Effect of COVID-19 stress on physical function performance and socioenvironmental factors of people with disabilities in Korea

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This study investigated the effect of stress during the COVID-19 pandemic and the potential moderating effects of socioenvironmental factors on the physical conditions of Korean people with disabilities. Data from 405 participants on depression, instrumental activities of daily living and socioenvironmental factors were analyzed using frequency analysis, descriptive statistics, t-tests, one-way analysis of variance, Pearson’s correlations and hierarchical regression analysis. Stress caused by COVID-19 was significantly correlated with depression, instrumental activities of daily living and social participation. Using socioenvironmental factors as moderators of the relationship between stress and depression, we found that increased depression was alleviated by social attitudes ($\beta=2.064; P<0.01$), family attitudes ($\beta=0.028; P<0.05$) and healthcare services and policies ($\beta=-4.579; P<0.001$). Moreover, instrumental activities of daily living increased with decreased stress as moderated by social attitudes ($\beta=0.140; P<0.05$) and healthcare services and policies ($\beta=-0.306; P<0.001$). Further, increased social participation alleviated stress as moderated by social attitudes ($\beta=0.166; P<0.01$), mobility and convenience facilities ($\beta=0.158; P<0.01$) and healthcare services and policies ($\beta=-0.342; P<0.001$). The results indicate that even in public healthcare crises, it is important for people with disabilities to manage their health and participate in social activities. Their self-management and social participation can be promoted by strengthening community-centered rehabilitation and providing consumer-oriented social services. \textit{International Journal of Rehabilitation Research} 45: 79–85 Copyright © 2022 The Author(s). Published by Wolters Kluwer Health, Inc.

Introduction

Since the COVID-19 was declared a pandemic on March 11, 2020 [1], the lives of Korea’s residents have changed due to response measures [2]. People with physical disabilities (PwDs) in Korea have been experiencing a deteriorated quality of life due to prolonged changes such as social distancing, mask usage and closure of education and social welfare facilities [3]. They are already at a higher risk of exposure to infection due to circumstances such as poor health status, high chronic disease rates and dependency on others to perform activities of daily living [4,5]. As they may find coping with health emergencies and recovering independently difficult, they need targeted resources and support [6].

Most people with physical disabilities in Korea have an increased risk for contracting COVID-19 and experience elevated stress levels due to related health and social issues [7]. Accordingly, their health conditions have worsened, delaying their return to daily life and deteriorating their quality of life [3,8,9]. Moreover, depression has increased among PwDs, largely due to limited voluntary movement, social isolation and health concerns, including anxiety and fear caused by COVID-19 [9,10]. To understand the relationship between PwDs’ health and various relevant factors, such as activity constraints and physical functioning [12], we used the International Classification of Functioning, Disability, and Health (ICF) model [13]. The model comprehensively measures health status, emphasizing an integrated model including psychosocial and medical factors [14].

Instrumental activities of daily living (IADLs) are individuals’ ability to perform tasks and activities required for independent living. PwDs need assistance in IADLs, and limitations and discomfort in performing these activities are positively correlated with stress [15,16]. Community assistance has been hampered due to social distancing rules, and individual movements have been restricted by lockdowns, thus reducing the overall support for PwDs [3,17]. Thus, it is necessary to offer appropriate assistance...
services, cultivate self-management practices and provide social participation opportunities [18–20]. For this, a greater understanding of PwDs’ needs in the context of stress due to a public health crisis is needed.

Therefore, this study investigated the effects of COVID-19 and socioenvironmental factors on the health and physical functioning of PwDs in Korea, based on the ICF model. The main study objectives were as follows:

1. to determine whether stress caused by COVID-19 affected the health and physical functioning in terms of depression, IADL, and social participation.
2. to determine whether socioenvironmental factors affected stress caused by COVID-19 and physical functioning.
3. to determine whether socioenvironmental sub-factors moderated the relationship between stress caused by COVID-19 and physical functioning.

