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Computer-Assisted Measurement of Perceived Stress: An Application for a Community-Based Survey

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ABSTRACT

The assessment of stress is a key issue in health promotion policies as well as in treatment strategies for patients. The aim of this study was to confirm the accessibility and reliability of computer-assisted data collection for perceived stress measurement, using the Japanese version of the Perceived Stress Scale (JPSS), within the setting of a community-based survey. There were two groups of participants in this survey. One group responded to a Web-based application, and the other to the VBA of a spreadsheet software. The total scores of JPSS were almost normally distributed. The means of total scores of JPSS were 23.6 and 23.1. These results were lower than the previous study of JPSS. Since Cronbach's alpha coefficients in both surveys were more than 0.8, high reliability was demonstrated despite a number of computer-illiterate and/or aged participants. They felt that the spreadsheet form was easier to respond to. Two components were extracted with the Varimax rotation of principal component analysis, and these were named "perception of stress and stressors" and "behavior to stress". This finding suggests that it is possible to determine sub-scales. From the viewpoint of preventive medicine, it is expected that the JPSS applications will be utilized to investigate the relationship between stress and other factors such as lifestyle, environment and quality of life.

Key words: *Stress, Mental health, Questionnaires, Personal computer*

The Ministry of Health, Labour and Welfare in Japan is promoting a national health movement which includes reducing the number of people who feel stress as well as lifestyle modification such as cessation of cigarette smoking and changes in dietary habits toward the prevention of cancer, diabetes, cerebrovascular and cardiovascular diseases[7)]. Since 54.6% of the Japanese population felt stress at the start point (2000), a target reduction of 10% by the end of the Movement (2010) has been set.

Several objective or subjective approaches have been commonly used for stress measurement. Representative of objective approaches is counting the number of stressful events weighted[6,8,12)]. However, the impacts caused by stressful events such as the death of a family member, unemployment and debt differ among individuals. Subjective assessment of stress is thought to be a better approach for monitoring psychosomatic symptoms and preventing mental disease and suicide[1,5,14)]. Even infectious diseases such as the common cold are known to be related to stress[3,4)]. For stress assessment, a single question such as "Do you feel stress in daily life?" is considered insufficient. It is necessary to use an instrument (questionnaire) that is proven to be valid and reliable. It is unclear whether the instrument for patients of psychosomatic medicine clinics can be used in a community-based survey.

Several research groups have developed and studied methods of collecting data on a computer[10,11,16)], which have the advantage of decreasing the number of invalid or missing values, shortening the time for processing raw data and providing feedback of the results to respondents. It may be difficult, however, for computer-illiterate people to use this instrument to provide their response; or they may refuse to complete the questionnaire. It is necessary to test this type of procedure preliminarily on a small scale. The aims of this study were to develop applications for a personal computer, to confirm the accessibility of computer-assisted data collection for perceived stress measurement, and to clarify the reliability and characteristics of these data within the setting of a community-based survey.

METHODS

Computer-assisted data collection was conducted at an event for health promotion and food production at Ohito Town, over 100 km distant from Tokyo, Japan, in May 2003. At the booth of a health checkup service, we set up a personal com-

Table 1. The number of participants by gender and age group in survey 1 and 2

Age group		< 29	30–39	40–49	50–59	60–69	70 <	Sum
Survey 1	Total	22	10	15	16	21	16	100
	male	9	4	11	3	4	5	36
	female	13	6	4	13	17	11	64
Survey 2	Total	24	33	39	66	42	18	222
	male	6	13	19	24	13	10	85
	female	18	20	20	42	29	8	137

puter with a touch screen display and recruited participants for this survey (survey 1). The subjects consented to taking part in the survey after hearing an explanation of the aims and contents of the questionnaires. Individual data such as names and addresses were not collected. The second survey was conducted at the same event in May 2004, using another application explained below (survey 2).

The Japanese version of the Perceived Stress Scale (JPSS), which was developed by Cohen et al[2] and translated by Iwahashi et al,[9] was used for subjective stress assessment. JPSS comprises 14 five-point Likert-type items, and seven of the items were reversal. Each item is scored from 0 to 4, therefore, the range of the total score is 0–56. Higher scores indicate more perceived stress. We developed a Web-based application of the JPSS questionnaire which was used in survey 1, and another application using VBA (Visual Basic for Applications) of a spreadsheet software (Excel for Windows, Microsoft Corporation) for survey 2.

The means and standard deviations (SD) of the JPSS scores were determined for gender as well as in total. Cronbach's alpha coefficients were calculated to examine internal consistency. In survey 2, we examined the characteristics of the data including correlation and factor structure. Correlations between the items were measured with Spearman's coefficients. Factors were extracted with the Varimax rotation of principal component analysis. Statistical analyses were conducted using SPSS for Windows, version 11.0[15]. Statistical significance was set at $p < 0.05$.

