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Original

Internal consistency, convergent validity, and structural validity of the Japanese version of the Physical Activity Self-Regulation scale (PASR-12) among Japanese workers: A validation study

Kazuhiro Watanabe[1,2], Norito Kawakami[1], Hidehiko Adachi[1], Shigeru Inoue[3] and M. Renee Umstattd Meyer[4]

[1]Department of Mental Health, Graduate School of Medicine, The University of Tokyo7-3-1, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, [2]Research Fellow of Japan Society for the Promotion of Science, [3]Department of Preventive Medicine and Public Health, Tokyo Medical University6-1-1, Shinjuku, Shinjuku-ku, Tokyo 160-8402, Japan and [4]Department of Health, Human Performance and Recreation, Robbins College of Health and Human Sciences, Baylor University, USA. One Bear Place #97313, Waco, TX 76798, USA

Abstract: Objectives: Self-regulation for physical activity is considered as one of the most effective factors in promoting physical activity. However, there is no reliable and valid scale to measure it in Japanese. The purpose of this study was to investigate the internal consistency, convergent validity, and structural validity of the newly developed Japanese version of the 12-item Physical Activity Self-Regulation scale (PASR-12) among Japanese workers. **Methods:** A cross-sectional Internet-based survey recruiting 516 Japanese workers was conducted in Japan. The PASR-12 was translated according to the International Society of Pharmacoeconomics and Outcomes Research (ISPOR) task force guidelines. Physical activity and self-efficacy for physical activity were measured as comparisons for convergent validity. We calculated Cronbach's alphas, and conducted correlational analyses and confirmatory factor analysis (CFA). **Results:** Of 516 workers, 485 workers were eligible for all analyses. Cronbach's alpha for the scale scores ranged from 0.79 to 0.95. The scores of the total and 6 factor scales of the Japanese version of the PASR-12 had small-to-moderate positive correlations with the total physical activity and self-efficacy. Moreover, the 6-factor hypothesized model demonstrated excellent fit ($\chi 2$ (39) = 100.74, CFI = 0.973, RMSEA = 0.057). **Conclusions:** The Japanese version of the PASR-12 showed good reliability and factor-based and construct validity. Therefore, this scale could be applied to assess self-regulation for physical activity among Japanese workers.
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Correspondence to: K. Watanabe, Department of Mental Health, Graduate School of Medicine, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan (e-mail: kzwatanabe-tky@umin.ac.jp)

Introduction

Physical activity is important to improve the physical and mental health among workers. Previous studies indicated that physical activity is associated with a decreased risk of mortality and non-communicable disease[1,2]. In addition, several meta-analyses and systematic reviews have concluded that physical activity reduces depressive symptoms and anxiety and enhances quality of life and well-being[3-7]. Furthermore, these desirable effects of physical activity on health have promising implications for work-related outcomes, such as work ability, which includes workers' health, functional capacity, professional knowledge and skills, values, attitudes, and motivation[8-10].

Among psychosocial factors associated with physical activity, self-regulation is considered as one of the most powerful factors in predicting and promoting physical activity[11,12]. Self-regulation is defined as personal regulation of a goal-directed behavior along the dimensions of goal setting, reinforcement, self-monitoring, corrective self-reaction, performance self-guidance, and preparation for individual outcome expectations[13]. Rhodes and Pfaeffli[11] conducted a systematic review and concluded that only a change in self-regulation was empirically supported as a

mediator between physical activity interventions and behavioral changes in physical activity. In addition, several prospective and cross-sectional studies have indicated that self-regulation is correlated more strongly with physical activity than self-efficacy, outcome expectations, or other psychosocial factors[14-16]. Furthermore, the positive relationship between self-regulation and physical activity has also been confirmed among workers[17-19]. Improving self-regulation for physical activity is important when promoting physical activity in a target population, and the measurement of self-regulation is necessary in determining current self-regulatory strategy use and subsequent changes.

