

ORIGINAL RESEARCH

Feasibility of a Smartphone-Based Exercise Program for Office Workers With Neck Pain: An Individualized Approach Using a Self-Classification Algorithm



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Abstract

Objective: To explore the feasibility of a newly developed smartphone-based exercise program with an embedded self-classification algorithm for office workers with neck pain, by examining its effect on the pain intensity, functional disability, quality of life, fear avoidance, and cervical range of motion (ROM).

Design: Single-group, repeated-measures design.

Setting: The laboratory and participants' home and work environments.

Participants: Offices workers with neck pain (N=23; mean age \pm SD, 28.13 \pm 2.97y; 13 men).

Intervention: Participants were classified as having 1 of 4 types of neck pain through a self-classification algorithm implemented as a smartphone application, and conducted corresponding exercise programs for 10 to 12min/d, 3d/wk, for 8 weeks.

Main Outcome Measures: The visual analog scale (VAS), Neck Disability Index (NDI), Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36), Fear-Avoidance Beliefs Questionnaire (FABQ), and cervical ROM were measured at baseline and postintervention.

Results: The VAS ($P<.001$) and NDI score ($P<.001$) indicated significant improvements in pain intensity and functional disability. Quality of life showed significant improvements in the physical functioning ($P=.007$), bodily pain ($P=.018$), general health ($P=.022$), vitality ($P=.046$), and physical component scores ($P=.002$) of the SF-36. The FABQ, cervical ROM, and mental component score of the SF-36 showed no significant improvements.

Conclusions: The smartphone-based exercise program with an embedded self-classification algorithm improves the pain intensity and perceived physical health of office workers with neck pain, although not enough to affect their mental and emotional states.

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A high prevalence of neck pain is noted in office workers,¹⁻³ peaking in individuals aged 30 to 59 years.¹⁻³ Noticeably, younger individuals aged 18 to 39 years have a higher incidence, although they recover more often from neck pain than do older individuals.³ If their incorrect postures, caused by their sedentary lifestyle, continue and their pain is not treated at the proper time, the pain can become chronic, generating a high individual and

societal burden.^{4,5} It is therefore necessary to explore methods of treating office workers with mild-to-moderate neck pain to minimize this burden.

A great deal of variation appears in intervention choices for neck pain—for example, strengthening and endurance exercises,⁶⁻⁹ stretching¹⁰⁻¹² and coordination^{13,14} exercises, and manual therapy¹⁵⁻¹⁸—which causes uncertainty about optimal strategies for patients. The problem is that most intervention studies do not clearly explain their clinical decision-making process about when and why to use a particular treatment, and

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individual patients' needs vary depending on the different pain mechanisms. This uncertainty might be because the exact pathologic cause underlying many cases of neck pain is elusive.

Recognizing the inadequacy of causal neck pain treatments, therapists and researchers have developed alternative methods by classifying patients into subgroups, based on their conditions and symptoms.¹⁹⁻²² Some researchers suggest the following subgroups for patients with neck pain, each with a label describing the primary treatment goal^{20,21}: (1) exercise and conditioning; (2) mobility; (3) centralization; (4) reduce headache; and (5) pain control. The researchers also proposed specific treatments corresponding to each of the subgroups^{20,21} and verified that the corresponding treatments were associated with greater improvements in pain ratings than the noncorresponding treatments.²¹ Despite the effectiveness of this classification system, it requires a therapist's diagnosis, which might limit office workers' access to the treatment, as they are prone not to seek medical care because of their hectic routine. Thus, not only an effective, but also an accessible treatment method needs to be explored.

A smartphone-based exercise program may be pragmatically accessible for office workers. It was estimated in July 2015 that approximately 86.4% of the South Korean population owned a smartphone.²³ Coinciding with the smartphone popularity, the number of smartphone applications (apps) had increased so rapidly that 48 apps were installed per person on average, and 34.7% of app users used them to gain health and exercise information.²³ Regrettably, only limited information is available on the feasibility of smartphone-based exercise programs, although some researchers have suggested study protocols for smartphone-based relaxation²⁴ and monitoring²⁵ programs for patients with low back and neck pain.