**Methods**

**Participants**

This study was conducted using a survey approved by the Institutional Review Board (IRB) of Korea University (KUIRB-2021-0061-01). A recruitment notice before the visit was announced online and offline after prior consultation with organizations and welfare centers for the disabled and public health centers. Furthermore, the study purpose and procedure, its benefits and risks were explained to the participants to obtain informed consent. The questionnaire was self-administered. Participants’ identities were not known to the researchers during data analysis, to protect the participants’ personal information. Data were sealed and stored by the researchers and discarded after study completion. The inclusion criteria were being aged over 19 years and having the ability to understand the researchers’ instructions and the questionnaire. Data were collected from 411 participants between 23 February 2021 and 20 March 2021. After excluding unreliable and missing data, data from 405 respondents were analyzed. The minimum required sample size was 222 (G-power version 3.1.9.7) to perform a hierarchical regression with 15 predictors, a median effect size of 0.15, significance level of 0.05, statistical power of 0.95 and dropout rate of 10%. However, based on a finding that 200–450 participants are desirable for multivariate statistical analysis [21], we collected data from as many participants as possible, to better understand the environment and personal characteristics of PwDs during the COVID-19 pandemic.

**Measures**

**Stress**

To measure stress, we used the Korean version of the Perceived Stress Scale (PSS) [22], which is based on the original PSS [23]. The item ‘How bad have you been over the past month?’ in the original questionnaire was modified to ‘In the past month, how many times have you felt bad because something unexpected happened due to COVID-19?’ Similarly, nine other items were modified. Participants rated items using a 5-point Likert scale ranging from 1 (‘never’) to 5 (‘very often’); higher scores indicated higher stress levels. Cronbach’s α in the original study was 0.828 and 0.901 in this study.

**Depression**

Depression was measured using the Korean version of The Center for Epidemiologic Studies Depression Scale (CES-D) [24,25]. Of the 11 items in the Korean version, 10 were modified, including ‘I felt lonely as if I was the only person in the world’, which was revised to ‘I felt lonely as if I was the only person in the world due to COVID-19’. Responses to items ranged from 0 (‘extremely rare’) to 3 (‘mostly so’); higher scores indicated higher depression levels. Items 2 and 7 were reverse-coded. Cronbach’s α in the original study was 0.888 and 0.912 in this study.

**Instrumental activities of daily living**

The Korean version of IADL (K-IADL) [12,26,27], based on the original scale [28], was used to measure participants’ ability to perform IADLs. Eleven items were modified, including ‘Did you have any difficulties going to the store and purchasing items?’ which was changed into, ‘Did you have any difficulties going to the store and purchasing items due to COVID-19?’ Items were rated on a 4-point Likert scale ranging from 1 (‘I can do it alone’) to 4 (‘it is impossible for me’); higher scores indicated lower ability to perform IADLs and higher dependence. Cronbach’s α in the original study was 0.944 and 0.867 in this study.

**Social participation**

The level of participation in social activities and outings was measured [22] to assess behavioral continuity and integration with society during the COVID-19 pandemic. A reconstructed version [29] of the original scale [12,27] was used, which consists of 32 items, including ‘I freely use the shops near my house’ which was modified to, ‘I freely used the shops near my house during the COVID-19 period’. Items were rated on a 5-point Likert scale ranging from 1 (‘not at all’) to 5 for (‘strongly agree’); higher scores indicated higher social participation. Cronbach’s α in the original study was 0.975 and 0.968 in this study.

**Socioenvironmental factors**

The 32-item Environmental Scale for the Disabled [12,27] was used to measure PwD’s perceived social support. Items included ‘Social prejudice against disability greatly diminished my self-esteem’ which was modified to, ‘Social prejudice against disability greatly diminished my self-esteem during the COVID-19 period’. Responses were based on a 5-point Likert scale ranging from 1 (‘not...
at all’) to 5 for (‘strongly agree’); higher scores indicated higher perceived social support. Cronbach’s α in the original study was 0.953 and 0.968 in this study.

