ISSN 1229-6090

# 간 호 학 논 집

KOREA UNIVERSITY NURSING JOURNAL

2023년 제25권


고려대학교 간호학연구소

Korea University
Nursing Research Institute

# 발 간 사

**신 나 미**
간호학연구소장

안녕하십니까?

1997년에 개소한 고려대학교 간호학연구소는 국내외 저명한 학자들과 최신 간호연구와 전문직 간호 실무 및 미래 교육 방향 등 다양한 영역에 걸친 논의의 장을 마련하며 국내 간호학의 발전을 주도해 왔습니다. 특히, 21세기에 들어서면서 '만성질환 관리 및 건강증진'에 대한 사회 요구에 부응하기 위해 특성화 전략을 추진해왔습니다.

OECD 국가인 한국이 65세 이상 인구가 14%를 넘는 고령사회로 진입한 건 2018년, 불과 6년 전이었는데, 이미 초고령사회로의 유례없이 빠른 진입을 앞두고 있습니다. 이는 그만큼 만성질환자도 급증한다는 뜻으로 이에 대한 대처가 필요합니다. 고려대학교 간호학연구소는 이미 20년 전부터 건강 관련 주요 현안으로 만성질환 관리와 예방 등에 초점을 두고 학술대회를 통해 다양한 임상 현장의 전략과 분야별 중재 및 접근 방안 등을 꾸준히 모색해왔습니다.

작년 2023년은 간호법으로 인해 간호사들이 주목도 받았지만, 3년 넘게 COVID-19 팬데믹 최전선에서 수고한 간호사들의 헌신에 박수받던 때와는 온도 차가 있었습니다. 이 경험은 국민의 건강권 옹호자인 간호사에 대한 사회적 신뢰 못지않게 중요한 50만 국내 간호사의 전문성에 대한 사회적 인정에 대해 돌아보게 된 시간이기도 했습니다.

이제 초점을 돌려 전문직 간호사의 역량, 특히 만성질환 관리와 질병 예방 및 건강 증진의 key player가 될 간호사, 우리 자신을 조명할 필요가 있습니다. 의료인력 중 규모가 가장 큰 간호 인력에 대한 정부 지원과 정책을 논하고, 질병의 급성기부터 전환기까지, 즉 병원 기반 임상 현장부터 만성질환자들의 지역사회기반 현장까지 우리의 활동무대를 조명하며, 우리의 자화상도 reflect 하고자 '국내 간호사의 역량, 만성질환 관리자로서 충분한가?'라는 주제로 최근에 학술대회도 개최하였습니다,

또한, 한국연구재단과 지방자치단체 및 전문직단체 등에서 다양한 연구비를 지원받은 간호학연구소는 선도적인 연구 활동에도 매진하고 있습니다. 급변하는 사회가 기대하는 더 좋은 양질의 전문적 간호를 추구하고자 간호학연구소는 앞으로도 국내외 심포지엄과 활발한 학술교류 및 산학연 협력 등에 힘쓸 것입니다. 이번에 발간하는 '간호학 논집'은 소속 연구자들의 다양한 연구 활동을 보여주는 것으로 많은 관심과 응원을 바랍니다. 감사합니다.

2023. 12.

고려대학교 간호학 논집

◇ 제 25권 ◇ 2023년 12월

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KOREA UNIVERSITY NURSING JOURNAL

Vol. 25 December, 2023

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# BodyThink program-based body image education improves Korean adolescents' attitudes toward cosmetic surgery: Randomized controlled trial

Hyeonhwa Sung[1], A Young Han[1,2] and Geun Hee Seol[1,3*]

[1] Department of Basic Nursing Science, College of Nursing, Korea University, Seoul, Republic of Korea

[2] Department of Nursing, College of Life Science and Industry, Sunchon National University, Suncheon, Republic of Korea

[3] BK21 FOUR Program of Transdisciplinary Major in Learning Health Systems, Graduate School, Korea University, Seoul, Republic of Korea

**Background**

Body image formation during adolescence plays an important role in self-perception, self-esteem, and overall quality of life [1]. The transition to adolescence sees children become more aware of their physical appearance, including their height, weight, and facial features, and increasingly compare themselves to social standards and peer groups. Body image is closely related to self-esteem in adolescence. A more positive body image is associated with a higher tendency for positive rational acceptance, whereas a negative body image is associated with a tendency for maladaptive coping, including binge eating [2].

Body image formation in adolescents is greatly influenced by peers and social media. They may compare themselves to friends, celebrities, and influential people, which can affect how they perceive their bodies [3]. Media, including magazines, television, and social media platforms, often portray unrealistic beauty standards. Social media use by adolescents can lead to long-term exposure to such images, which can create perceptions of ideal bodies and cause dissatisfaction with their own bodies [4].

According to the Korean Youth Health Behavior Survey, one in four Korean female students with a body mass index within the normal range had a distorted body image and perceived themselves as overweight [5]. This means that female Korean teenagers show a level of dissatisfaction with their body image that is not in line with their actual appearance. In particular, Korean teenagers are widely exposed to media genres such as K-pop and K-dramas that promote specific beauty standards [6]. In addition to the cultural trend of viewing appearance as a means for social success, Koreans adolescents have long considered cosmetic surgery to be an easy way to improve their appearance [7].

Plastic surgery involves reconstructing or modifying parts of the human body. Reconstructive surgery aims to rebuild or improve the function of a part of the body, such as removal of burns or micro-scars, whereas cosmetic surgery aims to improve the appearance of the body even in the absence of physical or medical problems [8]. Cosmetic surgery has recently become increasingly popular as a means of pursuing beauty by

Keywords: Body image, Depression, Cosmetic surgery, Adolescent
This study was published in BMC Nursing (2023) 22:481
* Corresponding author: Geun Hee Seol
E-mail: ghseol@korea.ac.kr

people who are dissatisfied with their appearance [9]. Korea ranks first in the world in terms of cosmetic procedures per capita, with 13.5 procedures per 1,000 people [10], and ranks 5th according to the estimated number of plastic surgeons per 1,000 population. This excessive interest in cosmetic surgery is having a great influence on adolescent students [11].

Negative body image during adolescence can give rise to physical and psychological problems such as eating disorders and bullying, and can continue into adulthood, causing problems throughout life [12]. For this reason, it is essential to guide adolescents toward a healthy body image rather than view their excessive interest in their appearance as a minor problem [13]. To date, educational programs aimed at improving body image have been deployed based on a variety of topics and approaches both domestically and internationally. Among them, the BodyThink program, which was developed by the British Eating Disorders Association with the aim of improving body image and self-esteem and cultivating the ability to critically view images in the mass media, has been shown to improve body image and self-esteem in Australian youth [14]. The purpose of the present study was to apply the BodyThink program to Korean adolescents and determine its effects on body esteem, body image, appearance stress, depression and cosmetic surgery attitude. The results of this study are expected to be helpful in providing effective information on how to promote healthy body image to school and community nurses in charge of the physical and emotional health of adolescents.

## Methods

### Participants

Participants were 184 third-grade students from two middle schools in Gyeonggi-do, South Korea. The study was conducted with the approval of the school principal, and classroom units were randomly assigned to intervention or control groups. In brief, an author of this study, AH, randomly assigned each class to the control or intervention group using a random number table in Microsoft Excel, and notified the researcher HS, who conducted the actual classes, of the results of the assignment. To reduce contamination effects from intergroup communication, classes were conducted without informing participating students whether they were assigned to the control or intervention group. In addition, the purpose of the research and the meaning of participating in the research were explained at each session, and the participants were instructed not to share class content. Participants were eligible for selection if both they and their parents agreed to participate in the study, and if they did not have disabilities in hearing, vision, or literacy. Students who were receiving hospital treatment or counseling for body image-related diseases, students with physical or emotional disabilities, and students who had completed body image promotion education were excluded.

G*power 3.1 was used to determine the number of subjects needed to achieve a power of 80%, significance level of 0.05, and effect size of 0.4, where these levels were set based on previous research [15]. Assuming a 15% dropout rate, a total of 184 students were selected as the sample size. A total of 92 students were enrolled in the experimental group and 92 in the control group, of which 2 students dropped out in the experimental group. Hence, the final analysis included 90 students in the experimental group and 92 in the control group (Fig. 1).

### Body esteem instruments

Body esteem refers to an individual's subjective perception and evaluation of his or her own body. Body esteem was assessed using the scale developed by Mendelson, Andrews, Balfour, and Buchoiz (1997) for adolescents and adults, adapted by Lee [16, 17]. This scale consists of 23 questions on a 4-point Likert scale, with a higher score indicating higher body esteem. Questions 4, 7, 9, 11, 13, 17, 18, 19, and 21, which have negative connotations, were reverse calculated. Cronbach's α coefficient was found to be 0.90 in the present study, similar to the value of 0.92 obtained by Lee (2001).

### Body image instruments

Body image refers to an individual's satisfaction with the shape and function of each part of his or her body. Body image was assessed using the body cathexis scale developed by Secord and Jourard [18]. This scale consists of 46 questions on a 5-point Likert scale, with

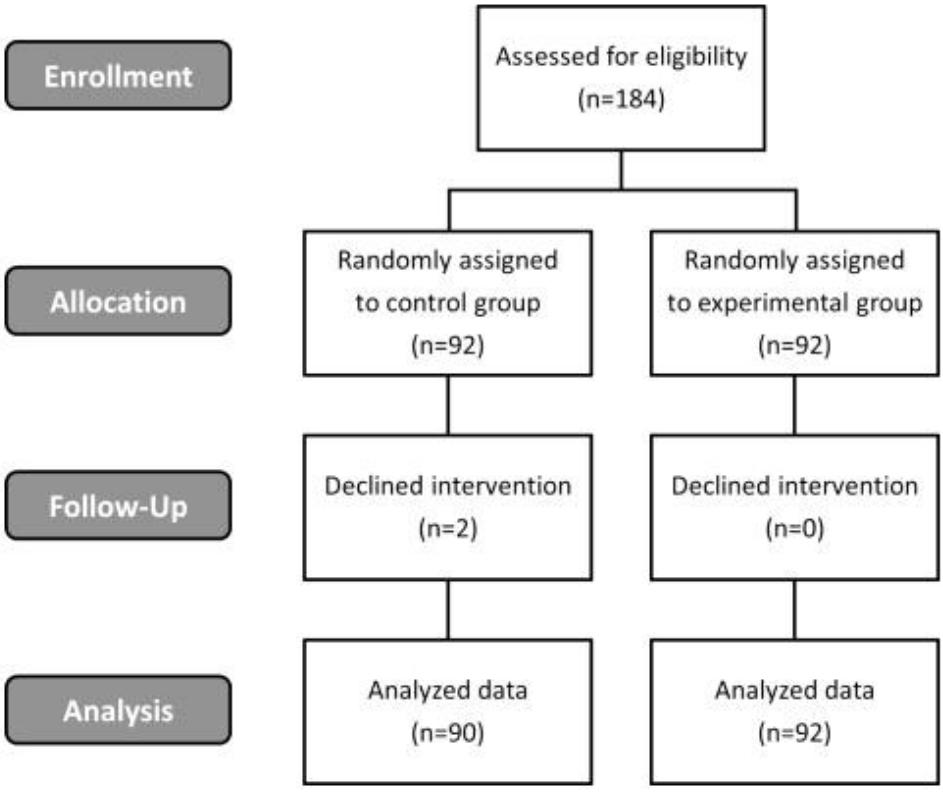


**Fig. 1** Flow diagram of the study and number of participants at each stage

higher scores indicating higher satisfaction with one's body. Cronbach's α coefficient was found to be 0.95 in the present study, compared to 0.83 in the study of Secord and Jourard (1953).

### Appearance stress instruments

Appearance stress refers to the psychological pressure felt about one's overall appearance, and was measured using the instrument developed by Yang [19]. A total of 19 questions are measured on a 5-point Likert scale, with higher scores indicating higher appearance stress. Cronbach's alpha value was 0.95 in the present study and 0.92 in the work of Yang (1993).

### Depression instruments

The Center for Epidemiological Studies-Depression (CES-D) scale Korean version was used to measure depression [20]. The CES-D scale developed by the American Institute of Mental Health (1971) was translated into Korean by Noh (1992) and revised to 26 questions by adding 4 questions to ensure reliability. The Korean version of CES-D uses a 4-point Likert scale to evaluate the frequency of recently experienced depressive symptoms, with higher scores indicating higher levels of depression. Questions 4, 8, 12, and 16 were back-calculated. This tool has been used several times in Korean adolescents. Cronbach's α coefficient was found to be 0.91 in the present study, and 0.89 in the study by Cho and Kim (1993).

### Cosmetic surgery attitude instruments

Cosmetic surgery attitude, which refers to an individual's attitudes toward cosmetic surgery, was assessed using the scale developed by Jeon & Lee [21]. This scale consists of 19 questions on a 4-point Likert scale, with higher scores indicating a more active intention toward cosmetic surgery. This tool consists of 5 sub-categories comprising 4 questions about secrecy regarding cosmetic surgery, 4 questions about the value of cosmetic surgery, 5 questions about conformity regarding cosmetic surgery, 4 questions about payment for cosmetic surgery, and 3 questions about risk tolerance for cosmetic surgery. Cronbach's α in Jeon's (2002) study was 0.63 for secrecy regarding cosmetic

surgery, 0.75 for value of cosmetic surgery, 0.84 for conformity regarding cosmetic surgery, 0.75 for payment for cosmetic surgery, and 0.79 for risk tolerance for cosmetic surgery, and the corresponding values obtained in the present study were 0.86, 0.87, 0.78, 0.86, and 0.90, respectively.

