.
- 38
39 563 38. Stewart DW, Vidrine JI, Shete S, et al. Health literacy, smoking, and health indicators in
40 564 African American adults. *J Health Commun.* 2015;20 Suppl 2:24-33. doi:
41 565 10.1080/10810730.2015.1066465.
- 42
43 566 39. Faresjö Å, Theodorsson E, Chatziarzenis M, et al. Higher Perceived Stress but Lower Cortisol
44 567 Levels Found among Young Greek Adults Living in a Stressful Social Environment in
45 568 Comparison with Swedish Young Adults. *PLoS One.* 2013;8(9):e73828.
46 569 doi: 10.1371/journal.pone.0073828
- 47
48 570 40. Mimura C & Griffiths G. A Japanese version of the perceived stress scale: translation and
49 571 preliminary test. *International Journal of Nursing Studies.* 2004; 41(4): 379-385.
- 50
51 572 41. Mimura C & Griffiths G. A Japanese version of the Perceived Stress Scale: cross-cultural
52
53
54
55
56
57
58
59

- 1
2
3 573 translation and equivalence assessment. *BMC Psychiatry*. 2008;8:85. doi:
4 574 10.1186/1471-244X-8-85.
- 5
6 575 42. Shima S, Kano T, Kitamura T, et al. Atarashii yokuutsusei jiko hyouka syakudo ni tsuite (A
7 576 new self-report depression scale). *Clinical Psychiatry*, 1985;27; 717–723. Japanese
- 8
9 577 43. Radloff LS. The CES-D Scale. A self-report depression scale for research in the general
10 578 population. *Applied Psychological Measurement*.1985;1(3):385-401.
11 579 doi: <https://doi.org/10.1177/014662167700100306>
- 12
13 580 44. Shimomitsu T, & Odagiri Y. The brief job stress questionnaire. *Japanese Journal of*
14 581 *Occupational Mental Health*.2004;12(1):25-36. Japanese
- 15
16 582 45. Kawakami N & Fujigaki Y. Reliability and Validity of the Japanese Version of Job Content
17 583 Questionnaire: Replication and Extension in Computer Company Employees. *Industrial*
18 584 *Health*.1996;34(4):295-306.
- 19
20 585 46. Karasek R, Brisson C, Kawakami N, et al. The Job Content Questionnaire (JCQ): an
21 586 instrument for internationally comparative assessments of psychosocial job characteristics. *J*
22 587 *Occup Health Psychol*. 1998;3(4):322-55.
- 23
24 588 47. Kawakami N, Kobayashi F, Araki S, et al. Assessment of job stress dimensions based on
25 589 the Job Demands-Control model of employees of telecommunication and electric power
26 590 companies in Japan: reliability and validity of the Japanese version of Job Content
27 591 Questionnaire. *Int J Behav Med*. 1995;2(4):358-75.
- 28
29 592 48. Suzuki-Saito T, Yasumura S, Okamura T, et al. Medical care costs and the characteristics
30 593 of higher medical costs among BMI groups in the early-stage elderly Analysis of data
31 594 obtained from a large-scale study of 29,490 elderly. *Japanese Journal of Public*
32 595 *Health*.2012;59(7);466-473. Japanese.
33 596 doi: http://doi.org/10.11236/jph.59.7_466
- 34
35 597 49. Togari T, Yamazaki Y, Koide S, et al. Reliability and validity of the Modified Perceived
36 598 Health Competence Scale (PHCS) Japanese version. *Japanese Journal of Public*
37 599 *Health*.2006; 53(1); 51-57. Japanese.
38 600 doi:http://doi.org/10.11236/jph.53.1_51
- 39
40 601 50. Leon-Perez JM, Antino M, Leon-Rubio JM. The Role of Psychological Capital and
41 602 Intragroup Conflict on Employees' Burnout and Quality of Service: A Multilevel Approach.
42 603 *Front Psychol*. 2016; 7: 1755. doi: 10.3389/fpsyg.2016.01755
- 43
44 604 51. Smith MS, Wallston KA, Smith CA. The development and validation of the Perceived
45 605 Health Competence Scale. *Health Educ Res*. 1995 Mar;10(1):51-64.
- 46
47 606 52. Mitsutake S, Shibata A, Ishii K, et al. Developing Japanese version of the eHealth Literacy
48 607 Scale (eHEALS). *Japanese Journal of Public Health*.2011;58(5):361-371. Japanese. doi:
49 608 http://doi.org/10.11236/jph.58.5_361
- 50
51 609 53. Norman CD & Skinner HA. eHealth Literacy: Essential Skills for Consumer Health in a
52 610 Networked World. *J Med Internet Res*. 2006; 8(2): e9. doi: 10.2196/jmir.8.2.e9

