Internet of Things (IoT)-Based Behavioral Intervention for Older Adults with Major Depressive Disorder: Preliminary study

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Objective: To assess the effectiveness of Internet of Things (IoT)-based behavioral intervention for reducing depressive symptom of older adults with major depressive disorder.

Method: A 12-week randomized cross-over controlled study was conducted at community mental health center. We recruited 39 participants with major depressive disorder aged 60 years or older. As a multidomain intervention, four evidence-based therapeutic factors (physical activity, healthy diet, social activity, and emotional regulation) were approached. To maintain motivation of participants, we applied contingency management using IoT device based on operant conditioning theory.

Results: The primary outcome was change of depressive symptom measured by Montgomery-Asberg Depression Rating Scale (MADRS). Mixed-effect model compared the effectiveness of intervention and usual care management (intervention by time and period interaction, $p = 0.017$)

Conclusions: Community-implementable IoT-based behavioral intervention resulted in greater reduction of depressive symptom of elderly with major depressive disorder.

Keywords: Depression, Elderly, Internet of Things, Psychosocial intervention

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Table 1. Baseline characteristics of group 1 versus group 2, completers versus dropouts

Variable	Group 1 (Intervention→Control) (n=20)	Group 2 (Control→Intervention) (n=19)	χ^2 or t	p-value	Completers (n=35)	Dropouts (n=4)	t	p-value
Age (years)	73.9±5.6	73.4±6.1	0.2	0.820	73.9±5.5	71.3±8.4	0.874	0.388
Sex (female)	14 (70.0)	16 (84.2)	1.1	0.292	27 (77.1)	3 (75.0)		1.000
Years of education	9.5±5.3	7.1±3.9	1.6	0.119	8.2±4.9	9.0±3.5	0.300	0.766
MADRS	29.0±10.0	31.2±9.1	0.7	0.485	29.1±9.5	38.3±3.8	1.887	0.067
BAI	18.1±10.9	17.0±10.3	0.3	0.760	17.6±10.7	17.3±10.6	0.057	0.955
K-MMSE	25.7±2.7	24.2±3.5	1.5	0.143	24.7±3.2	26.8±2.8	1.210	0.234

T-test, chi-square test, and Fisher's exact test was performed to test for significant differences between groups (t-test for age, year of education, MADRS, BAI, K-MMSE, and chi-square test or Fisher's exact for sexuality). There were no significant differences in those baseline demographics or clinical characteristics. Values are mean±standard deviation or number (%). MADRS : Montgomery-Asberg Depression Rating Scale, BAI : Beck Anxiety Inventory, K-MMSE : Korean version of Mini Mental State Examination

Table 2. Means and standard deviations of primary and secondary outcomes at baseline and follow-ups

	MADRS		BAI		K-MMSE	
	Group 1 Mean (SD)	Group 2 Mean (SD)	Group 1 Mean (SD)	Group 2 Mean (SD)	Group 1 Mean (SD)	Group 2 Mean (SD)
Visit 1 (baseline)	29.0 (10.0)	31.2 (9.1)	18.1 (10.9)	17.0 (10.3)	25.7 (2.7)	24.2 (3.5)
Visit 2	16.6 (8.7)	23.4 (11.1)	14.7 (13.2)	14.3 (12.6)		
Visit 3	16.4 (10.8)	18.6 (10.2)	15.5 (13.7)	15.6 (10.6)		
Visit 4 (washout)	7.7 (3.4)	21.1 (11.5)	12.9 (12.0)	9.4 (8.8)	26.6 (2.4)	24.3 (4.0)
Visit 5	17.1 (11.5)	22.3 (10.7)	9.4 (8.8)	12.9 (12.0)	24.3 (4.0)	26.6 (2.4)
Visit 6	13.9 (9.7)	18.2 (8.7)	12.2 (9.7)	12.7 (12.5)		
Visit 7	9.6 (6.8)	15.4 (6.5)	10.5 (11.8)	11.8 (11.1)		
Visit 8	12.8 (8.3)	20.6 (11.4)	9.2 (8.3)	14.1 (12.5)	25.8 (3.0)	27.0 (2.9)

Values are mean (SD). MADRS and BAI were measured every eight visits. K-MMSE was measured at the beginning and end of each period. SD : standard deviation, MADRS : Montgomery-Asberg Depression Rating Scale, BAI : Beck Anxiety Inventory, K-MMSE : Korean version of Mini Mental State Examination

Figure 2. MADRS at each time measure compared with baseline performance

Figure 1. Flow diagram for 'Internet of things gold medal program'

Figure 1. Flow diagram for 'internet of things gold medal program.' Subjects were randomly assigned into two groups. Group 1 proceeds intervention followed by control, while Group 2 precedes control followed by intervention. Intervention means a gold medal program based on the internet of things, and control means an ordinary program.