### Revised BodyThink program

The BodyThink program applied in this study maintained the same topics and activities as the previously deployed BodyThink program [14], but several parts were modified to make it applicable to a Korean context (Table 1). For example, the existing program lasted 50 min per session, but in the present study sessions were 45 min, the regular class time in Korean schools. The intervention consisted of 4 sessions, the same as in the existing program. Some video materials were changed to feature Korean culture and Korean people. To increase intervention fidelity in our study, we implemented three strategies. First, the topics and activities of the revised program were verified for content validity through consultation with two nursing professors. Second, a syllabus was created for each session regarding the educational content provided to the control and intervention groups, and the classes were conducted according to the protocol. Third, to increase the internal validity of the study, the author of the present study, a middle school health nurse (HS), delivered the program to all students.

### Intervention

The intervention was conducted after school for 4 weeks, once a week from May to June 2023. The control group was given four sessions of healthy body image education linked to the existing curriculum. For example, it covered topics such as the characteristics of physical development during adolescence, establishment of a desirable body image, health promotion culture, and health threat culture. The experimental group was provided with 4 sessions of the revised BodyThink program. The interventions for each group are detailed in Table 1. Pre-data were collected immediately before the first training session, and post-data was collected immediately after the fourth training session.

### Ethical considerations

All procedures in this study were conducted with the approval of the Korea University Institutional Review Board (Code: KUIRB-2023-0141-01). Registration for this study as a CRIS clinical trial has been completed (Code: KCT0008839). Considering the characteristics of middle school students, the study was conducted with the consent of the school principal, parents, and the students themselves prior to data collection. A study description and consent form specifying the purpose of the study, research content and procedures, confidentiality of data, disposal after completion of the study, and possibility of cancellation at any time during participation were sent home, and written consent was obtained.

### Statistical analyses

Data were expressed as numbers and percentages or means and standard deviations. The collected data were subjected to a two-sided test at a significance level of 0.05 using SPSS 28.0. After verifying the normality of he data and homogeneity between groups, the independent t-test, Mann-Whitney U test, paired t-test, and Wilcoxon Signed-Rank test were used to compare the differences in the effectiveness of the intervention program between and within the experimental and control groups. The possibility of gender differences was considered, but because the analysis of the results of this study did not show significant differences between genders, the data were analyzed based on the control group and experimental group [22].

## Results

### Participant characteristics

Of the 182 participants, 105 (57.7%) were boys, and the average age was 14.47 years old. The average BMI of the participants was 21.32 kg/m2, and 95 (52.2%) were within the normal range. Ninety-four (51.7%) participants preferred sweet tastes. Among all participants, the average scores for the dependent variables were as follows: body esteem, 2.50±0.52 (out of 4.00) points; body image, 3.39±0.76 (out of 5.00) points; appearance stress, 2.28±0.88 (out of 4.93) points; depression, 1.88±0.51 (out of 3.65) points, and cosmetic surgery attitude, 1.55±0.56 (out of 3.16) points. There was no significant difference

**Table 1** Intervention programs for the control and experimental groups

| Sessions | | Control group | Experimental group |
|---|---|---|---|
| 1st | Aims | • Understand the characteristics of physical development during adolescence<br>• Accepting one's physical changes positively | • Understand the characteristics of physical development during adolescence<br>• Understand body image and self-esteem and identify influencing factors |
| | Development | 1. Growth surge<br>• Concept and influencing factors of the growth surge during adolescence<br>• Gender differences in the growth surge<br>2. Secondary sexual characteristics<br>• Explain secondary sexual characteristics according to gender<br>• Think about your own physical changes<br>3. Forming a positive body image<br>• Efforts to form a positive body image<br>• Attitude guidance to form a positive body image | 1. Physical development during adolescence<br>• Concept and influencing factors of the growth surge during adolescence<br>• Expressing changes in one's secondary sexual characteristics<br>2. Body image and self-esteem<br>• Explain definition of physical appearance<br>• Explain definition of self-esteem<br>3. Watch and discuss Real Beauty Sketch<br>• Discuss factors that affect body image and self-esteem<br>• Presentation on ways to improve body image and self-esteem |
| | Summary | • Summary of the growth surge, secondary growth, sexual maturity, and physical changes | • Summary of the meaning of physical development characteristics, body image, and self-esteem during adolescence |
| 2nd | Aims | • Understanding eating disorders caused by body image distortion<br>• Establishing one's standards for beauty and presenting a desirable body image | • Establishing one's standards for beauty and presenting a desirable body image<br>• Reduce internalization of ideal media appearances and body comparisons |
| | Development | 1. Body image distortion<br>• Teaching materials: News related to adolescent eating disorders<br>• Learn about the problems of anorexia<br>• Learn about the problems of bulimia<br>• Calculate one's BMI and think about ways to maintain an appropriate weight<br>2. Establishing a desirable body image<br>• Setting your own standards for healthy beauty<br>• Identifying ineffective weight management | 1. Improve media literacy<br>• Teaching material: Killing Us Softly III video<br>• Explain the definition of media literacy<br>• Discuss the impact of media images on the public after watching the video<br>• Think critically about appearance stereotypes produced by media such as movies, dramas, and advertisements<br>• Establishing your own standards for viewing appearance images produced by the media |
| | Summary | • Summary of characteristics of eating disorders that may appear during adolescence | • Summary of definition of media literacy and establishment one's ideal appearance standards |
| 3rd | Aims | • Explain how cultural elements such as beliefs, normative practices, and media affect health | • Understand the qualities you value in others<br>• Overcoming negative experiences related to appearance |
| | Development | 1. Health and culture<br>• Explain the concepts of beliefs, practices, norms, and media<br>• Explain the concepts of health beliefs, health practices, health norms, and health media with examples<br>2. Health promotion culture<br>• Describe a culture that pursues extension of life expectancy and well-being<br>• Describe healthy leisure, healthy company dinners, and healthy foods<br>• Explain that efforts are needed to maintain and promote a health culture | 1. Improved self-esteem and recovery from appearance-related injuries<br>• Talk about the effects of teasing one's appearance<br>• Participate in role-playing about appearance-related teasing<br>• Think about ways to deal with appearance-related teasing<br>• Write and exchange letters complimenting each other on appearance, personality, etc.<br>• Read the letters and share your impressions<br>2. Understanding others<br>• Sharing opinions on what makes people beautiful |
| | Summary | • Summary of the impact of culture on health and health promotion culture | • Summary of the effects of appearance-related teasing and countermeasures |

**Table 1** (continued)

| Sessions | | Control group | Experimental group |
|---|---|---|---|
| 4th | Aims | • Identify health risk cultures such as fad imitation and suggest improvements | • Understand the reality and risks of youth cosmetic surgery<br>• Reinforce behaviors that positively impact body image and self-esteem |
| | Development | 1. Health risk culture<br>• Explain the concepts of fashion imitation culture, appearance-oriented culture, safety insensitivity, and addiction culture<br>• Explain the seriousness of the culture of indiscriminate imitation of trends and emphasis on appearance due to the influence of consumer culture and media<br>• Explain the health threats of addiction culture and insensitivity to safety<br>• Think about ways to improve health risk culture in daily life | 1. The dangers of adolescent cosmetic surgery and the beauty of choosing oneself<br>• Explain the reality and risks of youth cosmetic surgery<br>• Watch and discuss the Choose Beautiful video<br>• Watch and discuss the video of a girl who was teased for having a rare disease, but became a top model<br>• Complete individual activity sheet 'What can I do to continue to help my body?' |
| | Summary | • Summarize the impact of health risk culture on health | • Summary of the effects of appearance-related teasing and countermeasures |

**Table 2** General characteristics of study participants

| Variables | Total (n = 182) | Control (n = 92) | Experimental (n = 90) | t/x² | P |
|---|---|---|---|---|---|
| Gender | | | | | |
| Male | 105 (57.7) | 53 (57.6) | 52 (57.8) | 0.001 | 0.982 |
| Female | 77 (42.3) | 39 (42.4) | 38 (42.2) | | |
| Age (years) | 14.47 ± 0.51 | 14.43 ± 0.52 | 14.50 ± 0.50 | -0.951 | 0.342 |
| Height (cm) | 166.47 ± 8.07 | 166.62 ± 8.46 | 166.32 ± 7.70 | -0.032 | 0.974 |
| Weight (kg) | 59.52 ± 13.83 | 59.90 ± 15.16 | 59.14 ± 12.41 | -0.410 | 0.682 |
| BMI (kg/m²) | 21.32 ± 3.77 | 21.35 ± 3.87 | 21.30 ± 3.70 | -0.051 | 0.960 |
| < 18.5 | 36 (19.8) | 19 (20.7) | 17 (18.9) | -0.198 | 0.843 |
| 18.5–22.9 | 95 (52.2) | 47 (51.1) | 48 (53.3) | | |
| 23-24.9 | 23 (12.6) | 10 (10.9) | 13 (14.4) | | |
| > 25 | 28 (15.4) | 16 (17.4) | 12 (13.3) | | |
| Siblings | | | | | |
| Only child | 37 (20.3) | 17 (18.5) | 20 (22.2) | 0.625 | 0.533 |
| With siblings | 145 (79.7) | 75 (81.5) | 70 (77.8) | | |
| Preferred flavor | | | | | |
| Salty | 42 (23.1) | 23 (25.0) | 19 (21.1) | -1.403 | 0.163 |
| Sweet | 94 (51.7) | 49 (53.3) | 45 (50.0) | | |
| Sour | 10 (5.5) | 6 (6.5) | 4 (4.4) | | |
| Spicy | 35 (19.2) | 14 (15.2) | 21 (23.3) | | |
| Bitter | 1 (0.6) | 0 (0) | 1 (1.1) | | |
| Body esteem | 2.50 ± 0.52 | 2.55 ± 0.54 | 2.45 ± 0.51 | -1.270 | 0.204 |
| Body image | 3.39 ± 0.76 | 3.39 ± 0.75 | 3.39 ± 0.69 | -0.037 | 0.971 |
| Appearance stress | 2.28 ± 0.88 | 2.20 ± 0.85 | 2.36 ± 0.90 | -1.271 | 0.204 |
| Depression | 1.88 ± 0.51 | 1.89 ± 0.55 | 1.86 ± 0.47 | -0.092 | 0.927 |
| Cosmetic surgery attitude | 1.55 ± 0.56 | 1.51 ± 0.54 | 1.59 ± 0.58 | -1.071 | 0.284 |
| Secrecy regarding cosmetic surgery | 1.81 ± 0.85 | 1.68 ± 0.82 | 1.94 ± 0.87 | -1.988 | 0.052 |
| Value of cosmetic surgery | 1.67 ± 0.76 | 1.61 ± 0.72 | 1.72 ± 0.80 | -0.847 | 0.397 |
| Conformity regarding cosmetic surgery | 1.53 ± 0.61 | 1.48 ± 0.56 | 1.58 ± 0.65 | -0.619 | 0.536 |
| Payment for cosmetic surgery | 1.42 ± 0.64 | 1.43 ± 0.62 | 1.42 ± 0.67 | -0.462 | 0.644 |
| Risk tolerance for cosmetic surgery | 1.31 ± 0.56 | 1.33 ± 0.59 | 1.30 ± 0.53 | -0.140 | 0.889 |

*Note.* **Mean ± SD or n (%)**

in the baseline scores of the participants' general characteristics, body esteem, body image, appearance stress, depression, and cosmetic surgery attitude between the control and experimental groups, ensuring homogeneity (Table 2).

**Effects of intervention on body esteem and body image**

**Table 3** Outcome variables of BodyThink program of study participants

| Variables | Control (n=92) | Experimental (n=90) | Z* | P* |
|---|---|---|---|---|
| Body esteem | | | | |
| Pre | 2.55±0.54 | 2.45±0.51 | | |
| Post | 2.59±0.53 | 2.49±0.51 | | |
| Difference | 0.04±0.28 | 0.04±0.36 | -0.276 | 0.782 |
| P† | 0.059 | 0.226 | | |
| Body image | | | | |
| Pre | 3.39±0.75 | 3.39±0.69 | | |
| Post | 3.42±0.84 | 3.55±0.72 | | |
| Difference | 0.02±0.39 | 0.16±0.56 | -1.509 | 0.131 |
| P** | 0.824 | 0.028 | | |
| Appearance stress | | | | |
| Pre | 2.20±0.85 | 2.36±0.90 | | |
| Post | 2.15±0.89 | 2.29±0.91 | | |
| Difference | -0.05±0.44 | -0.07±0.55 | -0.217 | 0.828 |
| P** | 0.455 | 0.297 | | |
| Depression | | | | |
| Pre | 1.89±0.55 | 1.86±0.47 | | |
| Post | 1.82±0.50 | 1.80±0.53 | | |
| Difference | -0.07±0.39 | -0.05±0.43 | -1.011 | 0.312 |
| P** | 0.288 | 0.046 | | |
| Cosmetic surgery attitude | | | | |
| Pre | 1.51±0.54 | 1.59±0.58 | | |
| Post | 1.54±0.64 | 1.40±0.52 | | |
| Difference | 0.03±0.38 | -0.19±0.41 | -3.851 | <0.001 |
| P** | 0.830 | <0.001 | | |

Note Mean±SD, *Mann-Whitney U test, ** Wilcoxon Signed-Rank test, †paired t-test

The body esteem scores of both the control and experimental groups increased slightly after training, with no statistically significant difference between the two groups. The body image score of the control group changed only slightly, with a score difference of 0.02±0.39 between before and after training, whereas the experimental group's score increased significantly from 3.39±0.69 before training to 3.55±0.72 after training ($p<0.05$, Table 3). After training, there was no statistically significant difference in body image between the two groups. These results show that the BodyThink program can help improve adolescents' body image.

### Effects of intervention on appearance stress and depression

The appearance stress scores of both the control and experimental groups were slightly lower after training compared to baseline, and there was no statistically significant difference between the two groups. The depression score of the control group decreased slightly from 1.89±0.55 before training to 1.82±0.50 after training, but the difference was not statistically significant. However, the score of the experimental group decreased significantly from 1.86±0.47 to 1.80±0.53 ($p<0.05$, Table 3). After the intervention, the depression scores of the two groups did not differ significantly. These results show that the BodyThink program has a positive effect on depression in adolescents.

