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Research Article

Application and Effect of Mobiletype-Bone Health Intervention in Korean Young Adult Women with Low Bone Mass: A Randomized Control Trial

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S U M M A R Y

Purpose: This randomized control trial was designed to examine the effect on the self-managing ability for promoting bone health of mobile type–bone health intervention (mobile type–BHI).
Methods: The mobile type–BHI consisted of a mobile application called "Strong bone, Fit body" (SbFb) and group education. A total of 82 college women with low bone mass (Z score < -1) participated. They were assigned randomly to three groups, experimental group I, ($n = 28$), experimental group II ($n = 32$), and control group ($n = 22$). This study ran from June 2014 to January 2015. The outcome variables were bone mineral density, minerals related to bone metabolism (calcium, phosphorus, vitamin D), biochemical markers related to bone remodeling (osteocalcin, C-terminal telopeptide, sclerostin), food intake diary by 24 hours recall, and psychosocial variables related to bone health (knowledge, health belief and self-efficacy). Data were analyzed using SAS program and a computer aided nutritional analysis program.
Results: Both the experimental group I, who used mobile type–BHI, and experimental group II, who only received group education, showed outcomes regarding knowledge of the benefits of exercise and calcium as compared with the control group. The two experimental groups also demonstrated results in the serum levels of calcium, vitamin D, and sclerostin compared to those of the control group.
Conclusion: Although both experimental groups exhibited positive outcomes in regards to the promotion of bone health, this study did not show an additional effect of the mobile application on self-management ability for the promotion of bone health. Nonetheless, the SbFb application is very meaningful as it is the first application developed with the aim of improving women's bone health.

Introduction

Recently, fragility fractures in patients with osteoporosis have become a major problem that imposes a heavy burden on individual patients and countries around the world [1]. According to the Fourth and Fifth National Health Nutrition Surveys carried out from 2008 to 2011 in Korean individuals 50 years old or older, the incidence of osteoporosis was 38.0% in women and 7.3% in men, and the incidence of osteopenia was 48.7% in women and 46.5% in men. Furthermore, Korean female and male adults aged 20–49 years old had lower bone mineral density (BMD) than did individuals in the same age group in the United States and Japan [2].

Low BMD is a significant risk factor for fracture. Thus, it is quite important to achieve peak bone mass (PBM) during adolescence in order to prevent osteoporotic fractures in adulthood, along with general maintenance of bone health. For example, based on the results of a study that used mathematical modeling to assess the

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relative influence of various causes of bone loss (e.g., PBM, menopause, age), a 10.0% increase in PBM during the adolescent period can postpone the occurrence of osteoporosis for 13 years, whereas a 10.0% increase in BMD at the time of menopause can delay the occurrence of osteoporosis for only 2 years. Therefore, the study emphasizes the importance of achieving appropriate PBM when inviduals are young and growing [3]. More than 60.0% of PBM is attributable to genetic factors, but the rest is influenced by risk factors associated with lifestyle, such as calcium and protein intake, vitamin D status, and the regular performance of weight-bearing exercise [4]. Therefore, for maintenance of adequate bone mass and achievement of proper PBM, it is important to adopt lifestyle changes (e.g., adequate nutritional intake of substances such as calcium and protein, increasing intake of vegetables and fruits, maintenance of the recommended amount of vitamin D, taking part in regular weight-bearing exercises, avoiding smoking and excessive drinking of alcohol) [5].

Until now, studies specifically targeting young adult women are relatively rare among all studies on educational intervention or osteoporosis prevention programs related to bone health. Most previous studies assessed and reported the outcomes of measurements of psychosocial variables, which may be linked with bone health-promoting behaviors such as knowledge about osteoporosis, health beliefs, and self-efficacy. Those studies demonstrated inconsistent effects of educational programs on the psychosocial variables. Furthermore, the previous studies could not determine precisely whether the psychosocial variables measured are truly associated with healthy behaviors [6-11].