We conducted reviews on studies that measured self-regulation for physical activity among workers in November 2015 using PubMed, PsycINFO, and PsycARTICLES as databases. Search terms included "self regulation" and "physical activity." Hence, we identified 338 studies, excluding 104 duplications. Finally, there were three studies that met the following criteria: The studies a) measured structured self-regulation for physical activity by reliable and valid scales, b) sampled workers as participants, c) were written in English or Japanese, and d) were published in peer-reviewed journals. Hallam and Petosa[17] measured self-regulation for physical activity among American workers using Petosa's scale (Physical Activity Self-Regulation scale: PASR-43)[20]. Umstattd et al.[18] used a short version of the PASR-43 among American workers, which consisted of 12 items (PASR-12) and was developed by the study's corresponding author[21]. Gell and Wadsworth[19] also used the PASR-12 to measure self-regulation for physical activity among working women in the US. It has been confirmed that the PASR-43 has the test-retest reliability and internal consistency[17], 6-factors with demonstrated structural validity, and hypotheses testing of the PASR-12 confirmed medium-to-strong positive correlations with physical activity and self-efficacy for physical activity[21]. Therefore, the PASR-12 is possibly the most convenient, reliable, and valid scale for the measurement of self-regulation for physical activity among workers.

However, the PASR-12 is not available in Japanese. Therefore, it is important to develop a Japanese version and test its reliability and validity for the promotion of research on physical activity in Japan and cross-country comparisons of psychological factors for physical activity. The purpose of this study was to investigate the internal consistency, convergent validity, and structural validity of the newly developed Japanese version of the PASR-12 among Japanese workers. To ensure fair judgment, our validation study was based on COnsensus-based Standards for the selection of health Measurement INstrument (COSMIN) and its checklist (boxes A, E, F, and Generalisability)[22]. We hypothesized that the Japanese version of the PASR-12 would have good internal consistency and structural validity. We also hypothesized that scores of the PASR-12 would positively correlate with physical activity ($r \geq 0.20$) and self-efficacy for physical activity ($r \geq 0.30$). These hypothesized effect sizes were estimated from previous studies[14-16,21] in which the correlation coefficients (r) between self-regulation and physical activity ranged from -0.03 to 0.85 ($M = 0.23$), and those between self-regulation and self-efficacy ranged from 0.11 to 0.79 ($M = 0.32$; COSMIN boxes F-4, F-5, F-6).

Subjects and Methods

Design

The design of this study was a cross-sectional validation study using an Internet-based survey in all prefectures in Japan (COSMIN box Generalisability-5).

Participants

Data were collected in August 2015. Of all workers who were registered as respondents of an Internet survey company, 516 workers were selected and completed a web-based questionnaire in the order of arrival. The Internet survey company that conducted this survey had access to more than 2,000,000 potential participants and recruited participants based on their demographic attributes (COSMIN boxes Generalisability-4, -7). The recruitment of participants was stratified by gender (258 men and 258 women). The inclusion criteria were as follows: (1) aged 18 or older and (2) workers. There were no exclusion criteria. Because the Internet survey company ceased the survey when the number of participants reached 103 % of the target number of respondents ($N = 500$ in this study), the response rate could not be calculated (COSMIN box Generalisability-8).

We obtained informed consent from all participants. Consent was obtained via questionnaire instructions on the website. The instructions assured protection of personal information and explained that data would be anonymized. The study protocol was approved by the ethical committee of the Department of Medicine, The University of Tokyo, Japan (No. 10919).

Measurements

Participants were asked to answer a web-based self-report questionnaire. As the standards of testing of convergent validity, we also measured physical activity and self-efficacy for physical activity.

Self-regulation for physical activity

The newly developed Japanese version of the PASR-12 was used to assess self-regulation for physical activity. This scale was translated and developed by the authors based on the original PASR-12[21]. The original scale consisted of 6 factors (self-monitoring, goal setting, eliciting social support, reinforcements, time management, and relapse prevention) across 12 items (e.g., "I mentally kept

track of my physical activity"). Total scores and each factor score of the PASR-12 were calculated by summing up the scores of the items. The items of the PASR-12 were based on Social Cognitive Theory[13] to explain the behavioral change in physical activity (COSMIN boxes A-1, E-1). All items were rated on a 5-point Likert-type scale (1 = Never, 5 = Very Often). The scale was developed according to the procedure specified in the International Society of Pharmacoeconomics and Outcomes Research (ISPOR) task force guidelines[23]. First, we obtained permission from the developers of the original PASR-12 to translate the scale into Japanese (preparation). After conducting forward translation by the two authors (KW and HA) independently, reconciliation, back translation, back translation review, harmonization, and cognitive debriefing were conducted. Back translation was conducted by a Japanese expert of English who did not know the purpose of the study. The original corresponding author checked the back-translated scale and made revisions in the back translation review section. The cognitive debriefing was conducted for five Japanese experts who majored in health science. They were asked to answer the harmonized scale and revise the wordings if they faced difficulty in understanding each item.