### Effects of the intervention on cosmetic surgery attitude

After the intervention, there was a significant difference in the change in cosmetic surgery attitude scores between the control and experimental groups (0.03±0.38 vs. −0.19±0.41, $p<0.001$). Compared to baseline, the cosmetic surgery attitude score of the control group did not differ significantly after the intervention, whereas the score of the experimental group after training was significantly lower (1.59±0.58 vs. 1.40±0.52, $p<0.001$, Table 3).

The change in score between before and after the intervention in the cosmetic surgery attitude subcategories differed significantly between the control and experimental groups (Fig. 2). The cosmetic surgery secrecy score, which indicates a person's desire to hide having undergone cosmetic surgery, of the control group changed very little whereas the score for the experimental group decreased, with the difference between the groups being significant (0.01±0.06 vs. −0.38±0.08, $p<0.001$). The change in cosmetic surgery value score, which indicates the desire to improve one's appearance through cosmetic surgery, also decreased significantly in the experimental group compared to the control group (0.07±0.06 vs. −0.21±0.05, $p<0.01$). The change in cosmetic surgery conformity score, which refers to the psychological pressure to imitate the appearance or opinions of others, showed no difference in the control group, while the experimental group showed a significant change, decreasing by 0.16 from before to after the intervention ($p<0.01$). The change in cosmetic surgery payment score, which indicates willingness to pay for cosmetic surgery, also significantly decreased in

the experimental group compared to the control group (0.01±0.05 vs. -0.16±0.06, $p<0.05$). These results show that the BodyThink program has a positive effect on the formation of adolescents' attitudes toward cosmetic surgery

## Discussion

The purpose of the current study was to evaluate the effects of the revised BodyThink program on overall body image in Korean middle school students. The results showed that the revised BodyThink program can improve body image, reduce depression, and make positive improvements in cosmetic surgery attitudes in Korean adolescents.

Educational interventions to improve body image have been applied on a variety of topics and through a variety of media. Interventions have been based on an ecological systems perspective [23], acceptance and commitment therapy [24], a peer education program [25], emotion regulation [26] and a health belief model [27]. Approaches such as school-based interventions [28], internet-based interventions [29] and application-based interventions are being actively deployed [27, 30]. Systematic reviews have shown that interventions that include topics such as media literacy, cognitive dissonance, and healthy weight information are the most promising approaches for improving body image perceptions in adolescents [31, 32].

In our study, the BodyThink program was found to have positive effects on body image satisfaction. This can be attributed to the emphasis of the BodyThink program on cultivating media literacy to enable adolescents to critically view media images based on their understanding of body image and self-esteem [14]. Given that young people consume large volumes of media and are highly affected by self-esteem issues, the preponderance of content related to media literacy and self-esteem in the BodyThink program makes it particularly suitable for this population [33].

The present results suggest a relationship between improving body image and positive changes in cosmetic surgery attitudes. A previous study showed that young people have a higher level of media involvement than other age groups, and that the higher the level of media involvement, the higher the desire for cosmetic surgery, value attributed to cosmetic surgery, and attitudes toward risk tolerance [34]. Eastern cultures, such as that of Korea, tend to pursue Western face and body shapes as beauty standards, emphasizing certain features such as double eyelids, V-shaped faces, and voluptuous breasts [35]. Adolescents may encounter psychological difficulties such as low self-esteem, appearance stress, and depression if they feel that they must change their appearance to be accepted or valued by their peers or society [4]. Additionally, adolescents are more likely to make decisions about cosmetic plastic surgery without sufficient information about the associated health risks, such as complications or infections [36]. Therefore, education to promote body image can help to free adolescents from social pressures and media portrayals of beauty and help mitigate these physical and mental health risks in adolescents. Depression has been identified as a major predictor of acceptance of cosmetic surgery among Korean women [37]. In the present study, the decrease in depression scores in students who participated in the BodyThink program may be related to the positive change in cosmetic plastic surgery attitudes.

Recently, Korean teenagers have developed a tendency to indulge in sweet foods while imitating 'mukbang' influencers on social networks [38]. In our study, we attempted a subgroup analysis based on preferred taste. Although there were no between-group differences according to taste preferences (data not shown), extreme stress regarding appearance often manifests itself as abnormal eating behavior [39]. For example, affected individuals eat a large amount of food in a short period of time and engage in purging behavior or consciously not eating. Therefore, we believe that the relationship between eating behavior and body image is worthy of study.

The students who participated in the present study showed high levels of treatment adherence and low levels of dropout, possibly due to the adjustment of topics and sessions to suit the circumstances of Korean schools. The key to behavior change in education is to change the environment or process to make it easier to adopt a new practice or procedure than a once-and-done strategy [40]. Therefore, providing evidence-based, multifaceted interventions in the school curriculum will be an effective

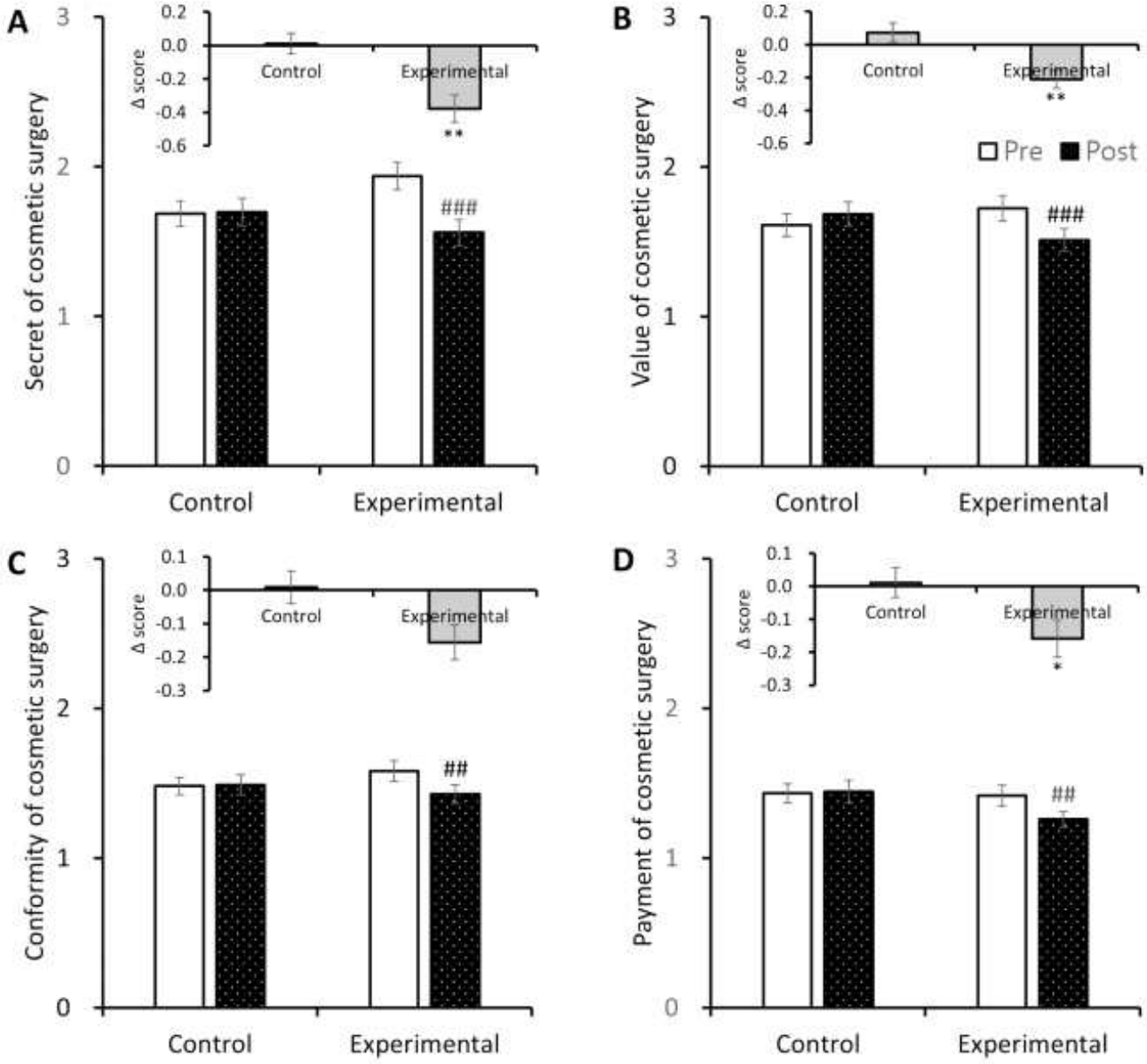


**Fig. 2** Effect of the BodyThink program on cosmetic surgery attitude subcategories
**(A)** Effect of the BodyThink program on secrecy regarding cosmetic surgery. **(B)** Effect of the BodyThink program on value of cosmetic surgery. **(C)** Effect of the BodyThink program on conformity regarding cosmetic surgery. **(D)** Effect of the BodyThink program on payment for cosmetic surgery. Data are expressed as mean ± SEM. $^{*}p<0.01$, $^{**}p<0.05$ compared with the control group. $^{\#\#}p<0.01$, $^{\#\#\#}p<0.001$ compared with the same group before training

educational method to improve the physical and psychological health of adolescents [41].

This study had several limitations. First, because the intervention program was applied in two middle schools in Korea, research on more diverse institutions and ages is needed to increase the external validity of the educational effect. Second, because one researcher conducted all of the training, it is necessary to verify the program's acceptability to existing school nurses and school institutions. Third, the present study measured the results immediately after the intervention; hence, there is a need to measure the improvement effects of key variables and whether they are maintained over a long period of time through longitudinal research.

## Conclusion

Body dissatisfaction is a growing public health problem among Korean adolescents. In this study, we confirmed

that the BodyThink program, which was modified to suit the circumstances of Korean schools, has a positive effect on adolescents' attitudes toward cosmetic surgery. Middle school is a critical time in which adolescents form attitudes and behaviors related to body image. Positive interventions at this stage can have a long-term impact on how individuals perceive themselves and others, potentially promoting a healthy body image and reducing appearance-related stress throughout their lives. Therefore, the present results suggest that the BodyThink program should be expanded or integrated into school curricula to benefit greater numbers of students. Additionally, the BodyThink program has the potential to be applied to other rehabilitation populations who experience body image changes during the course of a chronic illness.

## Abbreviations

CES-D Center for Epidemiological Studies-Depression

## Author contributions

GHS: Funding acquisition, Project administration, Conceptualization, Investigation, Supervision, Methodology, Formal analysis, Visualization, Writing - review & editing. HS: Conceptualization, Investigation, Formal analysis, Visualization, Writing - original draft. AYH: Formal analysis, Visualization, Writing - original draft. All authors approved the final version.


## Funding

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2021R1A2C2004118) and the Institute of Nursing Research, Korea University Grant. This manuscript is a revision of HS's master's thesis from Korea University.


## Data availability

Data are usable on request from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

All procedures in this study were conducted with the approval of the Korea University Institutional Review Board (Code: KUIRB-2023-0141-01). Informed consent was obtained from all the participants and legal guardians for the study. All methods were carried out in accordance with declaration of Helsinki.

### Consent for publication

Not applicable.

### Conflict of interest

The authors confirm that there are no conflicts of interest.


Received: 19 October 2023 / Accepted: 11 December 2023


## References


1. Tort-Nasarre G, Pollina-Pocallet M, Ferrer Suquet Y, Ortega Bravo M, Vilafranca Cartagena M, Artigues-Barberà E. Positive body image: a qualitative study on the successful experiences of adolescents, teachers and parents. Int J Qual Stud Health Well-being. 2023;18(1):2170007. https://doi.org/10.1080/17482631.2023.2170007.

2. Bianchi D, Schinelli A, Fatta LM, Lonigro A, Lucidi F, Laghi F. Body image impact on quality of life and adolescents' binge eating: the indirect role of body image coping strategies. Eat Weight Disord. 2023;28(1):75. https://doi.org/10.1007/s40519-023-01607-7.

3. Choukas-Bradley S, Roberts SR, Maheux AJ, Nesi J. The perfect Storm: a Developmental-Sociocultural Framework for the role of Social Media in adolescent girls' body image concerns and Mental Health. Clin Child Fam Psychol Rev. 2022;25(4):681 - 701. https://doi.org/10.1007/s10567-022-00404-5.

4. Rodgers RF, Slater A, Gordon CS, McLean SA, Jarman HK, Paxton SJ. A Biopsychosocial Model of Social Media Use and body image concerns, disordered eating, and muscle-building behaviors among adolescent girls and boys. J Youth Adolesc. 2020;49(2):399 - 409. https://doi.org/10.1007/s10964-019-01190-0.

5. Ji Y. Statistics of the 18th (2022) Youth Health Behavior Survey. In. Edited by Bureau CDM. Cheongju:

Korea Disease Control and Prevention Agency; 2023.

6. Tresna KAAD, Sukamto ME, Tondok MS. Celebrity worship and body image among young girls fans of K-pop girl groups. Humanitas Indonesian Psychological Journal.2021;18(2):100 - 11. https://doi.org/10.26555/humanitas.v18i2.19392.

7. Swami V, Hwang CS, Jung J. Factor structure and correlates of the acceptance of cosmetic Surgery scale among South Korean university students. Aesthet Surg J. 2012;32(2):220 - 9. https://doi.org/10.1177/1090820x11431577.

8. Sisti A, Restrepo DJ, Boczar D, Rinker BD, Forte AJ. The meaning of plastic Surgery. 2019;82(1):1. https://doi.org/10.1097/SAP.0000000000001712.