**Analysis**

Data were analyzed using SPSS 23.0. First, frequencies, means and SD were calculated. Differences in characteristics were analyzed using independent t-tests and one-way analysis of variance. For post hoc analysis, we performed Scheffé tests. Second, Pearson’s correlations were obtained to determine relationships among stress, IADLs, social participation, depression and socioenvironmental factors. Third, hierarchical regression was conducted to determine the effect of stress on physical functioning, and the moderating influences of socioenvironmental sub-factors on the relationship between stress and functioning. Mean centering was performed with an interaction term used to verify the moderating effect. Variance inflation factor values between variables were 1.000–5.646, indicating an absence of multicollinearity.

**Results**

**General characteristics**

Table 1 shows participants’ general characteristics. Stress was higher among those who were single, divorced or widowed; had middle-school education at most; were aged over 50 years; had severe disabilities and had internal organ disabilities versus external physical disabilities. Depression was significantly higher among women; those who were single, divorced or widowed; had lower educational backgrounds; were aged over 40 years and had severe disabilities. Men and participants living in large cities; over 45 years; with more severe disabilities and with internal organ disabilities had a lower level of ability to perform IADLs. Social participation was higher among married people; those with a college education or higher; those aged below 50 years and those with mild disabilities, especially external physical disabilities versus internal organ disabilities.

**Correlations of main variables**

Pearson’s correlations between the variables were all significant (P<0.001; Table 2). The analysis result showed the correlation coefficient between the variables was significant at P<0.001 level. Meanwhile, life stress, IADLs, social participation, depression and sub-factors of environmental factors (social attitudes, family attitudes, mobility and convenience facilities, supportive relationships and services and policies) showed a correlation. Further, the multicollinearity between the major variables had no problems because the correlation coefficient was not more than 0.8 [30].

**Moderating effect of socioenvironmental factors on stress and depression**

Table 3 shows that personal characteristics in Model 1 explained 58.6% of the variance in depression, whereas marital status (β = −2.81; P<0.01) and stress (β = 12.78; P<0.001) had significant effects. Greater depression was associated with living alone and greater experiences of stress during the pandemic. In Model 2, stress significantly affected depression (β = 8.23; P<0.001), with an explanatory power of 70.6%. Additionally, a 12% increase in explanatory power was observed after including socioenvironmental factors. Particularly, lower depression was associated with improved social attitudes (β = −2.11; P<0.001), family attitudes (β = −2.38; P<0.001) and mobility and convenience facilities (β = −3.17; P<0.001). In Model 3, explanatory power increased by 2.5–73.1%. Interactions between stress and social attitudes (β = 2.06; P<0.01) and family attitudes (β = 2.02; P<0.05) were significant, such that depression increased contingent on changes in social and family attitudes. Contrastingly, depression decreased with increased availability of healthcare services and policies (β = −4.57; P<0.001).

**Moderating effect of socioenvironmental factors on the relationship between stress and ability to perform instrumental activities of daily living**

In Model 1, personal characteristics explained 9.8% of the variance in the ability to perform IADLs (Table 4); gender (β = 0.14; P<0.05), age (β = 0.07; P<0.01) and stress (β = 0.17; P<0.001) had significant effects. Specifically, men, older persons and those experiencing higher stress demonstrated decreased independence in performing IADLs. In Model 2, stress significantly affected ability to perform IADLs (β = −0.12; P<0.05), with an explanatory power of 28.5%. Inclusion of socioenvironmental sub-factors increased explanatory power by 18.8%; particularly, improved social attitudes (β = −0.22; P<0.001) and services and policies (β = −0.18; P<0.01) were negatively correlated with dependence in performing IADLs. In Model 3, explanatory power increased by 4.0–32.6%. The interaction effect between stress and social attitudes (β = 0.14; P<0.05) was significant, indicating that improved independence in performing IADLs was correlated with improved social attitudes. Similarly, improved independence in performing IADLs was correlated with higher availability of healthcare services and policies (β = −0.30; P<0.001).
(β = 0.28; P < 0.001) and healthcare services and policies (β = 0.28; P < 0.001) had positive effects. In Model 3, explanatory power increased by 2.7–82.3%, indicating that increased social participation was correlated with improved social attitudes (β = 0.10; P < 0.01) and mobility and convenience facilities (β = 0.15; P < 0.01). Similarly, services and policies (β = −0.34; P < 0.001) improved social participation.