In this study, we developed a smartphone-based exercise program with an embedded self-classification algorithm for patients with neck pain. We determined the types of neck pain; designed an algorithm to self-classify the types of neck pain; implemented an app-based questionnaire that asked patients about their perceived conditions and symptoms to determine their type of neck pain; and guided corresponding exercise programs.

The purpose of this study was to explore whether this newly developed smartphone-based exercise program is feasible for office workers as a method of self-managing their neck pain. For this purpose, we first examined the effect of the program on pain intensity and functional disability. Second, we examined its effect on quality of life, fear avoidance, and cervical range of motion (ROM). Finally, we explored its acceptability using patient satisfaction and adherence.

Methods

Participants

Office workers were informed of the study via brochures and posters on the bulletin boards in Korea University. We recruited 30

office workers with neck pain and assessed their eligibility. Workers were included if (1) they were aged 18 to 39 years; (2) their neck pain had persisted for ≥ 3 months; (3) they had a mean pain score ≥ 3 on a visual analog scale (VAS) in the previous week; and (4) they owned a smartphone (iPhone or Android).

Workers were excluded if (1) they had received any other treatment or surgery within 3 months; or (2) their neck pain was caused by a known trauma, rheumatic disorder, or malignant disease. Approval for the study was obtained from the institutional review board (KU-IRB-15-94-P-2), and written informed consent was obtained from all the participants according to the Declaration of Helsinki.

Smartphone app

The smartphone app was developed by a group of experts, consisting of 5 clinicians, 1 professor of rehabilitation science, 4 physiotherapists, and 1 marketing consultant, through regular meetings once a week for 3 months. The app included a self-classification algorithm for patients to self-classify their type of neck pain, and a corresponding exercise program depending on the type of neck pain. This self-classification system with corresponding exercise programs was modified from similar programs designed for therapists in previous research.²¹ The previously reported classification system for therapists showed a high inter-rater reliability ($\kappa = .95$; 95% confidence interval, .87–1.0).²¹

Self-classification system

The experts designed a self-classification system using the following steps. First, they determined 4 types of neck pain with different conditions and symptoms: (1) exercise and conditioning; (2) mobility; (3) centralization; and (4) reduce headache (table 1). The experts judged that the conditions and symptoms of the 4 types of neck pain could be relieved through appropriately matched exercise programs, based on prior evidence^{6-12,15-17,26-31} and their clinical experiences.

Second, the experts developed an algorithm for patients to self-classify their type of neck pain (fig 1). The experts used a small number of simple tests to allow patients to easily determine their conditions and symptoms. These tests (ie, Neck Rotation and Extension Test, Repeated Movement Test) were chosen or modified from those that could detect impaired functions in nonspecific neck pain with acceptable retest reliability (table 2).^{29,32-35}

Third, the experts implemented the algorithm through an app-based questionnaire. The questionnaire was developed using lay language to make it easy for patients to follow the simple tests, check their perceived conditions and symptoms, and thereby determine their type of neck pain.

Corresponding exercise programs

The experts defined exercise programs for each type of neck pain, based on evidence when possible and their clinical experience when necessary. Once the type of neck pain was determined by the participants' responses to the questionnaire, the predefined corresponding exercise program was automatically provided by the app.

Each exercise program consisted of 10 postures, including 5 postures specifically tailored to the type of neck pain and 5 basic postures to strengthen the deep neck muscles. These latter were commonly included for all of the types because of their demonstrated effectiveness in treating neck pain.⁶⁻⁹ Each posture was repeated about 6 times, holding the posture for 3 seconds and then

List of abbreviations:

app	application
FABQ	Fear-Avoidance Beliefs Questionnaire
NDI	Neck Disability Index
ROM	range of motion
SF-36	Medical Outcomes Study 36-Item Short-Form Health Survey
VAS	visual analog scale

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