9. Elfving-Hwang J. Media, cosmetic Surgery and aspirational beauty aesthetics of the ageing body in South Korea. Asian Stud Rev. 2021;45(2):238 - 52. https://doi.org/10.1080/10357823.2020.1736513.

10. Global Survey. 2021 https://www.isaps.org/discover/about-isaps/global-statistics/reports-and-press-releases/global-survey-2021-full-report-and-press-releases/.

11. Kim YA, Chae D, Kim H. Factors affecting acceptance of cosmetic Surgery among undergraduate students. J Korea Contents Association. 2017;17(1):455 - 64. https://doi.org/10.5392/JKCA.2017.17.01.455.

12. Hayes JF, Fitzsimmons-Craft EE, Karam AM, Jakubiak J, Brown ML, Wilfley DE. Disordered eating attitudes and behaviors in Youth with overweight and obesity: implications for treatment. Curr Obes Rep. 2018;7(3):235 - 46. https://doi.org/10.1007/s13679-018-0316-9.

13. Hartman-Munick SM, Gordon AR, Guss C. Adolescent body image: influencing factors and the clinician's role. Curr Opin Pediatr. 2020;32(4):455 - 60. https://doi.org/10.1097/mop.0000000000000910.

14. Richardson SM, Paxton SJ, Thomson JS. Is BodyThink an efficacious body image and self-esteem program? A controlled evaluation with adolescents. Body Image. 2009;6(2):75 - 82. https://doi.org/10.1016/j.bodyim.2008.11.001.

15. Titov N, Andrews G, Robinson E, Schwencke G, Johnston L, Solley K, Choi I. Clinician-assisted internet-based treatment is effective for generalized anxiety disorder: Randomized Controlled Trial. Australian & New Zealand Journal of Psychiatry. 2009;43(10):905 - 12. https://doi.org/10.1080/00048670903179269.

16. Lee J. Correlation among adolescents gender, obesity, others appraisal of their bodies and the adolescents body-esteem. Cheongwon: Korea National University of Education; 2001.

17. Mendelson B, Mendelson M, Andrews J, Balfour L, Bucholz A. Three aspects of body esteem in adolescents and young adults: Differential relations with weight and self-esteem. Research in Child Development 1997;17(1):145 - 160.

18. Secord PF, Jourard SM. The appraisal of body-cathexis: body-cathexis and the self. J Consult Clin Psychol. 1953;17(5):343. https://doi.org/10.1037/h0060689.

19. Yang K. The link between body-esteem and self-esteem during adolescence. Cheongju: Chungbuk National University; 1993.

20. Noh S, Avison WR, Kaspar V. Depressive symptoms among Korean immigrants: Assessment of a translation of the Center for epidemiologic studies—Depression Scale. Psychol Assess. 1992;4(1):84. https://doi.org/10.1037/1040-3590.4.1.84.

21. Jeon KR, Lee MH. A study on the need, Self-Esteem and aesthetic Surgery attitude of female. J Korean Soc Costume. 2002;52(6):71 - 83.

22. Wilksch SM, Tiggemann M, Wade TD. Impact of interactive school-based media literacy lessons for reducing internalization of media ideals in young adolescent girls and boys. Int J Eat Disord. 2006;39(5):385 - 93. https://doi.org/10.1002/eat.20237.

23. Engel SG, Crosby RD, Thomas G, Bond D, Lavender JM, Mason T, Steffen KJ, Green DD, Wonderlich SA. Ecological momentary assessment in eating disorder and obesity research: a review of the recent literature. Curr Psychiatry Rep. 2016;18:1 - 9. https://doi.org/10.1007/s11920-016-0672-7.

24. Rezaeisharif A, Cheraghian H, Naeim M. Effectiveness of acceptance and commitment therapy on reducing body image disorders in adolescent girls. Addict Disorders Their Treat. 2021;20(4):336 - 41. https://doi.org/10.1097/ADT.0000000000000265.

25. Eickman L, Betts J, Pollack L, Bozsik F,

Beauchamp M, Lundgren J. Randomized controlled trial of REbeL: a peer education program to promote positive body image, healthy eating behavior, and empowerment in teens. Eat Disord. 2018;26(2):127 – 42. https://doi.org/10.1080/10640266.2017.1349005.

26. Debeuf T, Verbeken S, Boelens E, Volkaert B, Van Malderen E, Michels N, Braet C. Emotion regulation training in the treatment of obesity in young adolescents: protocol for a randomized controlled trial. Trials. 2020;21:1 – 17. https://doi.org/10.1186/s13063-019-4020-1.

27. Franko DL, Cousineau TM, Rodgers RF, Roehrig JP. BodiMojo: effective internet-based promotion of positive body image in adolescent girls. Body Image. 2013;10(4):481 – 8. https://doi.org/10.1016/j.bodyim.2013.04.008.

28. Lewis-Smith H, Garbett KM, Chaudhry A, Dhillon M, Shroff H, White P, Diedrichs PC. Evaluating a body image school-based intervention in India: a randomized controlled trial. Body Image. 2023;44:148 – 56. https://doi.org/10.1016/j.bodyim.2022.12.006.

29. Gordon CS, Rodgers RF, Slater AE, McLean SA, Jarman HK, Paxton SJ. A cluster randomized controlled trial of the SoMe social media literacy body image and wellbeing program for adolescent boys and girls: study protocol. Body Image. 2020;33:27 – 37. https://doi.org/10.1016/j.bodyim.2020.02.003.

30. Cerea S, Ghisi M, Bottesi G, Manoli T, Carraro E, Doron G. Cognitive behavioral training using a mobile application reduces body image-related symptoms in high-risk female university students: a randomized controlled study. Behav Ther. 2021;52(1):170 – 82. https://doi.org/10.1016/j.beth.2020.04.002.

31. Stice E, Onipede ZA, Marti CN. A meta-analytic review of trials that tested whether eating disorder prevention programs prevent eating disorder onset. Clin Psychol Rev. 2021;87:102046. https://doi.org/10.1016/j.cpr.2021.102046.

32. Pursey KM, Burrows TL, Barker D, Hart M, Paxton SJ. Disordered eating, body image concerns, and weight control behaviors in primary school aged children: a systematic review and meta-analysis of universal – selective prevention interventions. Int J Eat Disord. 2021;54(10):1730 – 65. https://doi.org/10.1002/eat.23571.

33. Diedrichs PC, Atkinson MJ, Garbett KM, Leckie G. Evaluating the dove confident me five-session body image intervention delivered by teachers in schools: a cluster randomized controlled effectiveness trial. J Adolesc Health. 2021;68(2):331 – 41. https://doi.org/10.1016/j.jadohealth.2020.10.001.

34. Park SK. The effect of media involvement and appearance satisfaction on plastic Surgery related attitudes and intentions – focusing on gender and age. Korean Soc Fashion Des. 2014;14(4):101 – 16.

35. Lee H, Son I, Yoon J, Kim SS. Lookism hurts: appearance discrimination and self-rated health in South Korea. Int J Equity Health. 2017;16(1):204. https://doi.org/10.1186/s12939-017-0678-8.

36. Robinson IS, Carswell JM, Boskey E, Agarwal CA, Brassard P, Bélanger M, Zhao LC, Bluebond-Langner R. Gender-affirming Surgery in adolescents and young adults: a review of ethical and Surgical considerations. Plast Reconstr Surg. 2023;152(4):737e – 50. https://doi.org/10.1097/prs.0000000000010325.

37. Seo YA, Kim YA. Predictors of Acceptance of Cosmetic Surgery in South Korean women. Aesthetic Plast Surg. 2022;46(4):2031 – 9. https://doi.org/10.1007/s00266-022-02795-w.

38. Kwak Y-s. Tanghulu captures hearts of Korean millennials and Gen Z. In: The Korea Times Seoul, Korea; 2023.

39. Yang J, Han KS. A rational emotive behavior therapy-based intervention for binge eating behavior management among female students: a quasiexperimental study. J Eat Disorders. 2020;8(1):1 – 12. https://doi.org/10.1186/s40337-020-00347-8.

40. Bergren MD. Education is not enough. J School Nurs. 2023;39(2):103 – 4. https://doi.org/10.1177/10598405231158450.

41. Soong C, Shojania KG. Education as a low-value improvement intervention: often necessary but rarely sufficient. BMJ Qual Saf. 2020;29(5):353 – 7. https://doi.org/10.1136/bmjqs-2019-010411.

# BodyThink program-based body image education improves Korean adolescents' attitudes toward cosmetic surgery: Randomized controlled trial

Hyeonhwa Sung[1], A Young Han[1,2] and Geun Hee Seol[1,3*]

[1] Department of Basic Nursing Science, College of Nursing, Korea University, Seoul, Republic of Korea

[2] Department of Nursing, College of Life Science and Industry, Sunchon National University, Suncheon, Republic of Korea

[3] BK21 FOUR Program of Transdisciplinary Major in Learning Health Systems, Graduate School, Korea University, Seoul, Republic of Korea

**Background** The aims of this study were to modify the widely used BodyThink program to suit the circumstances of Korean schools and determine its effects on body esteem, body image, appearance stress, depression, and attitudes toward cosmetic surgery.

**Methods** Participants were 184 third-grade students from two middle schools in Korea, who were randomly assigned to a control or intervention group. Two of the participants dropped out; hence, data from 182 students were analyzed. The control group received the existing curriculum for 4 sessions, and the experimental group was provided with 4 sessions of the revised BodyThink program. Before and after the intervention, all participants completed questionnaires.

**Results** In the BodyThink group, improved body image, decreased depression, and positive improvements in attitudes toward cosmetic plastic surgery were observed after the intervention.

**Discussion** These results suggest that school health nurses can utilize interventions based on BodyThink program in their curricula to improve the physical and emotional health of adolescents.

**Trial registration** This study has been retrospectively registered with the Clinical Research information Service (CRIS) in Korea on October 5, 2023 (KCT0008839).

**Keywords Body** image, Depression, Cosmetic surgery, Adolescent

* *Address reprint requests to : Geun Hee Seol*
College of Nursing, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul 02841, South Korea.
E-mail: ghseol@korea.ac.kr

# Pain self-management plus activity tracking and nurse-led support in adults with chronic low back pain: Feasibility and acceptability of the problem-solving pain to enhance living well (PROPEL) intervention

Wanli Xu[1,2], Yiming Zhang[3], Zequan Wang[1,2], Susan G Dorsey[4], Angela Starkweather[5] and Kyounghae Kim[6,7,8*]

[1] University of Connecticut School of Nursing, Storrs, Connecticut, USA
[2] Center for Advancement in Managing Pain, University of Connecticut, Storrs, Connecticut, USA
[3] Department of Statistics, University of Connecticut, Storrs, Connecticut, USA
[4] School of Nursing, University of Maryland, Baltimore, USA
[5] University of Florida College of Nursing, Gainesville, USA
[6] College of Nursing, Korea University, 145 Anam-ro, Seongbuk-Gu, Seoul, South Korea
[7] Nursing Research Institute, Korea University, Seoul, South Korea
[8] BK21 FOUR R&E Center for Learning Health Systems, Korea University, Seoul, South Korea

**Background**

Chronic low back pain (cLBP) is one of the most prevalent pain conditions in the U.S., affecting 20.4% of adults [1]. Globally, cLBP is the most common cause of years lived with disability, affecting 64.9 million people worldwide [2, 3]. The direct medical costs of cLBP and indirect expenses related to disability impose a substantial economic burden on individuals and the society. In the U.S., the estimated annual expenditure related to spinal pain (combining neck and/or low back pain) is $134.5 billion [4]. While most episodes of acute low back pain resolve in 4–6 weeks, approximately 32% of individuals transition to cLBP and require ongoing care, constituting a majority of the annual expenditures related to spinal pain [5]. Previous studies have reported peripheral and central nervous system sensitization are involved in the functional alterations in cLBP, which can be captured by quantitative sensory testing (QST) [6]. Identifying effective interventions to facilitate cLBP management and preserve physical and social functioning is critically important for population health, quality of life, and efforts to reduce costs from the overuse of unwarranted diagnostic and treatment approaches [7].

Current practice guidelines for cLBP [8, 9] as well as the National Pain Strategy [10], emphasize that pain selfmanagement is the first-line standard of care but provide little guidance on the elements that should be addressed in a self-management intervention. Research on selfmanagement continues to advance with more extensive self-management-specific frameworks [11, 12]. None of the studies designed and implemented interventions that delineated theory-driven self-management elements for cLBP management [13]. To address this gap, our team used a

Keywords Activity tracking, Chronic low back pain, Self-management
This study was published in BMC Nursing (2023) 22:217
* Corresponding author: Kyounghae Kim
E-mail: kyounghaekim@korea.ac.kr

person-centered approach to develop a theoretically based self-management intervention called Problem-Solving Pain to Enhance Living Well (PROPEL) [14]. The PROPEL incorporates evidence-based strategies that are effective in improving pain and somatosensory function [15]. Specifically, PROPEL was guided by the Individual and Family Self-Management Theory (IFSMT) which delineates modifiable context and process factors [12] and has been verified in the context of chronic conditions, such as diabetes [16] and heart failure [17]. According to IFSMT, self-management knowledge and beliefs, self-regulation, and social facilitation are affected by condition-specific factors along with individual, family, and environmental factors, which in turn influence proximal (self-management behaviors) and distal outcomes (perceived well-being). PROPEL also incorporates evidence-based, standard-of-care methods to promote physical activity among individuals with pain, and tools to improve knowledge, skills, and confidence in coping with cLBP. The intervention and study protocol details have been previously reported [14], and the study was registered in a clinical trial database [NCT03637998].

## Methods

### Aim

The aim of this study was to examine the feasibility, acceptability, and preliminary efficacy of the PROPEL intervention using pre- and post-test data from a singlearm longitudinal study that enrolled 40 participants with cLBP.