Table 1  Comparative analysis of stress, depression, instrumental activities of daily living and social participation according to general characteristics (N=405)

| Variables | Categories | N (%) | Life stress | Depression | IADL | Social participation |
|-----------|------------|-------|-------------|------------|------|---------------------|
|           |            |       | M ± SD      | M ± SD     | M ± SD | M ± SD              |
| Sex       | Male       | 259 (64.0) | 3.27 ± 0.77 | 21.36 ± 14.11 | 2.14 ± 0.76 | 2.77 ± 0.88 |
|           | Female     | 146 (36.0) | 3.34 ± 0.90 | 24.17 ± 14.37 | 2.32 ± 0.67 | 2.68 ± 0.89 |
| t or F (P)|            | −0.84 | −1.91*      | 2.51*      | 0.99   |                     |
| Region    | Big city   | 204 (50.4) | 3.24 ± 0.84 | 22.20 ± 13.89 | 2.28 ± 0.70 | 2.73 ± 0.85 |
|           | Medium, small city | 201 (49.6) | 3.34 ± 0.80 | 22.55 ± 14.64 | 2.13 ± 0.76 | 2.75 ± 0.91 |
| t or F (P)|            | −1.24 | −0.25       | 2.15*      | −0.29   |                     |
| Marital status | Married/cohabitating | 194 (47) | 3.12 ± 0.72 | 19.11 ± 13.00 | 2.19 ± 0.77 | 2.85 ± 0.86 |
|           | Other      | 211 (52.1) | 3.45 ± 0.87 | 25.38 ± 14.71 | 2.22 ± 0.70 | 2.64 ± 0.90 |
| t or F (P)|            | −4.11*** | −4.54***  | −0.45     | 2.34*   |                     |
| Education | Elementary | 9 (2.2) | 3.92 ± 0.89 | 34.74 ± 11.93 | 2.97 ± 0.75 | 2.93 ± 0.87 |
|           | Middle     | 35 (8.6) | 3.84 ± 0.77 | 30.12 ± 16.11 | 2.39 ± 0.83 | 2.29 ± 0.87 |
|           | High       | 185 (45.7) | 3.47 ± 0.73 | 23.89 ± 14.64 | 2.16 ± 0.71 | 2.60 ± 0.80 |
| College   |            | 176 (43.5) | 2.97 ± 0.79 | 18.61 ± 14.25 | 2.19 ± 0.00 | 3.02 ± 0.88 |
| t or F (P)|            | 21.05*** | 11.30***   | 1.68      | 13.25*** |                     |
|          |            | (a,b>c,d)g | (a,b>c,d)g | 11.30*** | 20.81*** |                     |
|          |            |           | 8.88***     | 4.55***   |         |                     |
| Age      | 20–29a     | 40 (9.9) | 3.08 ± 0.45 | 16.45 ± 12.82 | 1.92 ± 0.81 | 3.22 ± 0.44 |
|          | 30–39b     | 51 (12.6) | 2.95 ± 0.68 | 15.90 ± 11.81 | 1.90 ± 0.65 | 3.31 ± 0.69 |
|          | 40–49c     | 110 (27.2) | 3.13 ± 0.99 | 22.76 ± 13.48 | 2.29 ± 0.69 | 2.97 ± 1.03 |
|          | 50–59d     | 96 (23.7) | 3.47 ± 0.77 | 24.10 ± 15.27 | 2.21 ± 0.65 | 2.44 ± 0.69 |
|          | 60–69e     | 78 (19.3) | 3.72 ± 0.65 | 29.04 ± 13.20 | 2.40 ± 0.75 | 2.17 ± 0.64 |
|          | 70<f       | 30 (7.4) | 3.11 ± 0.72 | 16.78 ± 13.09 | 2.30 ± 0.90 | 2.75 ± 0.91 |
| t or F (P)|            | 9.60*** | 8.88***    | 4.55***   | 20.81*** |                     |
|          |            |          | 8.88***    | 4.55***   |         |                     |
|          |            |          | 20.81***   |         |         |                     |
| Disability level | Severe (1–3) | 308 (76.0) | 3.49 ± 0.76 | 24.69 ± 14.58 | 2.27 ± 0.74 | 2.57 ± 0.83 |
|          | Mild (4–8) | 97 (24.0) | 2.66 ± 0.69 | 15.03 ± 10.10 | 1.95 ± 0.69 | 3.29 ± 0.92 |
| t or F (P)|            | 10.08*** | 7.30***    | 3.32***   | 7.37***  |                     |
|          |            |          |           |         |         |                     |
|           |            |          |           |         |         |                     |
| Disability type | Physical | 383 (94.6) | 3.23 ± 0.80 | 21.50 ± 13.89 | 2.19 ± 0.71 | 2.79 ± 0.87 |
|           | Internal organs | 22 (5.4) | 4.33 ± 0.41 | 37.52 ± 11.87 | 2.41 ± 1.01 | 1.91 ± 0.56 |
| t or F (P)|            | −11.14*** | −0.99      | −6.09***  | −6.76   |                     |

