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Original Article

Relationship between Chronic Low Back Pain, Social Participation, and Psychological Distress in Elderly People: A Pilot Mediation Analysis

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Several studies indicated that chronic low back pain (CLBP) worsened psychological distress (PD) and social participation (SP) improved PD. The relationships among CLBP, SP and PD have not been established. Here we investigate whether SP mediates the relationship between CLBP and PD in 96 elderly people. We evaluated CLBP and SP by a self-administered questionnaire and PD by K6 questionnaires. We used simple correlation analyses, the unpaired *t*-test, and a mediation analysis following the approach outlined by Structural Equation Modeling (SEM) to clarify the relationships among CLBP, SP and PD. Using SEM, was observed a significant relationship between CLBP and SP ($\beta = -0.321$, $p = 0.003$), a significant negative correlation between SP and K6 scores ($\beta = -0.357$, $p = 0.001$), and a significant positive correlation between CLBP and K6 scores ($\beta = 0.333$, $p = 0.002$). By including SP as a parameter, the coefficient of correlation between CLBP and K6 scores varied from 0.333 ($p = 0.002$) to 0.218 ($p = 0.035$). After bootstrapping, 0 was not included in the 95% confidence interval (0.119, 1.913). SP as a mediator may reduce PD in elderly people with CLBP.

Key words: psychological distress, chronic low back pain, social participation, mediation analysis

The maintenance of mental health in elderly people is an important issue. In Japan, the number of individuals with mood and anxiety disorders (including depression) in 2014 was reported to be 1,116,000, and 30% of these individuals were elderly (≥ 65 years old) (http://www.mhlw.go.jp/toukei/saikin/hw/kanja/14/dl/toukei.pdf [in Japanese] accessed 8, 2017). We have examined the relationships between social participation, psychological distress and physical activities [1], and we observed that social participation was significantly involved in psychological distress in elderly people. However, other factors affecting the mental health of elderly people can be assumed to exist. Chen *et al.* reported that "pre-existing chronic disease(s) significantly contribute to the development of mental health disorders over time, indicating a reciprocal interrelationship" [2]. We speculated that chronic low back pain (CLBP) was one of the significant symptoms of chronic diseases. Hishii *et al.* found a significant correlation between CLBP and mental health in patients undergoing artificial dialysis [3].

The global prevalence of low back pain in adults is approx. 12% [4]. In Japan, the percentage of patients with low back pain in 2013 was reported to be 9.2% (men) and 11.8% (women) (http://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa13/dl/04.pdf [in Japanese] accessed 8, 2017). In Australia, epidemiologic studies indicated a very high prevalence of CLBP in the elderly, *i.e.*, > 50% [5]. CLBP causes significant psychological health impairment, affects social communication and family life, and increases healthcare

costs. Thus, the prevention and improvement of mental health in the elderly with chronic pain is urgently required.

Previous studies demonstrated that CLBP in the elderly led to worsened psychological distress [6,7]. Some research groups found that social participation improved psychological distress [8-11]. CLBP was reported to reduce social participation [12-14]. However, the relationships among CLBP, social participation, and psychological distress have not been well investigation. We have thus conducted additional surveys of CLBP in healthy elderly and younger individuals [1].

We performed the present study to clarify whether social participation plays a role as a mediator between psychological distress and CLBP in elderly people. We used a mediation analysis, which is an effective method to examine an intervening element (mediator) between a probable cause and a probable result.

Methods

Study design. This was an observational cross-sectional study. We adopted the following hypothesis: social participation mediates the relationship between CLBP and psychological distress in elderly people. The subjects in our study were 96 individuals (30 men, 72.3 ± 5.6 years and 66 women, 71.9 ± 5.4 years old) who were members of a college health club, and additional subjects from a previous investigation [1]. We conducted the study from March 10 to March 20, 2017. The number of subjects required to perform a mediation analysis is > 400 [15], and we thus conducted this research as a pilot study.

We received approval from the Shikoku Medical College Ethics Screening Committee (approval no. H27-5), and written informed consent was obtained from each subject.

Clinical parameters and measurements. The data on the subjects' age, height, body weight and body mass index (BMI), excluding ≤ 1.5 Mets, were taken from our previous investigation [1]. In addition, chronic stiff shoulder was considered as a variable affecting psychological distress. We defined stiff shoulder as pain in the neck, shoulder or back, and we defined chronic stiff shoulder as pain lasting > 3 months. The subjects were instructed to respond to questionnaire items about chronic stiff shoulder by choosing "experienced" (1 point) or "not experienced" (0 points).