RESULTS

One hundred people (64 women and 36 men) participated in survey 1. The number of participants by age group is given in Table 1. The mean score of JPSS was 23.4 (±6.8 SD) in total. In the women, the mean score was 23.6 (±6.8 SD); whereas it was 23.1 (±5.9 SD) in the men. The Cronbach's alpha coefficient was 0.8373. Some computer-illiterate people complained about having difficulty responding to a question from the Web-based application and spent a considerable amount of time. A few aged subjects needed help with handling the computer, and about 10% of the subjects had difficulty responding to the questionnaire on the display.

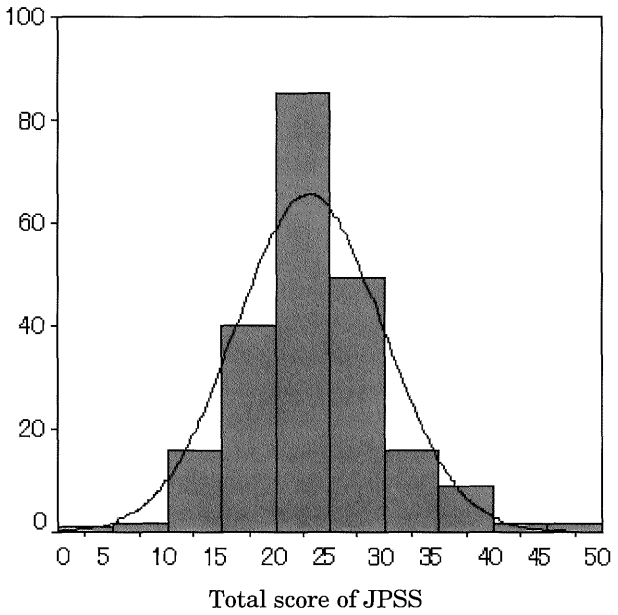

Fig. 1. Distribution of the total scores of JPSS in survey 2. A histogram is shown with the normal distribution curve. The number of subjects was 222, and the mean score was 23.1.

In survey 2, the number of participants was 222 (137 women and 85 men) (Table 1). The mean score of JPSS was 23.1 (±6.8 SD) in total. In the women, the mean score was 23.3 (±7.1 SD); whereas it was 22.8 (±6.3 SD) in the men. The Cronbach's alpha coefficient was 0.8408. The distribution of JPSS scores is shown in Fig. 1. The Spearman's correlation coefficients between total score and per item scores were distributed in the range of 0.668–0.343; whereas those between the items were in the range of 0.494–0.011 (Table 2). Three components were extracted with the eigenvalues exceeding 1.0 in the principal component analysis. Their proportions were 33.9%, 9.2%, 8.3%, respectively (cumulative proportion: 51.3%). In the condition of two components, the Varimax rotation of principal component analysis was performed (cumulative proportion: 43.0%). In component 1, ten items had higher factor loadings (Table 3).

Even computer-illiterate participants responded more easily and quickly to the application of

Table 2. Spearman's correlation coefficients between total score and each of the items, and between the items in JPSS

	Total score	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10	# 11	# 12	# 13
Item # 1	0.586													
# 2	0.668	0.494												
# 3	0.608	0.463	0.369											
# 4 †	0.399	0.081	0.278	0.247										
# 5 †	0.611	0.285	0.404	0.363	0.374									
# 6 †	0.550	0.195	0.219	0.419	0.244	0.349								
# 7 †	0.600	0.315	0.257	0.450	0.234	0.332	0.335							
# 8	0.545	0.258	0.375	0.275	0.188	0.260	0.217	0.290						
# 9 †	0.623	0.383	0.362	0.328	0.238	0.340	0.275	0.278	0.326					
# 10 †	0.531	0.290	0.249	0.305	0.302	0.276	0.246	0.349	0.204	0.351				
# 11	0.414	0.205	0.151	0.130	0.051	0.253	0.147	0.147	0.244	0.409	0.137			
# 12	0.605	0.330	0.427	0.357	0.176	0.292	0.265	0.455	0.350	0.281	0.367	0.125		
# 13 †	0.343	0.033	0.197	0.037	0.259	0.236	0.257	0.162	0.111	0.129	0.193	0.011	0.024	
# 14	0.581	0.338	0.353	0.289	0.108	0.343	0.192	0.426	0.287	0.331	0.331	0.266	0.493	0.092

† The reversal items were scored inversely.