IADL, instrumental activities of daily living.
*P<0.05,
**P<0.01,
***P<0.001.
9Post hoc test: Scheffe.

Table 2  Correlations between the main variables

| Variable | Environmental factors | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|----------|-----------------------|---|---|---|---|---|---|---|---|---|
| LS       | 1                      |   |   |   |   |   |   |   |   |   |
| IADL     | 0.755***               | 1 |   |   |   |   |   |   |   |   |
| SP       | 0.256***               | 0.370*** | 1 |   |   |   |   |   |   |   |
| Dep      | −0.766***              | −0.650*** | −0.513*** | 1 |   |   |   |   |   |   |
| SA       | −0.494***              | −0.622*** | −0.469*** | 0.617*** | 1 |   |   |   |   |   |
| FA       | −0.522***              | −0.632*** | −0.296*** | 0.586*** | 0.608*** | 1 |   |   |   |   |
| MCA      | −0.642***              | −0.727*** | −0.435*** | 0.696*** | 0.724*** | 0.716*** | 1 |   |   |   |
| SR       | −0.556***              | −0.589*** | −0.430*** | 0.762*** | 0.640*** | 0.697*** | 0.738*** | 1 |   |   |
| SP       | −0.675***              | −0.674*** | −0.455*** | 0.810*** | 0.622*** | 0.625*** | 0.803*** | 0.810*** | 1 |   |

*P<0.05,
**P<0.01,
***P<0.001.

Dep, depression; FA, family attitudes; IADL, instrumental activities of daily living; LS, life stress; MCA, mobility and convenience facilities; SA, social attitudes; SP, social participation; SR, supportive relationship.

Discussion
We investigated the effects of stress induced by COVID-19 and moderating effects of socioenvironmental sub-factors on PwDs in Korea. Our findings corroborate previous findings that stress due to COVID-19 significantly exacerbates participants’ depression [31,32] due to fear and anxiety about contracting the disease. Stress is a major predictor of depression [33], especially among PwDs due...
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...to social isolation and alienation, and it leads to increased mental health challenges, decreased independence in performing IADLs and lower life satisfaction and participation [34]. Moreover, social prejudice, depression, low self-esteem and isolation during disasters such as COVID-19 lead to secondary complications for PwDs.