### Design

This longitudinal study enrolled 40 participants with cLBP who received the PROPEL intervention, nurse-led self-management plus activity tracking. A control group was not included because the main focus of the evaluation was to assess differences in the intervention components from pre- to post-testing

### Study settings and participants

Participants were recruited from the local communities surrounding a research-intensive university in the New England region using active and passive strategies that included (1) contacting pain registry participants maintained by the research team; (2) distributing flyers in the local community and outpatient health clinics; and (3) placing advertisements in local newspapers, websites, and social media (Facebook and Instagram), which instructed interested volunteers to contact a study-designated phone or email address.

The inclusion criteria were as follows: (1) English speaking adults with cLBP aged 18 to 60 years; (2) having no other type of chronic pain conditions; and (3) access to a computer or smart mobile device with Internet connection. The exclusion criteria were as follows: (1) any history of comorbidities that influence sensorimotor function, including multiple sclerosis, cancer, spinal cord injury, or diabetes; (2) history of spinal surgery in the previous year; (3) presence of neurological deficits, including lower extremity weakness; (4) history of bowel or bladder dysfunction; (5) positive Romberg test or sciatica upon leg raise; (6) current pregnancy or within 3 months postpartum; and (7) hospitalization in the past 6 months due to mental health disorders.

### PROPEL intervention

Details of the PROPEL intervention have been reported elsewhere [10]. In brief, PROPEL consists of 10 online self-management modules, activity tracking, and biweekly nurse consultations during the 12-week intervention period. The modules offer factual information on low back pain neurophysiology, strategies for promoting self-regulation and problem-solving, and instructions on managing pain while maintaining regular functions.

### Procedures

Trained research assistants (RA) screened the interested volunteers during a confidential phone call to determine their eligibility. Eligible participants were scheduled for a baseline visit to discuss the study and answer any questions. Informed consent procedures were followed, and written consent was obtained from each participant by the study staff.

The enrolled participants were immediately scheduled for their baseline data collection visit, which involved a physical examination, completing study questionnaires and QST, as well

as the collection of blood samples [14]. The QST is used to measure pain sensitivity and uses standardized stimuli to test the nociceptive systems in the periphery and central nervous systems [6, 18]. Seven tests measuring 13 functional sensory pathways are grouped as follows [18]: "(1) thermal detection thresholds for the perception of cold, warm, and paradoxical heat sensation; (2) thermal pain thresholds for cold and hot stimuli; (3) mechanical detection thresholds for touch and vibration; and (4) mechanical pain sensitivity including thresholds for pinprick and blunt pressure, stimulus/response-functions for pinprick sensitivity and dynamic mechanical allodynia, and pain summation to repetitive pinprick stimuli (wind-up like pain)." QST was performed in both the pain and control sites. The medial side of the non-dominant forearm was used as a control. Venous blood samples were collected in one 2.5 ml PAXGENE tube (QIAGEN, Hilden, Germany) and were immediately transported, processed, and stored at -80° laboratory freezer conditions for RNA sequencing. If the blood draw was unsuccessful, the participants were required to provide a buccal cell sample for genetic testing. The analysis of gene expression will be reported separately and was not included in this manuscript.

Following data collection, study staff assisted participants in setting up and syncing a Fitbit device on their personal cell phone, and were then given instructions on how to maintain and wear it until their 12-week follow-up appointment. Participants were informed that they would receive an email link to a PROPEL module daily for the next 10 days, and were instructed to watch the modules and be prepared to discuss the content during the nurse consultation visit. Nurse consultations were delivered to participants via phone interviews at weeks 2, 4, 6, 8, and 10. At week 12, the nurse consultations were delivered in person. After the baseline visit, participants were scheduled for their 12-week follow-up visit, in which they completed the study questionnaires, QST, and a blood draw.

Participants in the study received a $20 gift card for the baseline visit and $40 for the final visit. Upon completion of both questionnaires and nurse consultations at weeks 2, 4, 6, 8, and 10, participants were given a $10 gift card. In addition, they received $5 biweekly for charging and syncing their Fitbit. If participants completed all follow-up questionnaires and intervention components, they were provided with a total of $140. The Fitbit was given to participants to keep..

**Measures of feasibility, acceptability, and preliminary efficacy**

**Feasibility and acceptability benchmarks**

Feasibility of recruitment: The enrollment rate was determined by the number of participants who consented divided by the total number of individuals who made initial contact with the study team (signed up on social media advertisements or made an initial phone call) and met the inclusion criteria.

Acceptability was assessed using the retention and attrition rates. This feasibility benchmark was defined as acceptable if 75% of the participants completed the baseline and the 12-week follow-up visits.

Adherence to Fitbit: We evaluated each participant's compliance rate with wearing the Fitbit device by the proportion of time with non-zero intensity during the awake time. A zero intensity in 1 h indicated that the participant did not wear the Fitbit device during that hour. Thus, a lower proportion of non-zero intensity time showed a higher compliance rate when wearing the Fitbit.

Adherence to surveys: Adherence to longitudinal selfreported data collection was evaluated by the mean percentage of completed biweekly REDCap survey questionnaires and consultations. Questionnaires were excluded from the analysis when entirely missing.

Adherence to nurse consultation: Participants had opportunities to express their concerns regarding their symptoms and self-management skills via bi-weekly consultations with nurse research staff. The nurse and the participant exchanged ideas on possible solutions to these challenges. We also measured the frequency of participants practicing pain self-management skills, including deep breathing, muscle relaxation, and guided imagery, throughout the study period. We considered it excellent if the proportion of participants completing consultation sessions was ≥80% and good if it was ≥75%.

Adherence to biospecimen and QST measures: The feasibility of biospecimen collection was measured by the percentage of

blood samples collected in the total collection attempts. The feasibility of the QST procedure was assessed based on the percentage of participants who had completed the QST protocol. Data collection was performed at baseline and at 12-week follow-up. We obtained a buccal cell sample if a blood sample could not be collected because of small or hard-to-find veins so that genetic assays could be included.Program satisfaction: PROPEL was assessed using a participant satisfaction questionnaire that captured the extent to which the intervention met the participants' needs and preferences. This 10-point Likert scale ranges from 0 to 10, with 0 being the lowest level of satisfaction and 10 being the highest. We considered program satisfaction to be excellent if the proportion of participants rating PROPEL was ≥80%, and good if it was ≥75%.

Program safety: The safety of the intervention was determined by recording self-reported adverse events during consultation phone calls and in-person visits. Program safety was considered excellent if no adverse events directly linked to PROPEL participation were reported and good if minimal to mild adverse events related to PROPEL occurred in <5% of the study participants.

**Pain (brief pain inventory [BPI]-SF, PROMIS-pain intensity, QST)**

The BPI-SF is a reliable and valid measurement to assess participants' average pain intensity and average interference with functioning due to pain, including activity, emotion, relationships with others, employment, and sleep [9]. A composite mean score of the BPI pain intensity items, including "worst," "least," "average," and "now," was generated, indicating BPI pain severity. BPI interference was estimated by calculating the mean interference score with seven daily activity domains. Additionally, the PROMIS-Pain Intensity measure is recommended as a supplemental instrument for NIH-funded research.

The QST is a non-invasive technique used to assess somatosensory functions and pain perception through the application of standardized thermal and mechanical stimuli [14]. Thirteen functional sensory pathways were evaluated to detect abnormalities in large A-beta and small C- and A-delta sensory fibers in the peripheral and central nervous systems [14]. Detailed information regarding the administration of the QST protocol among individuals with cLBP has been published elsewhere [6].

**Physical activity (fitbit, godin-leisure questionnaire)**

The Fitbit Flex 2 auto-detected the participants' activity and recorded the minute-level Metabolic Equivalents (MET) data and physical activity category data, such as sedentary time, lightly active time, fairly active time, and very active time. For each participant, we calculated the average MET level per minute during the effective wearing time in each week and use it as a weekly level continuous outcome in Fitbit data analysis. The effective wearing time was approximated by excluding the unoccupied time, which was identified by screening each participant's data based on a 30-min moving window. If the minimum MET level was constantly recorded over the 30-min window, the Fitbit device was considered unoccupied.

However, true sedentary time, sleeping time, and unoccupied time were all recorded as sedentary time due to the limitation of the Fitbit Flex 2. If a participant did not wear the Fitbit device continuously, the duration of different levels of active time recorded by Fitbit Flex 2 did not reflect the true activity variability. Since this type of "missing" data cannot be identified in the Fitbit data set, the statistical missing data algorithm would not be applied. Therefore, more accurate and reliable measurements of physical activity are required for studies based on data collected using the Fitbit Flex 2.

We processed Fitbit data using minute-level MET data to approximate the effective wearing time for each participant. If the device did not move or was not worn by the participant, it recorded a minimum MET level of 1.0. We identified the unoccupied time of each participant's Fitbit device by screening the data based on a 30-min moving window. If the minimum MET level was constantly recorded over the 30-min window, the Fitbit device was considered unoccupied. By excluding the estimated unoccupied time, we were able to estimate the duration of the effective time when the participants were wearing the Fitbit device. The weekly average MET level durin g the effective wearing time was used as the physical activity

**Table 1** Descriptive table for demographic and clinical characteristics (N = 40)

| Demographic and Clinical Characteristics | | Descriptive Statistics | |
|---|---|---|---|
| | | Mean | SD |
| | Age | 29.8 | 11.7 |
| | BMI | 26.8 | 7.0 |
| | | Frequency | Proportion (%) |
| Gender | Male | 15 | 37.5 |
| | Female | 25 | 62.5 |
| Race | White | 27 | 67.5 |
| | Black or African American | 4 | 10 |
| | Asian | 6 | 15 |
| | Not reported | 3 | 7.5 |
| Ethnicity | Not Hispanic or Latino | 35 | 87.5 |
| | Hispanic or Latino | 4 | 10 |
| | Not reported | 1 | 2.5 |
| Education Level | High school or below | 3 | 7.5 |
| | College and undergraduate | 27 | 67.5 |
| | Graduate school | 10 | 25 |
| Employment Status | Working now | 19 | 47.5 |
| | Unemployment | 3 | 7.5 |
| | Student | 18 | 45 |
| Marital Status | Married | 8 | 20 |
| | Never married | 27 | 67.5 |
| | Others | 5 | 12.5 |
| Alcohol Use | Never | 11 | 27.5 |
| | Occasional | 22 | 55 |
| | Weekly or daily | 7 | 17.5 |
| Have you drunk or used drugs more than you meant to? | Never | 30 | 75 |
| | Rarely | 9 | 22.5 |
| | Sometimes | 1 | 2.5 |
| Exercise amount | None | 10 | 25 |
| | 1–3 days/week | 25 | 62.5 |
| | 4–5 days/week | 5 | 12.5 |
| How long has LBP been an ongoing problem for you? | 3–6 months | 3 | 7.5 |
| | 6 months-1 year | 9 | 22.5 |
| | 1–5 years | 18 | 45 |
| | More than 5 years | 10 | 25 |
| How often has LBP been an ongoing problem for you over the past 6 months? | Every day | 13 | 32.5 |
| | At least half of the days | 22 | 55 |
| | Less than half of the days | 5 | 12.5 |
| Using Opioid painkillers | Yes | 4 | 10.0 |
| | No | 36 | 90.0 |
| Using exercise therapy | Yes | 13 | 32.5 |
| | No | 27 | 67.5 |

Abbreviations: BMI, body mass index; LBP, low back pain

measure in Fitbit data analysis.

The Godin Leisure-Time Exercise Questionnaire is a reliable and valid measure to assess the number of strenuous, moderate, and mild intensity leisure-time physical activities for at least 15 min a week [19] in patients with cLBP. The weekly leisure activity score was calculated by multiplying nine, five, and three for strenuous, moderate, and mild activities, respectively.

### Statistical analysis

Statistical analyses were conducted using the SPSS 27 and R 4.0.3. Feasibility and acceptability were assessed using descriptive statistics. Summary statistics for baseline characteristics, self-reported pain, self-management skills, and physical activity were reported at each time point. To examine the preliminary efficacy of the PROPEL intervention, we performed a paired two-sample t-test on pain and self-management skills outcomes at baseline and visit seven (12-week follow-up visit). Shapiro-Wilk test was conducted to check the normality of the pre-post difference of each variable. If the normality assumption did not hold, paired Wilcoxon sign-rank test was used for testing. We calculated the effect size for the pre- and post-pain changes and QST measurements using Cohen's D. We summarized the longitudinal Fitbit data from baseline to the 12th week and Godin-Leisure measures using descriptive statistics and trajectory plots.

### Ethical considerations

Prior to participant recruitment, this study was approved by the Institutional Review Board (IRB# H18-086).

## Results

### Demographic and clinical characteristics

The summary statistics of the demographic and clinical characteristics are presented in Table 1. The participants were predominantly female (62.5%), white (67.5%), non-Hispanic or Latino (87.5%), never married (67.5%), and had college or undergraduate education (67.5%).