Psychological distress. Psychological distress was assessed using six items of the Japanese edition of the K6 scale [16]. The K6 is a self-completed questionnaire developed by Kessler as a screening test for psychological distress that has been demonstrated to effectively discriminate [17]; it is valid and reliable. The subjects answered six items on a five-point Likert scale, and their responses for each item were transformed to scores ranging from 0 to 4 points. The questionnaire consisted of six questions that asked, "Over the last month, about how often did you feel: (1) nervous, (2) hopeless, (3) restless or fidgety, (4) so sad that nothing could cheer you up, (5) that everything was an effort, (6) worthless?" The subjects were requested to respond by choosing from the following: "all of the time" (4 points), "most of the time" (3 points), "some of the time" (2 points), "a little of the time" (1 point), and "none of the time" (0 point), and the total number of points was the evaluation level [18]. Thus, the score range was 0-24. A higher total score corresponds to higher psychological distress [1].

CLBP. Chronic low back pain was defined as pain localized between the 12th rib and the inferior gluteal folds [19] lasting > 3 months [20]. The subjects were requested to respond to the item about chronic low back pain on the questionnaire by choosing "experienced" (1 point) or "not experienced" (0 point).

Social participation. We evaluated social participation as established by Haeuchi *et al*. [21]. The subjects were asked whether they participated in 8 types of social activities: (1) local events and festivals, (2) resident and neighborhood associations, (3) circle activities, (4) golden age club, (5) volunteer activities, (6) religious activities, (7) paid work, or (8) learning, within the past year from the date of the survey. The subjects were requested to respond by choosing from the following: some kind of social activity or more than one within the past month, once or more per week (1 point), or, participates in no activities (0 point) [1].

Statistical analysis. First, by performing a simple correlation analysis on continuous variables (such as BMI) and by using the unpaired *t*-test on binary variables (such as participation), we examined the relationships between the clinical parameters and the K6 scores. For CLBP, we performed a multivariate analysis to calculate the multivariate adjusted odds ratio adjusted for age, ≤ 1.5 Mets, BMI, social participation, and the K6.

Second, we examined the relationships among CLBP, social participation, and psychological distress with Structural Equation Modeling (SEM) as the mediation analysis [22, 23]. We used the bootstrap method to verify the SEM in detail. We confirmed our results by repeating the regression analysis four times (multilevel mediation model) using the same factors [24]. Finally, we analyzed the influence of other factors affecting the K6 scores (psychological distress).

We used AMOS ver. 24.0 (IBM SPSS Institute) and JMP 13.0 (SAS Institute) software for the statistical analyses. The threshold for significance was $p < 0.05$.

Results

The subjects' characteristics are summarized in Table 1, and the relationships between the clinical parameters and the K6 scores are shown in Table 2. The K6 scores did not correlate with BMI (kg/m^2) or ≤ 1.5 Mets (%/day). However, the K6 scores differed significantly between the female subjects with and without chronic stiff shoulders, CLBP, and social participation (all $p < 0.001$). The odds ratios compared with CLBP were as follows: age, 1.081 ($p = 0.097$); ≤ 1.5 Mets, 0.991 ($p = 0.855$); BMI, 1.028 ($p = 0.672$); social participation, 0.270 ($p < 0.05$); and the K6, 1.242 ($p < 0.01$).

As shown in Fig. 1, there was a significant relationship between CLBP and social participation (β [standardization coefficient] = −0.321, $p = 0.003$). In addition, a significant negative correlation was found between social participation and K6 scores (β = −0.357, $p = 0.001$). A significant correlation between CLBP and K6 scores was also revealed (β = 0.333, $p = 0.002$). We therefore examined the indirect effects of social participation on the relationship between CLBP and K6 scores. By including social participation as a mediator, the

Table 1　Clinical characteristics of enrolled subjects

	Total			Men			Women		
	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum
Number of subjects	96			30			66		
Age (year)	72.0 ± 5.4	65	85	72.3 ± 5.6	65	85	71.9 ± 5.4	65	85
Height (cm)	156.9 ± 8.9	138.3	178.4	166.3 ± 6.2	155.3	178.4	152.6 ± 6.1	138.3	166.4
Body weight (kg)	56.1 ± 9.6	40.3	86.2	64.7 ± 9.1	49.3	86.2	52.1 ± 6.9	40.3	65.4
BMI (kg/m²)	22.7 ± 2.9	14.9	30.2	23.4 ± 2.9	17.6	29.1	22.4 ± 2.8	14.9	30.2
≤1.5 Mets (%/day)	55.0 ± 9.9	35.4	79.9	59.4 ± 11.4	36.8	79.9	53.2 ± 8.7	35.4	75.5
K6 scores	2.7 ± 3.3	0	14	3.1 ± 3.6	0	13	2.5 ± 3.2	0	14
Social participation (Presence) (%)	83.3			76.7			86.4		
Chronic stiff shoulder (Presence) (%)	26.0			16.7			30.3		
Chronic low back pain (Presence) (%)	47.9			50.0			47.0		

BMI, body mass index (kg/m²); Mets, Metabolic equivalents.
≤1.5 Mets (%/day): n=86.