Physical activity

The Japanese version of the Global Physical Activity Questionnaire version 2 (GPAQ v2) was used to assess physical activity[24]. This scale asks participants about their sitting time in a day, frequency and duration of work-related (e.g., housework, farm work, nursing care), transportation-related (e.g., commuting, going for shopping), and leisure time (e.g., sport, exercise, recreation) physical activity in moderate-to-vigorous intensity per week, calculating the total physical activity, based on 16 items. This scale is widely used and has demonstrated reliability and validity (COSMIN boxes F-7, F-8)[25,26]. Metabolic equivalents (METs) were used as a unit of physical activity intensity. The total physical activity (MET-hours/week) was calculated according to the analysis guide[27].

Self-efficacy for physical activity

Self-efficacy was measured using a scale developed by Oka[28,29]. Because the scale was first developed to measure self-efficacy for exercise, we revised the word "exercise" to "physical activity." The scale consisted of 4 items (e.g., "I have the confidence to perform physical activity even if I am a little tired"). All items were rated on a 5-point Likert-type scale (1 = Not at All, 5 = Almost). Oka[28] confirmed the internal consistency and unidimensional structural validity of the scale (COSMIN boxes F-7, F-8). Cronbach's alpha in this study was 0.90.

Analysis

We calculated Cronbach's alphas for internal consistency, conducted correlational analyses for convergent validity testing, and conducted confirmatory factor analysis (CFA) for structural validity (COSMIN boxes A-9, E-6, F-10). We used SPSS version 22 and Mplus version 7.4[30] for each analysis.

Internal consistency

To assess internal consistency reliability, we calculated Cronbach's alphas for the total scores and each factor score of the Japanese PASR-12. Based on a previous study[31], the sample size of more than 100 was considered as excellent for the methodological quality for Cronbach's alpha (COSMIN box A-4). Because the previous study had confirmed a 6-factor structure of the scale, we did not check the dimensionality of the scale, but calculated Cronbach's alphas for the total scores and each factor score directly (COSMIN boxes A-5, A-7).

Convergent validity

We also calculated the Pearson's correlation coefficients among PASR-12, physical activity, and self-efficacy for physical activity to assess convergent validity. The minimum effect size for detection in the study was 0.20 (ρ). Based on a sample size calculation using G*Power version 3.1.9.2[32,33], the necessary sample size was estimated to be more than 314 in the case of an alpha error probability of 0.05 and a power ($1-\beta$) of 0.95. Hence, there were an adequate number of participants in the study (COSMIN box F-3).

Structural validity

CFA was conducted to confirm structural validity. We assumed a 6-factor model as observed in the previous study[21]. Based on the previous study[31], the sample size required for factor analysis was at least five to seven times the number of items with a minimum of 100. Because the Japanese version of the PASR-12 has 12 items, there were an adequate number of participants in the study (COSMIN box E-4). We used a robust maximum likelihood estimation method and referenced the following three model fit indices: chi square ($\chi 2$), comparative fit index (CFI), and root mean square error of approximation (RMSEA). Based on the original validation study[21], we considered that the model demonstrated good fit if CFI exceeded 0.95 and RMSEA was less than 0.06[34].

Results

Characteristics of participants

A flow chart of the participants is shown in Fig. 1 (COSMIN boxes A-8, E-5, F-9). Of the 516 initial participants, we excluded 31 participants because they answered "not employed" to a demographic question, and/or because they reported that the total time of being physically active and sitting were 18 hours or more per day on GPAQ. These participants were considered not to be applicable to the inclusion criteria of the study and/or not to correctly understand the instructions of GPAQ since they were physically active for three quarters of a day or more. Because the study employed an Internet-based survey,

there were no missing values on any variables or items (COSMIN boxes A-2, A-3, E-2, E-3, F-1, F-2). The