Hence, socioenvironmental factors that positively impact their health and quality of life must be identified. We found that relationships between stress and depression, ability to perform IADLs and social participation were significantly modified by socioenvironmental sub-factors including social attitudes, family attitudes, availability

### Table 3 The moderating effects of socioenvironmental factors on the relationship between stress and depression

| Variable          | Model 1          | Model 2          | Model 3          |
|-------------------|------------------|------------------|------------------|
|                   | B    | S.E  | T     | B    | S.E  | T     | B    | S.E  | T     |
| Sex               | 1.77 | 0.96 | 1.83* | 1.55 | 0.82 | 1.88* | 1.43 | 0.80 | 1.77  |
| Marital status    | −2.81| 1.03 | 2.72* | 1.15 | 0.89 | 1.29  | 1.39 | 0.87 | 1.60  |
| Education         | 0.52 | 0.37 | 1.39  | −0.14| 0.33 | −0.44 | 0.08 | 0.32 | 0.25  |
| Disability level  | 1.94 | 1.21 | 1.60  | 2.72 | 1.04 | 2.61* | 2.07 | 1.02 | 2.02  |
| Disability type   | 1.34 | 0.62 | 1.52  | 1.86 | 0.81 | 0.81  | 0.73 | 1.91 | 0.38  |
| Life stress       | 12.78| 0.67 | 18.99***| 8.23 | 0.71 | 11.48***| 10.28| 0.79 | 12.87***|
| EF                |      |      |       | −2.11| 0.61 | −3.44***| 1.09 | 0.63 | 1.74  |
| FA                | −2.38| 0.66 | −3.59***| 2.58 | 0.65 | −3.92***| 1.78 | 0.67 | −3.24**|
| MCA               | −3.17| 0.75 | −4.20***| −2.12| 0.74 | −2.84**| 0.87 | 0.74 | 1.09  |
| SR                | 1.81 | 0.89 | 2.03  | 1.93 | 0.87 | 2.21* |
| SP                | −1.02| 0.83 | −1.22 | −2.23| 0.84 | −2.64**|
| Life Stress × SA  |      |      |       | 2.06 | 0.77 | 2.67**|
| Life Stress × FA  |      |      |       | 2.02 | 0.88 | 2.29* |
| Life Stress × MCA |      |      |       | 0.88 | 1.15 | 0.59  |
| Life Stress × SR  |      |      |       | 1.09 | 1.14 | 0.96  |
| Life Stress × SP  |      |      |       | −4.57| 1.11 | −4.69**|
| R²                | 0.586|      |       | 0.706|      |       | 0.731|      |       |
| Adj.              | 0.580|      |       | 0.698|      |       | 0.720|      |       |
| ΔR²               | 0.586***|      |       | 0.120***|      |       | 0.025***|      |       |

*P<0.05, **P<0.01, ***P<0.001

EF, environmental factors; FA, family attitudes; MCA, mobility and convenience facilities; SA, social attitudes; SP, service and policy; SR, supportive relationship.

### Table 4 The moderating effects of socioenvironmental factors on the relationship between stress and instrumental activities of daily living