- 1
2
3 611 54. Norman CD & Skinner HA. eHEALS: The eHealth Literacy Scale. *J Med Internet Res.*
4 612 2006 Oct-Dec; 8(4): e27. doi: 10.2196/jmir.8.4.e27
- 5
6 613 55. Ministry of Internal Affairs and Communications [Internet] Tokyo: White Paper on
7 614 Information and Communications in Japan; 2016 [cited 22 February 2018]. Available from:
8
9 615 <http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2016/chapter-5.pdf#page=1>
- 10 616 56. Fukui S, Haratani T, Toshima Y, et al. Measuring Workplace Climate: Reliability and
11 617 Validity of the 12-item Organizational Climate Scale (OCS-12). *Japan Society for*
12 618 *Occupational Health.* 2004;46(6):213-222.
13
14 619 Japanese. doi:http://doi.org/10.1539/sangyoeisei.46.213
- 15
16 620 57. Hemingway MA & Smith CS. Organizational climate and occupational stressors as
17 621 predictors of withdrawal behaviors and injuries in nurses. *Journal of Occupational and*
18 622 *Organizational Psychology.* 1999;72(3):285-299.
19 623 doi:10.1348/096317999166680
- 20
21 624 58. Iwasa H, Gondo Y, Masui Y, et al. Reliability and validity of “Social Support Scale”,
22 625 Japanese language edition: Investigation targeting middle and old age. *Indicators of social*
23 626 *welfare.*2007 54(6), 26-33. Japanese.
- 24
25 627 59. Zimet GD, Dahlem NW, Zimet SG, Farley GK. The Multidimensional Scale of Perceived
26 628 Social Support. *Journal of Personality Assessment.* 1988;52(1):30-41. doi:
27 629 10.1207/s15327752jpa5201_2
- 28
29 630 60. Cohen J. A Power Primer. *Psychological Bulletin.* 1992; 112(1): 155-159.
- 30
31 631 61. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis
32 632 program for the social, behavioral, and biomedical sciences. *Behav Res Methods.* 2007;3:175-91.
- 33
34 633 62. Japan Institute for Labour Policy and Training [Internet] Tokyo: Labour statistics data;
35 634 2016 [cited 23 February 2018] Available from:
36 635 <http://www.jil.go.jp/kokunai/statistics/timeseries/html/g0209.html> (in Japanese)
- 37
38 636 63. Katsarou A, PANagiotos D, Zafeiropoulou A, et al. Validation of a Greek Version of
39 637 PSS-14: A global measure of perceived stress. *Cent Eur J Public Health.*
40 638 2012;20(2):104-109.
- 41
42 639 64. Remor E. Psychometric properties of a European Spanish version of the Perceived Stress
43 640 Scale (PSS). *Span J Psyvhol.* 2006; 9(1); 86-93.
- 44
45 641 65. Lee J, Kim EY, Wachholtz A. The effect of perceived stress on life satisfaction: The
46 642 mediating effect of self-efficacy. *Chongsonyonhak Yongu.* 2016;23(10):29-47.
- 47
48 643 66. Nutbeam D. Health promotion glossary. *Health Promotion International.*
49 644 1998;13(4):349-364.
- 50
51 645 67. Ishikawa H, Nomura K, Sato M, et al. Developing a measure of communicative and critical
52 646 health literacy: a pilot study of Japanese office workers. *Health Promotion International.*
53 647 *Health Promot Int.* 2008;23(3):269-274.
54
55 648 doi: 10.1093/heapro/dan017.

- 1
2
3 649 68. Ministry of Economy, Trade and Industry [Internet]. Tokyo: Employment Status Survey;
4 650 2012 [cited 22 February 2018] Available from:
5
6 651 <http://www.stat.go.jp/english/data/shugyou/pdf/sum2012.pdf> (in Japanese)
7
8 652 69. Ritterband LM & Palermo T. Introduction to the Special Issue: eHealth in Pediatric
9 653 Psychology. *Journal of Pediatric Psychology*. 2009;34(5):453-456.
10 654 doi: 10.1093/jpepsy/jsp008
11
12 655 70. Mitsutake S, Shibata A, Ishii K, et al. Associations of eHealth Literacy With Health
13 656 Behavior Among Adult Internet Users. *J Med Internet Res*. 2016;18(7):e192.
14 657 doi: 10.2196/jmir.5413.
15
16 658 71. Cropanzano R & Mitchell MS. Social Exchange Theory: An Interdisciplinary Review.
17 659 *Journal of Management*. 2005;31(6): 874-900
18
19 660 72. Koizumi Y, Awata S, Kuriyama S, et al. Association between social support and depression
20 661 status in the elderly: results of a 1-year community-based prospective cohort study in Japan.
21 662 *Psychiatry Clin Neurosci*. 2005;59(5):563-569.
22
23 663 73. Frasure-Smith N, Lesperance F, Gravel G, et al. Social Support, depression, and mortality
24 664 during the first year after myocardial infarction. *Circulation*. 2000;101(16):1919-1924.
25
26 665
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-9
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8-9
		(b) Describe any methods used to examine subgroups and interactions	-
		(c) Explain how missing data were addressed	8-9
		(d) If applicable, describe analytical methods taking account of sampling strategy	5,8-9
		(e) Describe any sensitivity analyses	8-9
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	8-9
Outcome data	15*	Report numbers of outcome events or summary measures	9-11
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(b) Report category boundaries when continuous variables were categorized	-
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.