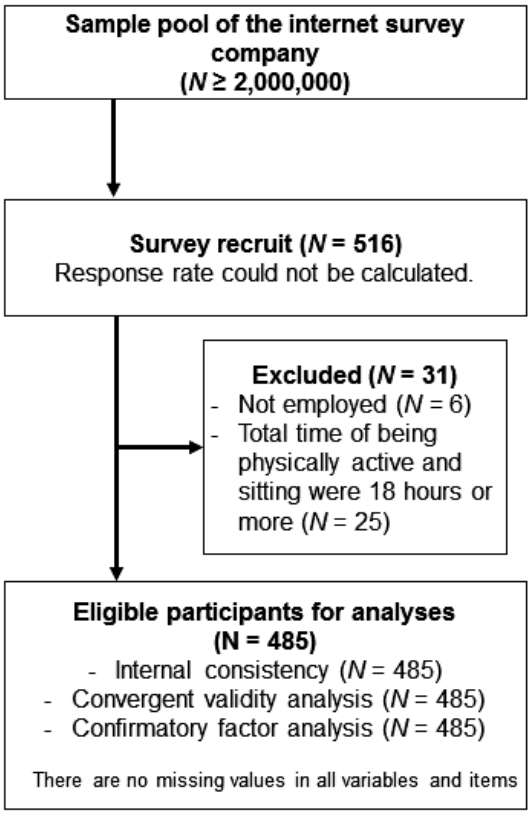

Fig. 1. Flow chart of participants in the study

demographic characteristics of 485 participants (243 men and 242 women) are shown in Table 1 (COSMIN boxes Generalisability-1, -2). Of the marital and educational status, a majority of the participants were married (58.6%) and received educations for 13 to 16 years (60.6%). With regard to occupational status, most of the participants were full-time workers (54.2%), day-time shift workers (88.5%), and employed by worksites that had less than 50 workers (47.0%).

Internal consistency of the Japanese version of the PASR-12

Table 2 shows mean scores and Cronbach's alpha for the Japanese version of the PASR-12. Cronbach's alpha coefficients of the total score and all 6 factors ranged from 0.79 to 0.95.

Convergent validity of the Japanese version of the PASR-12

Table 3 shows the correlation coefficients among physical activity, self-efficacy for physical activity, and scores of the Japanese version of the PASR-12. The total score and 6 factor scores of the Japanese version of the PASR-12 had small-to-moderate positive correlations with self-efficacy ($0.17 \leq rs \leq 0.35$, $ps < 0.05$). In addition, they had small-to-moderate positive correlations with the total physical activity ($0.19 \leq rs \leq 0.27$, $ps < 0.05$). Of area-stratified physical activities, work-related and leisure-time physical activities were positively correlated with the scores of the Japanese version of the

Table 1. Demographic characteristics of participants

	Total (*N*=485)		Men (*N*=243)		Women (*N*=242)	
	N	%	N	%	N	%
Age	*M*=42.8 (*SD*=11.6)		*M*=47.2 (*SD*=11.4)		*M*=38.4 (*SD*=10.1)	
Marital status						
Married	284	58.6	85	35.0	116	47.9
Unmarried	201	41.4	158	65.0	126	52.1
Educational status						
9-12 years	161	33.2	80	32.9	81	33.5
13-16 years	294	60.6	144	59.3	150	62.0
≥17 years	27	5.6	17	7.0	10	4.1
Employment status						
Full-time	263	54.2	165	67.9	98	40.5
Others	222	45.8	78	32.1	144	59.5
Employment shift status						
Day-time	429	88.5	213	87.7	216	89.3
Others	56	11.5	30	12.3	26	10.7
Size of worksite						
≤49 employees	228	47.0	99	40.7	129	57.4
50-299 employees	127	26.2	67	27.6	60	24.8
≥300 employees	130	26.8	77	31.7	53	21.9

Table 2. Mean scores and internal consistency of Japanese version of PASR-12 (*N*=485)

	Range	Mean (*SD*)	Cronbach's α
Total score (12 items)	12-60	22.7 (9.6)	0.95
Self-monitoring (2 items)	2-10	4.0 (1.9)	0.89
Goal-setting (2 items)	2-10	4.1 (2.1)	0.89
Eliciting social support (2 items)	2-10	3.0 (1.6)	0.90
Reinforcement (2 items)	2-10	4.4 (2.1)	0.84
Time management (2 items)	2-10	3.8 (1.9)	0.82
Relapse prevention (2 items)	2-10	3.4 (1.7)	0.79

Table 3. Correlation coefficients (*r*s) among physical activity, self-efficacy for physical activity, and Japanese version of PASR-12 (*N*=485)