| Variable          | Model 1          | Model 2          | Model 3          |
|-------------------|------------------|------------------|------------------|
|                   | β    | S.E  | T     | β    | S.E  | T     | β    | S.E  | T     |
| Sex               | 0.14 | 0.07 | 1.98* | 0.09 | 0.06 | 1.36  | 0.06 | 0.06 | 0.94  |
| Marital status    | 0.02 | 0.07 | 0.30  | −0.03| 0.07 | −0.48 | −0.04| 0.07 | −0.55 |
| Education         | 0.07 | 0.02 | 2.59**| 0.01 | 0.02 | 0.44  | 0.02 | 0.02 | 0.76  |
| Disability level  | −0.11| 0.09 | 1.26  | −0.10| 0.08 | −1.23 | −0.15| 0.08 | −1.81 |
| Disability type   | −0.05| 0.16 | 0.35  | −0.03| 0.15 | −0.21 | −0.15| 0.15 | −1.00 |
| Stress            | 0.17 | 0.05 | 3.39***| −0.12| 0.05 | −2.19*| 0.01 | 0.06 | 0.16  |
| EF                |      |      |       | −0.22| 0.05 | −4.50***| −0.14| 0.05 | −2.74*|
| FA                | 0.09 | 0.05 | 1.83  | 0.11 | 0.05 | 2.07* |
| MCA               | −0.06| 0.06 | −1.06 | −0.06| 0.07 | −1.40 | −0.10| 0.07 | −1.40 |
| SR                | −0.09| 0.07 | −1.13 | −0.18| 0.06 | −2.74***| −0.26| 0.06 | −3.88***|
| SP                |      |      |       | −0.18| 0.06 | −2.13*| 0.14 | 0.06 | 2.20* |
| Stress × SA       |      |      |       | 0.05 | 0.07 | 0.77  |
| Stress × MCA      |      |      |       | 0.81 | 0.09 | 0.85  |
| Stress × SR       |      |      |       | 0.02 | 0.09 | 0.02  |
| Stress × SP       |      |      |       | −0.30| 0.09 | −3.33***|
| R²                | 0.098|      |       | 0.285|      |       | 0.326|      |       |
| Adj.              | 0.084|      |       | 0.265|      |       | 0.298|      |       |
| ΔR²               | 0.098***|      |       | 0.188***|      |       | 0.040***|      |       |

*P<0.05, **P<0.01, ***P<0.001

EF, environmental factors; FA, family attitudes; MCA, mobility and convenience facilities; SA, social attitudes; SP, service and policy; SR, supportive relationship.
of services and policies and mobility and convenience. Thus, interventions focused on promoting PwDs’ health that consider social dynamics should be implemented. For example, there is a need to consider health promotion and rehabilitation measures from various angles such as the UK’s Social Prescribing system (providing nonpharmaceutical services supporting health and well-being), Personal Health Record, and Community Based Rehabilitation (enhances lives of PwDs within the community).

PwDs are also often highly dependent on their families for assistance [20], which increases during disaster situations; however, family members cannot effectively alleviate PwDs’ psychological stress [35]. Thus, services to help families cope with changes and restrictions due to public health crises should be developed.

The relationship between stress and ability to perform IADLs was significant, indicating that increased stress is correlated with increased physical dependence, which is aggravated by suspension of community activities, restriction of mobility and difficulty in using assistance services [36,37]. Additionally, since many PwDs cannot perform IADLs, they need contact with others, making it challenging to practice social distancing [18,38]. Therefore, independence in performing IADLs during rehabilitation must be emphasized. In disaster situations, it is necessary to classify approaches to treatment, prevention and health promotion according to the risk of disease contraction, and rehabilitation experts should be trained and deployed during critical stages. Moreover, targeted policy responses and improved healthcare service access are needed for people with different types and severities of disabilities.

The effect of stress on social participation was also statistically significant, corroborating previous findings [27,36]. The prolongation of COVID-19 has limited the use of community resources and social participation for PwDs [7,12,27], increasing their stress [3]. We found that improved social attitudes, mobility and convenience facilities, and healthcare services and policies increased social participation, supporting previous findings that increased social participation is related to increased quality of life [29]. Therefore, it is necessary to improve social attitudes, increase the availability and accessibility of mobility and convenience facilities and enhance healthcare services and policies aligned with global disruptions caused by COVID-19 [39].