Table 2　Simple correlation and Unpaired t test for K6 scores and clinical parameters

Simple correlation	Total		Men		Women	
	r	p	r	p	r	p
BMI (kg/m²)	−0.019	0.852	0.183	0.333	−0.135	0.281
≤1.5 Mets (%/day)	0.031	0.778	0.152	0.467	−0.020	0.881

Unpaired t test	Total		Men		Women	
	Mean ± SD	p	Mean ± SD	p	Mean ± SD	p
Social participation (Presence)	2.3 ± 2.8	**0.003**	3.0 ± 3.6	0.635	2.0 ± 2.4	**<0.001**
(none)	4.9 ± 4.6		3.7 ± 3.9		5.8 ± 5.1	
Chronic stiff shoulder (Presence)	4.5 ± 4.2	**<0.001**	4.4 ± 3.1	**<0.001**	4.5 ± 4.4	**<0.001**
(none)	2.0 ± 2.8		2.7 ± 3.7		1.6 ± 2.1	
Chronic low back pain (Presence)	3.8 ± 4.2	**<0.001**	4.1 ± 4.5	**<0.001**	3.7 ± 4.1	**<0.001**
(none)	1.6 ± 1.9		1.8 ± 2.2		1.5 ± 1.7	

Bold values are significant ($p < 0.05$).
BMI, body mass index (kg/m²).
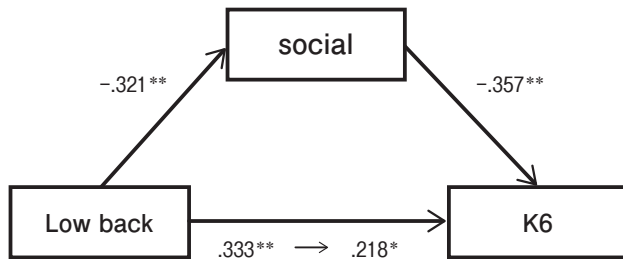≤1.5 Mets (%/day): n = 86

Fig. 1　Mediation analysis results. Low back: Chronic low back pain. Social participation. K6: The K6 scores. The numbers in the figure are standardized coefficients.　*$p < 0.05$.　**$p < 0.01$.
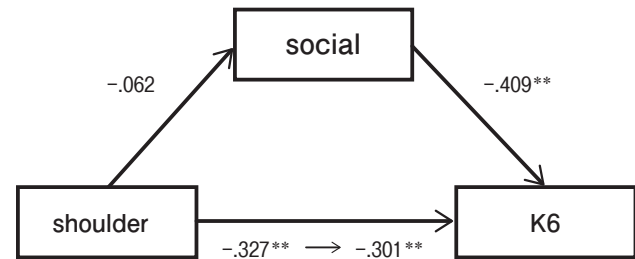

Fig. 2　Mediation analysis results. Shoulder: Chronic stiff shoulder. Social: Social participation. The numbers in the figure are standardized coefficients.　*$p < 0.05$.　**$p < 0.01$.

correlation between CLBP and K6 scores varied from 0.333 ($p = 0.002$) to 0.218 ($p = 0.035$). Thus, indirect effects: 0.333 0.218 $= -0.321 \times (-0.357) = 0.115$.

After we performed bootstrapping (10,000 samples), 0 was not included in the 95% confidence interval (CI) (0.119, 1.913), and the indirect effects of social participation were significant. In addition, the Sobel Test [15] result was Z $= 2.327$, $p = 0.020$. We confirmed the results with a multilevel mediation model as follows: (1) When the independent variable was CLBP and the dependent variable was social participation, there was a significant negative correlation ($\beta = -0.321$, $p = 0.003$). (2) When the independent variable was social participation and the dependent variable was the K6 scores, there was a significant negative correlation ($\beta = -0.357$, $p = 0.001$). (3) When the independent variable was CLBP and the dependent variable was the K6 scores, there was a significant positive correlation ($\beta = 0.333$, $p = 0.002$). (4) When the independent variables were CLBP and social participation and the dependent variable was the K6 scores, there was a significant positive correlation (CLBP: $\beta = 0.218$, $p = 0.019$, variance inflation factor (VIF) $= 1.115$; social participation: $\beta = -0.357$, $p = 0.020$, VIF $= 1.115$; $R^2 = 0.226$, $p = 0.001$) (figure not shown).