The average age was 29.8 (SD=11.7) years, and the average BMI was 26.8 (SD=7.0). Individuals with less than 150 min of moderate physical activity were eligible for this study, and

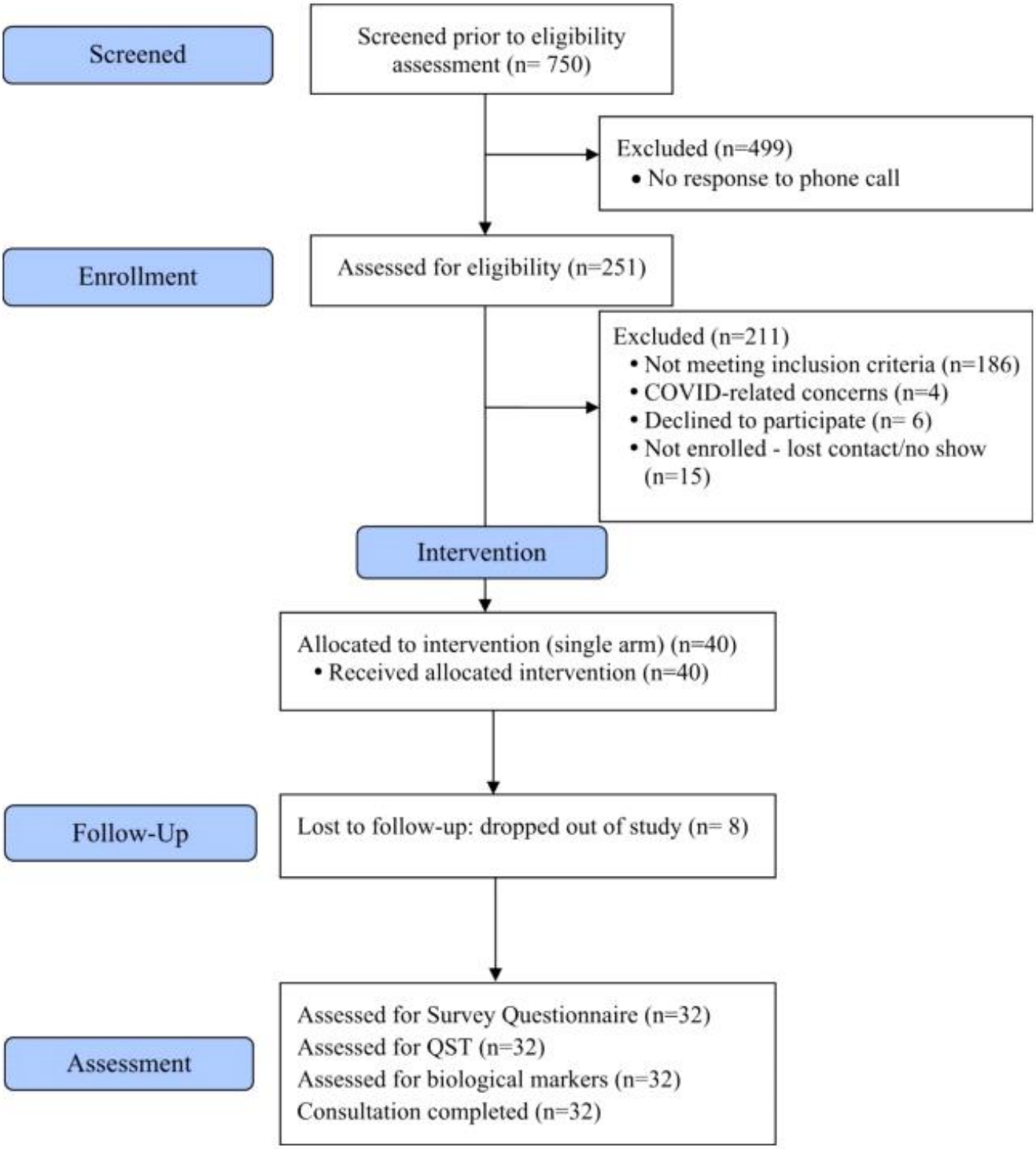


**Fig. 1** Study process
Abbreviations: QST, quantitative sensory testing

62.5% of the participants reported engaging in some form of physical activity 1–3 days per week. Approximately 45% of the participants had low back pain for 1–5 years, and 55% reported pain frequency on at least half of the days over the past six months. Nearly 10% of the participants used opioid analgesics, and 32.5% used exercise therapy for cLBP.

**Feasibility and acceptability**

Figure 1 displays the consort study diagram of this single-arm trial. Of the 750 individuals who had initial contact,

499 no longer responded to our team's phone call; therefore, we could not complete the eligibility assessment. Of the 251 individuals assessed for eligibility, 186 did not meet the inclusion criteria. The most common reason for participants not meeting the inclusion criteria was having other types of chronic pain conditions, a history of spinal cord injury or spinal surgery, or neurological deficits. Among the 65 eligible participants, four could not attend a baseline visit because of possible COVID symptoms. Six participants declined, and 15 did not show up for baseline assessment. Of the 40 who initiated the data collection process, eight dropped out of the study. Thirty-two participants (80%) completed the assessment of the survey questionnaire, QST, biological markers, and nursing consultation. The overall enrollment rate was 61.5% (40/65), with 83% (25/30) in the pre-COVID period (09/2018 - 03/2020) and 42.8% (15/35) in the post-COVID period (10/2020 - 12/2021). Four participants (10%) withdrew from the study because of time conflicts and personal circumstances. Four participants (10%) were lost to follow-up despite multiple efforts. The overall retention rate was 80%, and the attrition rate was 22% for both pre- and post-COVID).

**Intervention/consultation (video-watching, consultation, and participant utilization of self-management strategies)**

Thirty-seven participants (92.5%) watched the 10 video modules online, among whom six participants (16.2%) watched them a day after they received the modules, 21 participants (56.7%) watched them within a week, seven participants (18.9%) watched them within a month, and three participants (8.1%) completed them within more than a month. Participants found that the video modules were beneficial in providing information on their pain self-management (86.2%) and motivated them to engage in better pain self-management efforts (82.7%). Among the 10 videos, guided imagery and stretching were rated as the most favorable. Satisfaction with the overall quality of the video

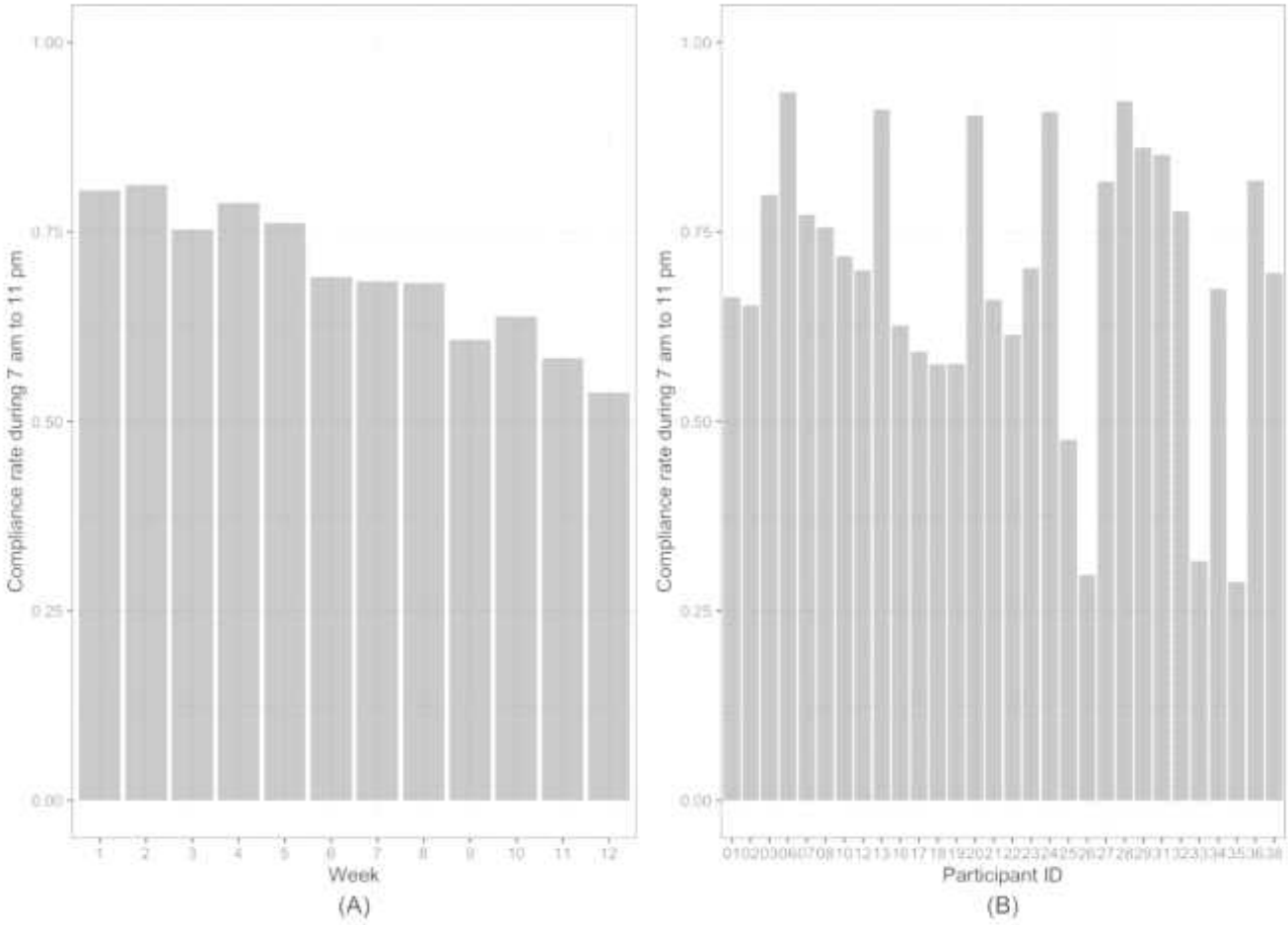


**Fig. 2** Compliance rate of wearing the Fitbit device from 7 am to 11 pm. (**A**) Average Fitbit compliance rates of all participants in different weeks. (**B**) Average Fitbit compliance rates of each participant in the study

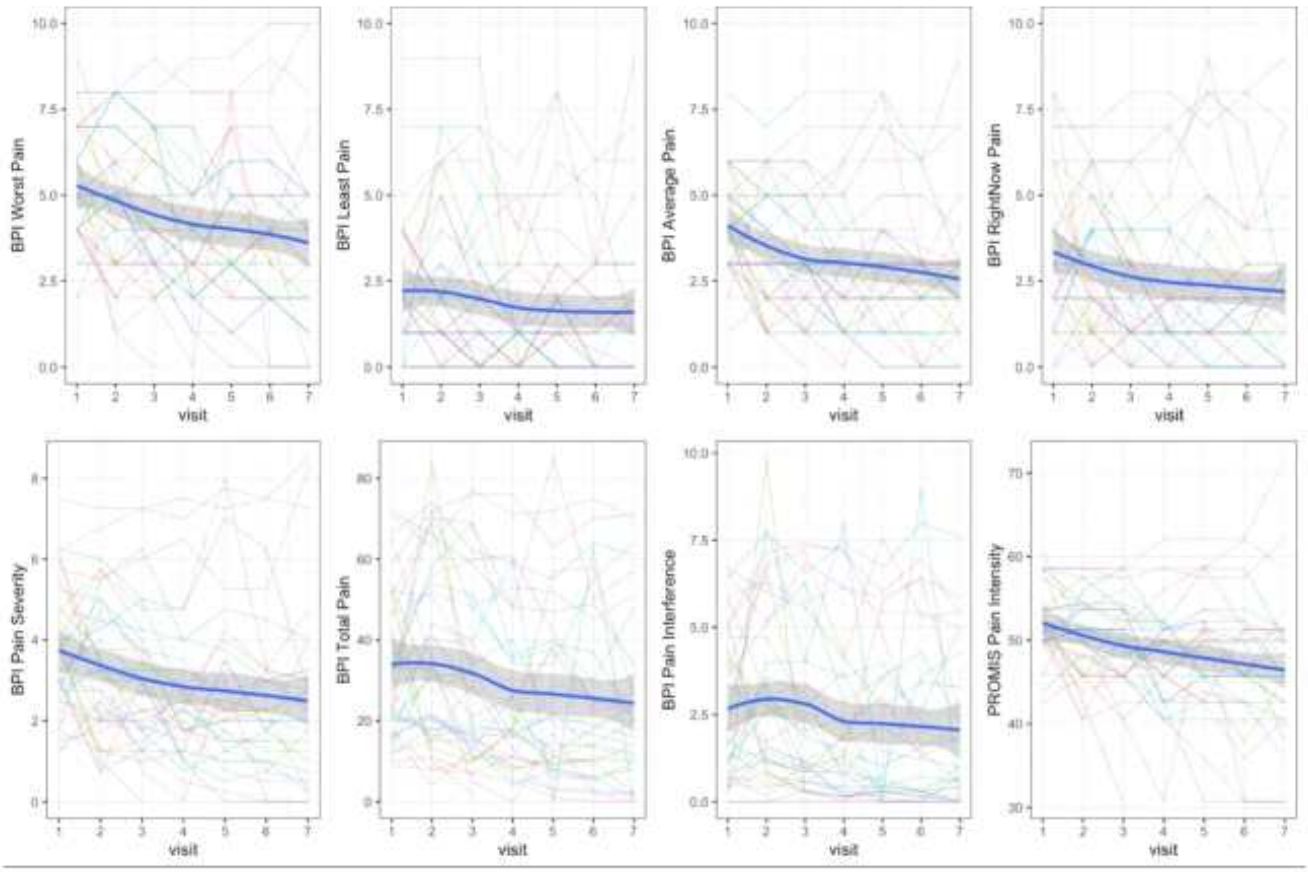


**Fig. 3** Subject trajectories and mean curves of pain measurement
Abbreviations: BPI, brief pain inventory; PROMIS, patient-reported outcomes measurement information systems

**Table 2** Results of two sample paired t-test for pain outcomes (N = 31)

| Pain outcomes | Visit 1 Mean (SD) | Visit 7 Mean (SD) | Mean Difference (d) | p-value | Cohen's D |
|---|---|---|---|---|---|
| BPI Worst Pain | 5.25 (1.80) | 3.61 (2.64) | -1.68 | 0.003 | 0.57 |
| BPI Least Pain | 2.19 (2.10) | 1.65 (2.30) | -0.55 | 0.239 | 0.21 |
| BPI Average Pain | 4.19 (1.55) | 2.61 (2.11) | -1.61 | < 0.001 | 0.77 |
| BPI RightNow Pain | 3.19 (2.22) | 2.23 (2.25) | -0.97 | 0.020 | 0.44 |
| BPI Pain Severity | 3.70 (1.63) | 2.52 (2.23) | -1.20 | 0.004 | 0.56 |
| BPI Total Pain | 34.06 (18.77) | 24.07 (22.19) | -10.23 | 0.004 | 0.54 |
| BPI Pain Interference | 2.75 (2.15) | 2.00 (2.16) | -0.77 | 0.020 | 0.43 |
| PROMIS Pain Intensity | 52.12 (4.59) | 46.54 (8.87) | -5.61 | 0.002 | 0.62 |

Abbreviations: BPI, brief pain inventory; PROMIS, patient-reported outcomes measurement information systems; SD, standard deviation

s (audio, pace, and organization) was rated as satisfied or very satisfied by 92.5% of the sample.