Therefore, further studies for improving bone health in women in early adulthood are needed to attempt a different approach to interventions and measurement of their effects. When developing interventions that will improve bone health, there is a need to consider alternative approaches that make use of interactive technology, like mobile applications, in addition to conventional and educational interventions. Interactive technology-assisted feedback provides a convenient means for informing, enabling, motivating, and guiding people in their efforts to make lifestyle changes [12]. Therefore, healthcare interventions that utilize mobile applicatoins can enable personalized feedback and motivate changes in an individual's lifestyle habits. In the end, we can expect to gain substantial positive effects from the use of technology, such as reinforcement of modified behaviors and enhancement of self-managing abilities.

Moreover, there is a need to conduct studies that measure physiological variables reflecting direct and objective effects (e.g., BMD and bone metabolism related to blood markers) on improvements in bone health, rather than measuring indirect effects with psychosocial variables, which only predict bone health changes such as the effects of bone health knowledge, health beliefs, and health-related behavioral changes on improving bone health. Recently, studies on exercise interventions in healthy adult groups have measured serum sclerostin, a glycoprotein that inhibits osteoblast differentiation and bone formation. Sclerostin has been recommended as a highly sensitive variable in mechanical loading. Furthermore, sclerostin inhibition is a promising approach to preserving bone mass. Sclerostin can also play a role as an antagonist of the Wnt/β-catenin signaling pathway, decreasing extinction of osteocytes (bone cells) and improving bone formation following mechanical stimulation such as exercise or other physical activities [13].

This study, a randomized control trial (RCT) was designed to examine the effect of the mobile type–bone health intervention (mobile type–BHI) in young adult women with low BMD (Z score ≤ -1) utilizing the "Strong bone, Fit body" application (SbFb application) developed in our previous pilot study [14]. The hypothesis of this study was that there would be a difference of the study variables in the experimental group I (mobile type–BHI), the experimental group II (group education), and a control group. Study variables were as follows: (a) bone health knowledge, health beliefs and self-efficacy; (b) nutrient intake; (c) body composition and body mass index (BMI); (d) lumbar BMD; (e) minerals related to bone metabolism (calcium, phosphorus, and vitamin D); and (f) biochemical markers of bone remodeling [osteocalcin, C-terminal telopeptide (CTX), and sclerostin].

Methods

Study design

This is an RCT study designed to examine the effects of mobile type–BHI using the SbFb application developed in the previous study [14] in young adult women with low bone mass in Korea.

The theoretical framework of this RCT is illustrated in Figure 1. Mobile type–BHI using a mobile application for the promotion of bone health might positively influence bone health–related knowledge, health beliefs and self-efficacy in young adult women. Provision of continuous feedback through the mobile application will have positive effects on preventive health behaviors regarding exercise and nutrition as well as general improvement in bone health, which can be measured by a diversity of variables including BMD, minerals related to bone metabolism, and biochemical markers of bone remodeling.

Participant sampling

The sample of 120 participants were recruited from a pool of 715 participants. They were screened by the following procedures: First, we emailed 715 participants who had participated in the prior study [15] and had low bone density (Z score < -1 as measured at the calcaneus bone). We explaned this study and asked whether they could participate in the research. Those who did not reply or refused to participate, as well as the 32 participants in the previous pilot study [14] were excluded. The inclusion criteria were, Android phone users, undergraduate or graduate female students and participants who agreed to participate in this study. A total of 120 participants were randomly assigned to the two experimental groups and the control group as 1:1:1 ratio. However, 17 participants did not complete the pretest; thus, 103 participants received the allocated interventions or were in the control group; 36 participants were in experimental group I; 38 participants were in experimental group II; 29 participants were in the control group. Finally, 82 participants (28 in experimental group I, 32 in experimental group II, 22 in control group) were included in the analysis. Eight participants in experimental group I, six participants in experimental group II, and seven participants in control group did not complete the post-intervention measurements and were excluded from data analysis (Figure 2). No significant differences existed in the demographic characteristics and study variables at baseline.

The sample size was estimated based on Cohen's method [16], and the effect size of .4 in the *F* test of the independent mean in the three groups was considered, with a significance level of .05, power of .8 based on the estimation using G*Power 3.1; the total number of participants was 120. Thus, each group needed 40 subjects, considering an expected dropout rate.

Ethical considerations

This study was approved by the institutional review board ethics committee of the university where the researchers work (IRB No. KU-IRB-14-82-A-1). Study participants voluntarily agreed to