Finally, we analyzed the relationship between chronic stiff shoulder and K6 scores because they were significantly correlated. As shown in Fig. 2, a significant relationship was observed between chronic stiff shoulder and K6 scores ($\beta = 0.327$, $p = 0.002$). In addition, a significant negative correlation was found between social participation and K6 scores ($\beta = -0.409$, $p < 0.001$). However, social participation was not correlated with chronic stiff shoulder ($\beta = -0.062$, $p = 0.570$). By including social participation as a mediator, the correlation between chronic stiff shoulder and

the K6 scores varied from 0.327 ($p = 0.002$) to 0.301 ($p = 0.002$). After performing bootstrapping (10,000 samples), 0 was included in the 95% confidence interval (CI) (-0.401, 1.232). In addition, the Sobel Test [15] was Z $= 0.566$, $p = 0.572$.

Discussion

We evaluated the relationships among K6 scores and five variables (BMI, ≤ 1.5 Mets, social participation, chronic stiff shoulder, and CLBP). The results demonstrated that the K6 scores did not correlate with BMI or ≤ 1.5 Mets. These results were not consistent with many previous studies [25]. This is likely because elderly people between the ages of 60 and 74 were reported to have lower K6 scores than other age groups (http://saigai-kokoro.ncnp.go.jp/k6.html [in Japanese] accessed 8, 2017). As the 96 elderly subjects in our study were generally above this age group (72.3 ± 5.6 years old for the men, and 71.9 ± 5.4 years old for the women), the BMI and ≤ 1.5 Mets values minimally affected the K6 scores. However, the K6 scores were significantly different in the female subjects with and without chronic stiff shoulder, CLBP and social participation. These results are in agreement with many previous studies [3-11].

Social participation by elderly people was demonstrated to reduce their psychological distress [6,7], and several studies revealed that stiff shoulder and CLBP worsened psychological distress [8-11]. However, those studies did not examine the relationships among psychological distress, CLBP, and social participation. By using SEM, we found that social participation played the role of a mediator between CLBP and psychological distress in elderly people. According to Sobel [15], a normal distribution can be assumed asymptotically with over 400 subjects. Thus, the distribution may be dis-

torted with small samples. As the sample size in our study was only 96 subjects, we adopted the bootstrapping method to determine indirect effects. In this case, when 0 was not included when the confidence interval was determined, significance was at the 5% level.

We next analyzed the relationships among CBLP, social participation, and K6 scores by a regression analysis. Baron *et al.* [24] reported that a mediation analysis could be performed using the multilevel mediation model. If there were no missing values, this method and SEM obtained the exact same estimates [26]. Our results were also the same except for one *p*-value. As such, our results were significant by SEM because 0 was not in the confidence interval (95%CI: 0.119-1.913); The Sobel Test [15] result was $Z = 2.327$, $p = 0.020$. In addition, by using a multilevel mediation model, we observed that three single regression analyses and one multiple regression analysis were effective. With social participation as a mediator, the correlation between CLBP and K6 scores varied from 0.333 ($p = 0.002$) to 0.218 ($p = 0.019$). The above two results validated our hypothesis that social participation acts as a mediator between CLBP and psychological distress in elderly people. We suggest that CLBP care for elderly people should include encouraging social participation because this participation may reduce psychological distress in elderly people.

Finally, we considered the relationship between chronic stiff shoulder (a factor affecting the K6 score) and the K6 scores. In this case, because 0 was in the confidence interval (95% CI: −0.401-1.232), it was not significant. Moreover, the Sobel Test [15] result was $Z = 0.566$, $p = 0.572$. Although chronic stiff shoulder and K6 scores exhibited a significant relationship, social participation did not act as a mediator between chronic stiff shoulder and psychological distress in these elderly subjects. Chronic stiff shoulder did not affect walking as an aspect of social participation, but CLBP did. Thus, chronic stiff shoulder minimally affects social participation.

The potential limitations of this study are as follows. First, the study was cross-sectional and not longitudinal. We therefore cannot confirm a causal relationship by the mediation model (SEM and multilevel mediation model) in this study. Second, we used a model in which social participation mediated between CLBP and K6. However, the possibility of other mediators such as household income, obesity, exercise and many treat-

ments could not be evaluated sufficiently [9, 23, 27, 28, https://hpi.georgetown.edu/agingsociety/pubhtml/backpain/backpain.htmi accessed 8, 2017]. Thirdly, the small sample size makes it difficult to validate this study's findings. An increased number of subjects (≥ 400) should be examined in the future. Finally, in a questionnaire survey, it is unknown whether the patient fully understood the definition of CLBP. It is thus necessary to examine a variety of measurement methods such as questions by an interviewer.

In conclusion, the results of our analyses suggest that social participation as a mediator may be related to reducing psychological distress in elderly people with CLBP.

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