Thirty participants (75%) completed six nurse consultation sessions, with consultation durations ranging from 8 to 20 min. Of the total sample, 90% successfully provided goals to better manage their cLBP symptoms and learned problem-solving skills with nurses during the consultation, including aerobic and resistant physical activities, symptom management, medication management, diet/weight control, and stress management. With sufficient and understandable nurse consultation, participants could utilize self-management strategies to manage their pain over the course of this study. Satisfaction with nurse consultations was rated as satisfied to very satisfied by 89.6% of the sample, who reported that nurses were willing to listen to were satisfied to very satisfied) and pain self-management (92.9% were satisfied to very satisfied).them, and participants were satisfied with respectful, sufficient, and understandable information. Participants reported that the nurse consultations provided a better understanding of decision-making (89.3% were

**Table 3** Results of two sample paired Wilcoxon sign-rank test for QST outcomes (N = 32)

| QST | | Visit 1 Mean (SD) | Visit 7 Mean (SD) | Mean difference | p-value |
|---|---|---|---|---|---|
| Mechanical detection threshold (mN) | | | | | |
| | Control site | 3.04 (0.24) | 3.10 (0.35) | 0.06 | 1.000 |
| | Pain site | 3.21 (0.52) | 3.24 (0.43) | 0.03 | 0.466 |
| Mechanical pain threshold (mN) | | | | | |
| | Control site | 6.14 (0.48) | 6.25 (0.44) | 0.10 | 0.132 |
| | Pain site | 6.00 (0.45) | 6.13 (0.43) | 0.13 | 0.071 |
| Mechanical pain sensitivity (pain rating 0–10) | | | | | |
| | Control site | 1.96 (1.79) | 1.91 (1.67) | -0.05 | 0.617 |
| | Pain site | 2.66 (2.11) | 2.44 (1.72) | -0.22 | 0.439 |
| Dynamic mechanical allodynia (pain rating 0–10) | | | | | |
| | Control site | 0.76 (1.19) | 0.76 (1.03) | 0.11 | 0.452 |
| | Pain site | 0.84 (1.38) | 0.73 (0.97) | -0.05 | 0.975 |
| Windup ratio (multiple average/single average) | | | | | |
| | Control site | 2.35 (5.21) | 1.57 (1.37) | -0.78 | 0.899 |
| | Pain site | 2.57 (3.98) | 2.32 (3.96) | -0.25 | 0.766 |
| Vibration detection threshold (sec) | | | | | |
| | Control site | 9.64 (3.13) | 10.12 (3.08) | 0.32 | 0.516 |
| | Pain site | 6.71 (4.66) | 7.12 (3.89) | 0.43 | 0.765 |
| Heat Limits (°C) | | | | | |
| | Control site | 43.31 (3.67) | 42.51 (3.38) | -0.80 | 0.651 |
| | Pain site | 41.38 (3.48) | 41.30 (3.10) | -0.08 | 0.919 |
| Cold detection threshold (°C) | | | | | |
| | Control site | 28.58 (2.22) | 28.14 (2.55) | -0.44 | 0.304 |
| | Pain site | 28.60 (1.43) | 28.40 (1.12) | -0.20 | 0.304 |
| Warm detection threshold (°C) | | | | | |
| | Control site | 35.38 (1.37) | 35.70 (1.64) | 0.32 | 0.477 |
| | Pain site | 35.82 (1.79) | 36.08 (1.35) | 0.26 | 0.029 |
| Cold pain threshold (°C) | | | | | |
| | Control site | 18.01 (9.90) | 19.32 (8.12) | 1.30 | 0.599 |
| | Pain site | 18.63 (10.05) | 20.24 (8.08) | 1.61 | 0.583 |
| Heat pain threshold (°C) | | | | | |
| | Control site | 40.94 (3.83) | 41.51 (3.09) | 0.57 | 0.410 |
| | Pain site | 40.65 (3.20) | 40.69 (3.21) | 0.03 | 0.978 |
| Pressure pain threshold (kPa) | | | | | |
| | Control site | 242.79 (120.25) | 228.51 (140.43) | -14.28 | 0.239 |
| | Pain site | 252.6 (128.6) | 277.22 (175.06) | 24.62 | 0.360 |

**Abbreviations:** QST, quantitative sensory testing; SD, standard deviation

satisfied to very satisfied) and pain self-management (92.9% were satisfied to very satisfied).

### Fitbit compliance

In total, 30 participants (75%) were included in the Fitbit analysis. Of the remaining 10 participants, eight dropped out of the study, one participant's Fitbit data were missing due to the replacement of the device, and one participant reported unexpectedly high physical activity (outlier) and was excluded from the analysis. Figure 2displays the average Fitbit compliance rate from 7 am to 11 pm for each week of the study and for each participant. A decreasing trend in the compliance rate was observed over time (Fig. 2A), from 80.5% at week 1 to 53.8% at week 12. The overall compliance rate from 7 am to 11 pm varied among the participants (Fig. 2B), ranging from 28.9 to 93.4%. The average compliance rate of all participants was 69.5%. Nearly 83% of the participants reported that the feedback provided by Fitbit was helpful, while 58.6% reported that Fitbit helped them achieve their pain self-management goals. Approximately 65% of participants found it easy to use the Fitbit device in pain self-management, and 71% recommended using it to increase physical activity. The overall level of satisfaction with the Fitbit device in pain self-management was rated as satisfied by 89.6% of the sample.

### Biospecimen collection

A total of 33 blood samples (82.5%) were collected at the baseline visit and 25 blood samples (62.5%) were collected at the final visit. We collected buccal cell samples from seven participants because of small or hard-to-find veins. Therefore, 80% of the participants (n=32) completed the biomarker assessment.

### Intervention efficacy

We observed decreasing trends in the intensity of cLBP after participants received the PROPEL intervention. Figure 3 presents the subject trajectories and the decreasing sample mean curves of BPI worst pain, BPI least pain, BPI average pain, BPI right now pain, BPI pain severity, BPI total pain, BPI pain interference, and PROMIS-Pain Intensity.

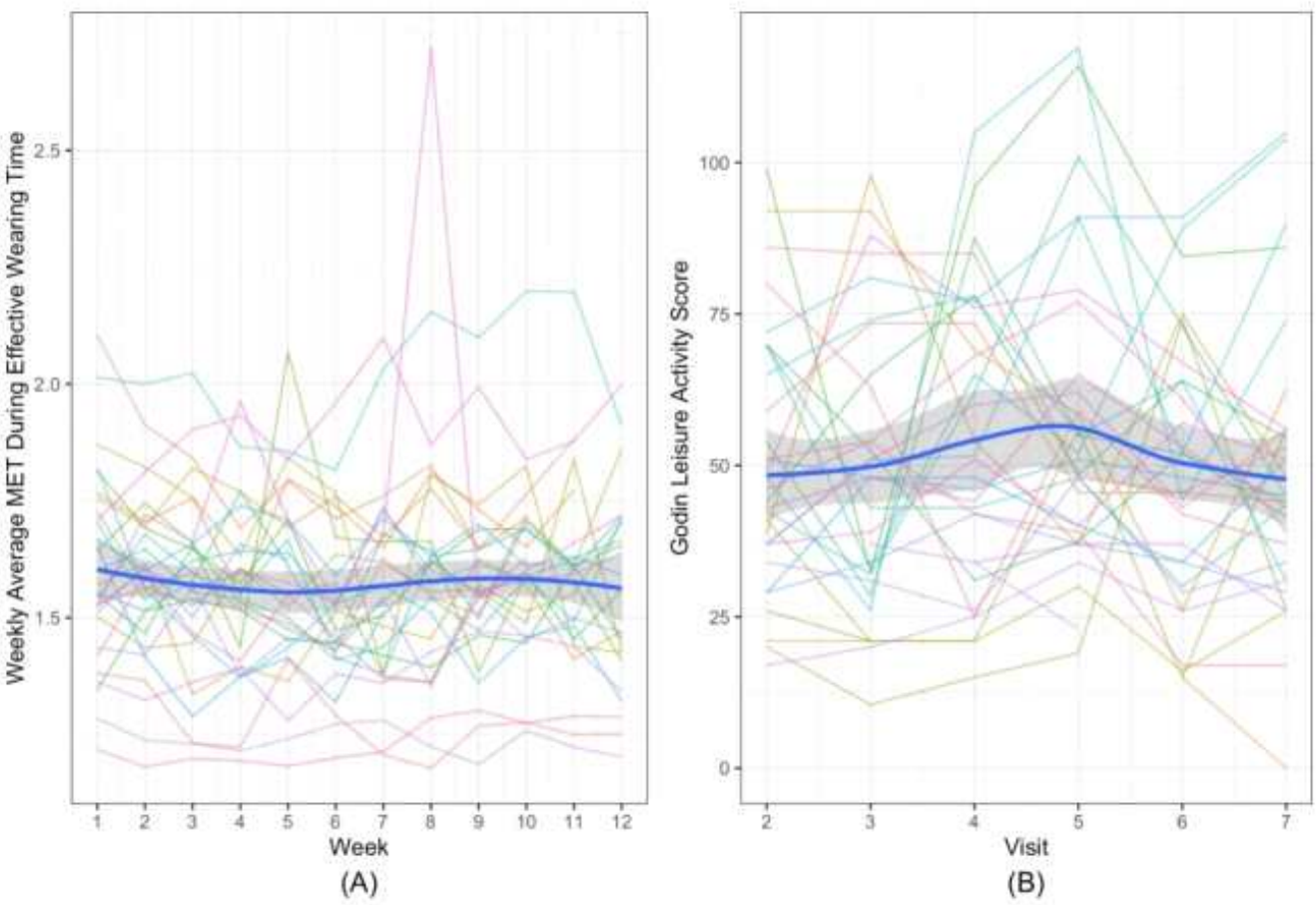


**Fig. 4** Subject trajectories and mean curves of Fitbit and Godin-Leisure physical activity measurements. (**A**) Weekly average MET during the effective wearing time of each participant. (**B**) Longitudinal Godin-Leisure activity scores of each participant. Each trajectory represents one participant's longitudinal measurements during the PROPEL study, and the blue curves represent the average level of all participants
Abbreviations: MET, metabolic equivalent; PROPEL, Problem-Solving Pain to Enhance Living Well

Table 2 shows the results of the two-sample paired t-test used to detect the mean difference in pain outcomes between the baseline and 12-week follow-up visits. Participants reported significantly decreased BPI worst pain (d = -1.68, p=0.003), BPI average pain (d = -1.61, p<0.001), BPI right now pain (d = -0.97, p=0.020), BPI pain severity (d = -1.20, p=0.004), BPI total pain (d = -10.23, p=0.004), BPI pain interference (d = -0.77, p=0.020), and PROMIS-Pain Intensity (d =-5.61, p=0.002) between pre- and post-intervention. Cohen's D values indicated medium to large effect sizes for BPI worst pain (D=0.57), BPI average pain (D=0.77), BPI pain severity (D=0.56), BPI total pain (D=0.54), and PROMIS-Pain Intensity (D=0.62).

Table 3 shows the changes in the 12 QST measurements from the baseline visit to the last visit on both the control site and the pain site (n=32). Only the warm detection threshold (WDT) at the pain site significantly increased (d=0.26, p=0.029) between the two visits, which showed that the participants' sensitivity to detecting warm temperatures at the pain site increased after the PROPEL intervention.

Figure 4 A and 4B display the trajectory plots of the weekly average MET and Godin-Leisure activity scores, respectively. There was no clear increasing trend in physical activity levels over the 12 weeks of the study.

## Discussion

We demonstrated the acceptability and feasibility of an Internet-based dissemination of pain self-management video modules and multidimensional data collection from adults with cLBP. Using the REDCap links, participants completed 10 short video modules and provided self-reported data, including self-management variables and patient satisfaction. Most participants wore an activity tracker with no pain or discomfort,

and an online monitoring and storage system (Fitabase) using de-identified data was used to objectively measure physical activity levels. Participants' satisfaction with PROPEL, including activity tracking and nurse consultation, was reasonably high. We observed acceptable retention and completion/response rates for the intervention protocol.

The response rate of self-reported surveys and wearable activity tracking technology in our sample was comparable to that of other studies among people with cLBP [20 - 22]. Overall, the success of the protocol may have resulted from the level of participant training and the detailed information provided at baseline visits. It should be noted that approximately 40% of the sample were university students. Future research should investigate strategies to effectively reach out to diverse subgroups of people with cLBP who may face challenges in participating in clinical trials. Most participants reported that wearing the activity tracker for over three months in the Fitbit satisfaction survey was not challenging. Our study's definition of valid activity tracking data was comparableto that of studies commonly defining approximately 10 - 12 h of valid activity data as acceptable [23, 24].