	Mean (*SD*)	S-M	G-S	ESS	Rf	T-M	R-P	Total
Total physical activity (MET-hours/week)	32.3 (52.6)	0.24*	0.27*	0.19*	0.21*	0.25*	0.21*	0.24*
Work-related physical activity	15.4 (44.5)	0.11*	0.15*	0.15*	0.08	0.13*	0.10*	0.14*
Transportation physical activity	9.3 (14.7)	0.07	0.04	–0.06	0.08	0.05	0.03	0.05
Leisure-time physical activity	7.6 (20.8)	0.32*	0.34*	0.19*	0.31*	0.32*	0.29*	0.35*
Sitting time (hours)	6.3 (4.0)	–0.14*	–0.11*	–0.22*	–0.10*	–0.15*	–0.19*	–0.15*
Self-efficacy for physical activity	11.3 (3.7)	0.29*	0.30*	0.17*	0.35*	0.29*	0.26*	0.35*

Note: S-M: Self-monitoring, G-S: Goal setting. ESS: Eliciting social support, Rf: Reinforcement, T-M: Time management, R-P: Relapse prevention. * $p<0.05$

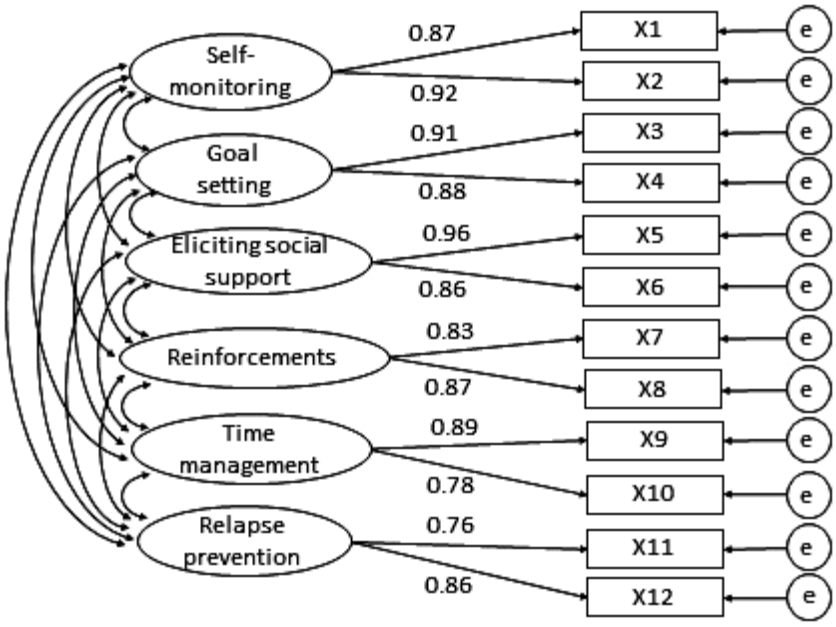

Fig. 2. Results of confirmatory factor analysis (CFA) of Japanese version of PASR-12 Note. The robust maximum likelihood estimation method of Mplus version 7.4 was used. Factor loadings were standardized. $\chi 2$ (39)=100.74, CFI=0.973, RMSEA=0.057.

PASR-12 ($0.08 \leq r\text{s} \leq 0.35$). However, there were no significant correlations between transportation physical activity and other variables ($-0.06 \leq r\text{s} \leq 0.08$).

Structural validity of the Japanese version of the PASR-12

The results of CFA are shown in Fig. 2. The 6-factor

hypothesized model demonstrated excellent fit ($\chi 2$ (39) = 100.74, CFI = 0.973, RMSEA = 0.057). The factors explained more than half of the variances of each item ($0.58 \leq R^2 \leq 0.92$, ps < 0.05). Correlation coefficients between the 6 latent variables ranged from 0.58 to 0.95. (ps < 0.05)

Discussion

The purpose of this study was to investigate the internal consistency, convergent validity, and structural validity of the newly developed Japanese version of the PASR-12 among Japanese workers. The results supported most of our hypotheses indicating that the Japanese version of the PASR-12 showed good reliability and factor-based and construct validity. Therefore, this scale could be applied to assess self-regulation for physical activity among Japanese workers.

Internal consistency was quite high, even for subscales with only two items. We could not compare the internal consistency of our scale with the original one because the original study did not report values of Cronbach's alpha[21]. However, the results of this study demonstrated partial, if not conclusive, evidence to support the reliability of the Japanese version of the PASR-12.