Table 3. Result of principal component analysis for the items of JPSS

	Component 1	Component 2	Content of question ‡
Item # 1	**0.7270**	*–0.0329*	... been upset because of something that happened unexpectedly?
# 2	**0.6195**	*0.2143*	... felt that you were unable to control the important things in your life?
# 3	**0.6415**	*0.1660*	... felt nervous and "stressed"?
# 4 †	*0.0766*	**0.6871**	... dealt successfully with irritating life hassles?
# 5 †	*0.4675*	**0.5223**	... felt that you were effectively coping with important changes ... in your life?
# 6 †	*0.3424*	**0.5164**	... felt confident about your ability to handle your personal problems?
# 7 †	**0.6017**	*0.2605*	... felt that things were going your way?
# 8	**0.5405**	*0.1893*	... found that you could not cope with all the things that you had to do?
# 9 †	**0.6196**	*0.2296*	... been able to control irritations in your life?
# 10 †	**0.5004**	*0.3939*	... felt that you were on top of things?
# 11	**0.4574**	*0.0155*	... been angered because of things ... outside of your control?
# 12	**0.6520**	*0.1024*	... found yourself thinking about things that you have to accomplish?
# 13 †	*–0.0531*	**0.7553**	... been able to control the way you spend your time?
# 14	**0.6653**	*0.1089*	... felt difficulties were piling up so high that you could not overcome them?
Proportion of variance	28.8%	14.2%	(Cumulative proportion = 43.0%)

† The reversal items were scored inversely.
‡ All questions begin "In the last month, how often have you ...". These are the original version of PSS.
Note: Principal component analysis was conducted with Varimax rotation.

spreadsheet software than to the other in survey 1. No subject had difficulty in handling the computer except where there was impairment of vision.

DISCUSSION

This study was carried out to develop a new method for measuring perceived stress using a personal computer. High reliability was demonstrated for both types of applications, although a number of computer-illiterate and/or aged subjects took part in these surveys. For this group, the application using the VBA of spreadsheet software was easier to respond to, because a touch screen display was used and the buttons of the form may were large. The advantage of the Web-based application is considered to be the ability to collect data through the Internet or LAN. However, participants would be restricted to those who can use or have access to a computer. These findings correspond to the general knowledge of information technology.

The total scores of JPSS were almost normally distributed in this sample, that is, the mean was coincident with the median and the mode. This means that the scores were better suited to deal with statistic values. The mean of scores (23.1) was lower than that of the validation study of the Japanese version (25.4)[9]. One reason for this was that the subjects this time included housewives, unemployed and self-employed individuals, unlike those in the previous study, where all participants

were employed in very stressful positions. Compared with the original version, however, the mean in this study was common to that of the college student sample[2].

A wide distribution from considerably strong to weak correlations was found between the total score and each of the items. These results suggest that a shortened version could be developed by selecting the more correlated items. The correlations between the items were distributed in a broader range from medium to nothing, which means that the 14 items did not consist of a single factor. The result from factor analysis reveals that two components accounted for all the items. One of the components, including the item of "how often have you felt nervous and stressed?", was named "perception of stress and stressors". The other component, including the item of "how often have you dealt successfully with irritating life hassles?", was named "behavior to stress". These items addressed the susceptibility to stress and the capability of coping with stress. However, the factor structure of three components was more valid statistically with a higher cumulative proportion as mentioned in the results. Although results from survey 1 are not shown in this article, the factor structures were different between survey 1 and 2. This suggests that subjects' attributes in a sample may be associated with the results of principal component analysis.

Nevertheless, there is no doubt that the current JPSS is a multifactor instrument. This finding suggests that it is possible to determine subscales. If these sub-scales are developed in the future, enhanced use of JPSS may be beneficial for stress management. For example, individuals may be classified into four groups: two sub-scales x two levels. When an effective intervention for stress reduction is planned, it is essential to know the characteristics of subjects with regard to their perception of stress and their capability of coping with it. Further studies need to be conducted for the application of JPSS and development of subscales or a shortened version.

Several limitations in this study were mentioned. One of the limitations was that this sample was not randomly selected from the population. The bias was toward subjects who were healthy people who were interested in their own health maintenance and enhancement. Second, newly developed applications were not compared with the conventional questionnaire method. Third, the participants' impression should have been recorded more systematically. Despite these limitations, these results confirm the reliability of JPSS and the accessibility of computer-assisted data collection.

Kleinman et al reported that no difference was found between paper-and-pencil and computer administration of the Quality of Life in Reflux and Dyspepsia questionnaire[10]. There is, however, evidence that data from the Web-based form were higher than those from paper or touch screen[11]. The computer-assisted data collection of JPSS also needs to demonstrate the difference or similarity. Recently, another Japanese version of PSS has been developed in Britain[13]. Comparison between the two versions will be one of the future tasks.

As mentioned in the introduction, the assessment of stress is a key issue in health promotion policies as well as in treatment strategies for patients. The JPSS applications are expected to be utilized to investigate, from the viewpoint of preventive medicine, the relationship between stress and other factors such as lifestyle, environment and quality of life in a community-based setting.

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