This study had the following limitations. First, it included participants who had physical disabilities; future studies could segregate disability types to properly differentiate the pandemic’s impacts on various groups of PwDs. Second, the scales used in this study were modified from their original version to be specific to the COVID-19 situation. More specific measures should be developed to better understand the physical, mental and social health of PwDs during future disaster situations. Third, all participants resided in Korea, so it may be useful to conduct future studies in other countries, particularly Western countries, to examine any cultural differences.

### Table 5 The moderating effects of socioenvironmental factors on the relationship between stress and social participation

| Variable          | Model 1 β | S.E  | T     | Model 2 β | S.E  | T     | Model 3 β | S.E  | T     |
|-------------------|-----------|------|-------|-----------|------|-------|-----------|------|-------|
| Sex               | 0.02      | 0.05 | 0.27  | 0.08      | 0.04 | 2.08³  | 0.06      | 0.04 | 1.46  |
| Marital status    | −0.09     | 0.06 | −1.49 | −0.04     | 0.04 | −1.05 | −0.05     | 0.04 | −1.21 |
| Education         | −0.15     | 0.02 | −6.93³ | −0.06     | 0.01 | −3.69³ | −0.05     | 0.01 | −3.54³ |
| Disability level  | 0.04      | 0.07 | 0.63  | 0.07      | 0.05 | 1.34  | 0.02      | 0.05 | 0.57  |
| Disability type   | 0.09      | 0.12 | 0.79  | 0.16      | 0.09 | 1.73  | 0.01      | 0.09 | 0.12  |
| Stress            | −0.75     | 0.03 | −18.28³ | −0.43     | 0.03 | −11.56³ | −0.29     | 0.04 | −7.33³ |
| Stress × SA       | 0.12      | 0.03 | 3.83³  | 0.19      | 0.03 | 6.19³  | 0.19      | 0.04 | 6.54³  |
| Stress × FA       | −0.02     | 0.03 | −0.71 | −0.08     | 0.03 | −0.23 | −0.04     | 0.03 | −1.29 |
| Stress × MCA      | −0.11     | 0.03 | −2.89³ | −0.04     | 0.03 | −1.29 | −0.04     | 0.03 | −1.29 |
| Stress × SR       | 0.28      | 0.04 | 6.17³  | 0.28      | 0.04 | 6.54³  | 0.19      | 0.04 | 4.65³  |
| Stress × SP       | 0.28      | 0.04 | 6.69³  | 0.28      | 0.04 | 6.54³  | 0.19      | 0.04 | 4.65³  |

|         | Model 1 | Model 2 | Model 3 |
|---------|---------|---------|---------|
| R²      | 0.636   | 0.796   | 0.823   |
| Adj. R² | 0.630   | 0.790   | 0.816   |

ΔR² = 0.636*** 0.160*** 0.027***

*P < 0.05,
***P < 0.001,
****P < 0.0001.

EF, environmental factors; FA, family attitudes; MCA, mobility and convenience facilities; SA, social attitudes; SP, service and policy; SR, supportive.
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Conclusion
This study highlights that multifaceted approaches, including socioeconomic factors such as family support and convenience of services, are essential to improve the health status and resilience of PwDs. Our findings could be used as primary data to drive the rehabilitation-related approaches to provide comprehensive social care in medical institutions and local communities.

During the ongoing COVID-19 crisis, support services should target the specific challenges experienced by PwDs, incorporating socioeconomic factors such as improving social and family attitudes and enhancing mobility. Institutions should encourage voluntary health promotion in local communities, even during infectious disease outbreaks. Moreover, social services must be customized for different types and severities of disabilities. Finally, it is necessary to establish comprehensive, integrated community health promotion and rehabilitation systems to encourage physical activity, social integration and participation, health management, secondary disability prevention, customized services for older adults with disabilities and partnerships with relevant organizations.

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Conflicts of interest
There are no conflicts of interest.

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