Convergent validity was partially confirmed. The total and subscale scores of the Japanese version of the PASR-12 moderately correlated with self-efficacy for physical activity (r = 0.17-0.35). Although the original validation study[21] reported stronger positive correlation with each other, this finding is concordant with our hypothesis. Only the correlation for the subscale of eliciting social support was below 0.2, which may be because the link between self-regulation for seeking social support and self-efficacy is expected to depend on the individual's human relationship resources. The total and subscale scores of the Japanese version of the PASR-12 moderately correlated with the total (r = 0.19-0.27) and leisure-time physical activity (r = 0.19-0.35) scores, while again the correlation for the subscale of eliciting social support was below 0.2. This is also in line with our hypothesis. Correlations of the total and subscale scores of the PASR-12 with work-related and transportation physical activity were weak in general (r = -0.06-0.15). This is probably because work-related and transportation physical activity were largely determined by the workplace settings and types of employment rather than by the decision and will of a worker[35-37]. It is possible that self-regulatory strategies are more important for planned physical activity versus more utilitarian or non-volitional physical activity. In addition, physical activity was measured by a self-report questionnaire, which might be subject to some measurement error. While the relationship between self-regulation for physical activity and physical activity using GPAQ could not be investigated through any previous study, reported values of the correlation varied among previous studies[14-16,21]. These results possibly depended on scales used to assess physical activity. Therefore, we may have underestimated the correlation effect between self-regulation and physical activity.

Factor-based structural validity was well-established in this study. The scale may be useful to assess different domains of self-regulation for physical activity that could be associated with physical activity in different manners in further studies. The results of our analysis were similar to those found in the original study[21] in terms of model fit ($\chi 2$ (39) = 70.75, CFI = 0.99, RMSEA = 0.04), factor loadings (0.76-0.92), and correlations between the 6 factors (0.55-0.87). Therefore, the 6-factor structure could be applicable for Japanese workers as well.

There are several limitations in this study. First, many other components of reliability and validity could not be confirmed in this cross-sectional study design (e.g., test-retest reliability, measurement error, and responsiveness). Second, the response rate could not be calculated, because the study was conducted through an Internet-based survey. This limitation might cause a selection bias and an underestimation for concurrent and construct validity. For instance, participants who self-regulated physical activity and had considerable amount of physical activity might not have the habit of using the Internet and/or may be reluctant to participate in the survey. Third, there could be some measurement error in the assessment of self-efficacy and physical activity. Fourth, other confounds that were not measured in the study might distort the results of correlation analyses, such as social support and environmental factors that promote or inhibit physical activity. Finally, the generalizability of the results for Japanese workers could be questioned due to the use of an Internet-based survey. Therefore, further studies are required to address these limitations.

In conclusion, the Japanese version of the PASR-12 showed good reliability and factor-based and construct validity. This scale could be useful to assess self-regulation for physical activity and promote physical activity among Japanese workers in further studies. Therefore, further studies are required to confirm other types of reliability and validity.

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Conflicts of interest: Kazuhiro Watanabe, Norito Kawakami, Hidehiko Adachi, Shigeru Inoue, and M. Renee Umstattd Meyer declare that we have no conflict of interest in connection with the paper.

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Japanese version

※普段から身体活動をするために， 様々な方法が用いられることがあります。 あなたは，過去4週間に行った身体活動に関して， 以下の方法をどのくらい用いましたか。 あなたの答えに最もあてはまるものに ○をつけてください。		全くなかった	めったになかった	ときどきあった	しばしばあった	非常に頻繁にあった
セルフモニタリング						
1	どのような身体活動をしたかを 頭の中で確認した。	1	2	3	4	5
2	身体活動をするために役立つ 具体的な気付きを得た。	1	2	3	4	5
目標設定						
3	どのくらいの頻度で身体活動をするかに ついて，短期的な目標を立てた。	1	2	3	4	5
4	自分の健康に関する 身体活動の目標を立てた。	1	2	3	4	5
社会的支援の獲得						
5	身体活動に関するアドバイスや 実演指導を，誰かに頼んだ。	1	2	3	4	5
6	身体活動に関するアドバイスや実演指導を， 身体活動や健康の専門家に頼んだ。	1	2	3	4	5
強化						
7	身体活動をした後で， その心地よさを味わった。	1	2	3	4	5
8	身体活動が健康に与える 利益について思い起こした。	1	2	3	4	5
時間管理						
9	身体活動をする具体的な日時について， 頭の中で予定を立てた。	1	2	3	4	5
10	身体活動をする時間を確保するために 予定を変更した。	1	2	3	4	5
身体活動不足の予防						
11	外泊等で家を離れる際に，身体活動を するための方法を意識して計画した。	1	2	3	4	5
12	天候が悪いときでも，身体活動が できるような方法を意識して計画した。	1	2	3	4	5

Supplement 1. The Japanese and original version of the PASR-12