Both baseline and 12-week follow-up visits involved surveys, QST measurements, and venipuncture for genetic markers. Despite the perceived concerns of participant burden, they were generally favorable toward our study protocol, including QST measures that involve noninvasive techniques to characterize pain phenotypes and can offer tailored exercise strategies [6]. Further research warrants describing pain phenotypic profiles and if and how exercise-based self-management interventions can change ones' pain phenotypes in a largescale randomized controlled trial. Of the 32 participants who visited the research suite for a 12-week follow-up period, only 25 blood samples were collected, which may be associated with the participants' physiology and the research team's experience. Our success rate of peripheral intravenous catheter insertion was 78.1% (25/32), slightly higher than studies reporting rates from 65 to 73% in the emergency department [25] and up to 65% in the hospital medical ward [26, 27].

We successfully delivered 10 short video modules focusing on pain physiology and pain management strategies, such as deep breathing and relaxation. Participants reported that receiving links (video URLs) for modules was convenient and helped them complete the modules based on their schedule. Existing studies mainly used REDCap links to collect self-reported data [28]; our study successfully disseminated video modules and tracked participants' activities, enhancing the fidelity of our study protocol.

### Challenges and lessons learned

We acknowledge some challenges experienced in conducting his study. First, although the intensive data collection schedule was communicated during the consent procedures, not all participants were able to engage throughout the data collection process. The research team made substantial efforts to set up and execute the study protocol, from scheduling baseline visits to collecting patient satisfaction data and following up with the participants. Researchers and clinicians in regions with limited resources might be cautious about the implementation of the PROPEL intervention due to the intensive multidimensional data collection. However, continued research on pain phenotyping can simplify QST measurements and generic markers needed for the patient classification for tailored interventions among individuals with cLBP.

Bi-weekly nurse consultations, in particular, need consideration to accommodate each participant's course and work schedule to avoid deviating from the study protocol. The maximum number of contact attempts was set a priori as a limit of three times over 2 - 3 day intervals. In some cases, we failed to retain participants despite multiple attempts. Innovative strategies to efficiently maintain high retention rates, such as using social media or a study Internet site, have been discussed [29]. Social media has recently been considered as a platform for disseminating research information and keeping participants engaged. We must also acknowledge the importance of understanding the target population's characteristics, emphasizing study benefits and commitments, including expectations, and being flexible in accommodating participants' needs [30].

Data recorded by Fitbit device needed additional data processing procedures to achieve an appropriate analysis. Due to the limitation of Fitbit Flex 2, true sedentary time, sleeping time,

and unoccupied time were all recorded as sedentary time in the Fitbit database. If a participant did not wear the Fitbit device continuously, the duration of different levels of active time recorded by Fitbit Flex 2 did not reflect the true activity variability. Since this type of "missing" data cannot be identified in the Fitbit data set, the statistical missing data algorithm cannot be applied. Therefore, we calculated the average MET level on the approximated effective wearing time to obtain a fair comparison of physical activity across the participants. More accurate and reliable measurements of physical activity are required for future studies based on data collected using Fitbit Flex 2.

The inter-and intra-rater reliability of the QST protocol is acceptable for determining somatosensory abnormalities in multiple areas [31 - 33]. Additionally, we conducted a series of hands-on trainings in QST, and written protocols were available to all research team members. These efforts made QST measurements feasible in this study, and only one participant declined the QST at the 12-week follow-up.

The participants' satisfaction with the video modules offered by the REDCap links was high. Using the REDCap system, we tracked when each participant started watching the video module. A nurse research staff member also invited the participants to discuss the video modules and self-management barriers during the consultation. However, as in other studies using online modules, we could not monitor participants' retention of information.

Technology-based interactive modules, such as online quizzes, drag-and-drop activities, and game-type activities, can be considered to enhance participants' learning experiences.

### Implications and contributions to research and practice

Pain is a complex condition involving bio-psychosocial factors that require multidimensional assessment and personalized management to improve health outcomes. Due to the refractory nature of non-specific cLBP, a selfmanagement program that often involves intensive education and training is crucial for empowering patients to manage their pain. Multidimensional assessment of the PROPEL intervention using biospecimen collection, wearable activity tracking technology, and the REDCap system appeared to be feasible. Self-management interventions delivered via technology have great potential to reach diverse, possibly hard-to-reach populations and offer personalized pain self-management interventions by integrating pain phenotypes, genetic markers, and physical activity types affecting pain conditions.

### Conclusions

This one-arm longitudinal study demonstrated adequate feasibility and acceptability of the PROPEL intervention and research protocol, and preliminary efficacy for improving cLBP outcomes. Additional research is needed to integrate strategies for increasing physical activity and measurement over time in people with cLBP, as well as a clinical trial of the PROPEL intervention with a control group to determine its effectiveness in a larger sample. As more robust evidence is needed to identify the most effective components of pain self-management for cLBP, this study is the first step in contributing to the evidence base. Overall, the results are promising and support continued research on PROPEL selfmanagement interventions for individuals with cLBP.

### Acknowledgements

We would like to thank all the patients with chronic low back pain who participated in this study; research assistants, Drs. Jie Chen and Zahra Barandouzi; Ms. Yuxuan Yang, Mrs. Tumilara Amoo, and Mr. Joseph Fetta; and pilot advisors, Drs. Michael Fendrich, Howard Tennen, and Stephen Walsh.

### Authors' contributions

WX contributed substantially to data collection and interpretation and drafted and revised the work. YZ conducted the data analysis and interpretation and drafted and revised the work. ZW performed data collection and analysis and drafted and revised the work. SG and AS contributed to conceptualizing and designing the study and reviewing and revising the work. KK made substantial contributions to conceptualizing and designing the study and drafting, reviewing, and revising the manuscript. All authors read and approved the final manuscript.

**Funding**

This study was supported by the National Institutes of Nursing Research of the National Institutes of Health under Award Number NIH-NINR P20NR016605 (PI: Starkweather) - Pilot 3 subaward (PI: Kim/Xu) and grants from Korea University Nursing Research Institute.

**Data Availability**

The data will be available upon reasonable request. Please contact the corresponding author for data requests.

**Declarations**

**Ethics approval and consent to participate**

This study was approved by the Ethics Committee of the University of Connecticut (IRB# H18-086). All methods were performed in accordance with the relevant guidelines and regulations. Trained research assistants screened the interested volunteers during a confidential phone call to determine their eligibility. After providing volunteers with the study objectives, methods, and the voluntary nature of the study participation, written informed consent was obtained from each individual by the study staff.

**Consent for publication**

Not applicable.

**Competing interests**

The authors have no conflicts of interest to report.

**Author details**

1 University of Connecticut School of Nursing, Storrs, Connecticut, USA

2 Center for Advancement in Managing Pain, University of Connecticut, Storrs, Connecticut, USA

3 Department of Statistics, University of Connecticut, Storrs, Connecticut, USA

4 School of Nursing, University of Maryland, Baltimore, USA

5 University of Florida College of Nursing, Gainesville, USA

6 College of Nursing, Korea University, 145 Anam-ro, Seongbuk-Gu, Seoul, South Korea

7 Nursing Research Institute, Korea University, Seoul, South Korea

8 BK21 FOUR R&E Center for Learning Health Systems, Korea University, Seoul, South Korea

Received: 8 December 2022 / Accepted: 31 May 2023

**References**

1. Dahlhamer J, Lucas J, Zelaya C, et al. Prevalence of chronic pain and highimpact chronic pain among adults - United States, 2016. MMWR Morb Mortal Wkly Rep. 2018;67:1001 - 6.

2. Wu A, March L, Zheng X, et al. Global low back pain prevalence and years lived with disability from 1990 to 2017: estimates from the global burden of Disease Study 2017. Ann Transl Med. 2020;8:299.

3. Vos T, Flaxman AD, Naghavi M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990 - 2010: a systematic analysis for the global burden of Disease Study 2010. Lancet. 2012;380:2163 - 96.

4. Dieleman JL, Cao J, Chapin A, et al. US health care spending by payer and health condition, 1996 - 2016. JAMA. 2020;323:863 - 84.

5. Stevans JM, Delitto A, Khoja SS, et al. Risk factors associated with transition from acute to chronic low back pain in US patients seeking primary care. JAMA Netw Open. 2021;4:e2037371.

6. Starkweather AR, Heineman A, Storey S, et al. Methods to measure peripheral and central sensitization using quantitative sensory testing: a focus on individuals with low back pain. Appl Nurs Res. 2016;29:237 - 41.

7. Cleeland C. Pain assessment in cancer. In: Osoba D, editor. Effect of cancer on quality of life. Boca Raton, FL: CRC Press; 1991. pp. 293 - 305.

8. Qaseem A, Wilt TJ, McLean RM, et al. Noninvasive treatments for acute, subacute, and chronic low back pain: a clinical practice guideline from the American College of Physicians. Ann Intern Med. 2017;166:514 - 30.

9. Geneen LJ, Moore RA, Clarke C, et al. Physical activity and exercise for chronic pain in adults: an overview of Cochrane Reviews. Cochrane Database Syst Rev. 2017;4:Cd011279.

10. United States Department of Health and Human Services Interagency Pain Research Coordinating Committee. National pain strategy: a comprehensive population health-level strategy for pain. Washington, D.C: United States Department of Health and Human Services; 2017.

11. Lorig KR, Holman H. Self-management education: history, definition, outcomes, and mechanisms. Ann Behav Med. 2003;26(1):1 - 7.

12. Ryan P, Sawin KJ. The Individual and Family Self-Management Theory: background and perspectives on context, process, and outcomes. Nurs Outlook. 2009;57(4):217 - 225e216.

13. Du S, Hu L, Dong J, et al. Self-management program for chronic low back pain: a systematic review and meta-analysis. Patient Educ Couns. 2017;100(1):37 - 49.

14. Kim K, Ramesh D, Perry M, et al. Effects of physical activity on neurophysiological and gene expression profiles in chronic back pain: study protocol. Nurs Res. 2020;69(1):74 - 81.

15. Polaski AM, Phelps AL, Szucs KA, et al. The dosing of aerobic exercise therapy on experimentally-induced pain in healthy female participants. Sci Rep. 2019;9(1):14842.

16. Verchota G, Sawin KJ. Testing components of a self-management theory in adolescents with type 1 diabetes mellitus. Nurs Res. 2016;65(6):487 - 95.

17. Zaharova S, Litwack K, Gopalakrishnan S, et al. Self-management in heart failure: the importance of self-regulation but not complexity of condition. West J Nurs Res. 2022;44(4):375 - 82.

18. Rolke R, Baron R, Maier C, et al. Quantitative sensory testing in the german research network on neuropathic pain (DFNS): standardized protocol and reference values. Pain. 2006;123:231 - 43.

19. Godin G. The Godin-Shephard leisure-time physical activity questionnaire. The Health & Fitness Journal of Canada. 2011;4:18 - 22.

20. Amorim AB, Pappas E, Simic M, et al. Integrating Mobile-health, health coaching, and physical activity to reduce the burden of chronic low back pain trial (IMPACT): a pilot randomised controlled trial. BMC Musculoskelet Disord. 2019;20:71.

21. Gordon R, Bloxham S. Influence of the Fitbit Charge HR on physical activity, aerobic fitness and disability in non-specific back pain participants. J Sports Med Phys Fitness. 2017;57:1669 - 75.

22. Cajita MI, Kline CE, Burke LE, et al. Feasible but not yet efficacious: a scoping review of wearable activity monitors in interventions targeting physical activity, sedentary behavior, and sleep. Curr Epidemiol Rep. 2020;7:25 - 38.

23. Ward WH, Meeker CR, Handorf E, et al. Feasibility of fitness tracker usage to assess activity level and toxicities in patients with colorectal cancer. JCO Clin Cancer Inform. 2021;5:125 - 33.

24. Nam S, Dunton GF, Ordway MR, et al. Feasibility and acceptability of intensive, real-time biobehavioral data collection using ecological momentary assessment, salivary biomarkers, and accelerometers among middle-aged African Americans. Res Nurs Health. 2020;43:453 - 64.

25. Carr PJ, Rippey JCR, Cooke ML, et al. Factors associated with peripheral intravenous cannulation first-time insertion success in the emergency department. A multicentre prospective cohort analysis of patient, clinician and product characteristics. BMJ Open. 2019;9:e022278.

26. Helm RE, Klausner JD, Klemperer JD, et al. Accepted but unacceptable: peripheral IV catheter failure. J Infus Nurs. 2015;38:189 - 203.

27. Xu Y, Lau Y, Cheng LJ, et al. Learning experiences of game-based educational intervention in nursing students: a systematic mixed-studies review. Nurse Educ Today. 2021;107:105139.

28. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42:377 - 81.

29. Frampton GK, Shepherd J, Pickett K, et al. Digital tools for the recruitment and retention of participants in randomised controlled trials: a systematic map. Trials. 2020;21:478.

30. Abshire M, Dinglas VD, Cajita MIA, et al. Participant retention practices in longitudinal clinical research studies with high retention rates. BMC Med Res Methodol. 2017;17:30 - 0.

31. Pigg M, Baad-Hansen L, Svensson P, et al. Reliability of

intraoral quantitative sensory testing (QST). Pain. 2010;148:220 - 6.

32. Felix ER, Widerström-Noga EG. Reliability and validity of quantitative sensory testing in persons with spinal cord injury and neuropathic pain. J Rehabil Res Dev. 2009;46:69 - 83.

33. Geber C, Klein T, Azad S, et al. Test-retest and interobserver reliability of quantitative sensory testing according to the protocol of the German Research Network on Neuropathic Pain (DFNS): a multi-centre study. Pain. 2011;152:548 - 56

# Pain self-management plus activity tracking and nurse-led support in adults with chronic low back pain: Feasibility and acceptability of the problem-solving pain to enhance living well (PROPEL) intervention

Wanli Xu[1,2], Yiming Zhang[3], Zequan Wang[1,2], Susan G Dorsey[4], Angela Starkweather[5] and Kyounghae Kim[6,7,8*]

[1] University of Connecticut School of Nursing, Storrs, Connecticut, USA
[2] Center for Advancement in Managing Pain, University of Connecticut, Storrs, Connecticut, USA
[3] Department of Statistics, University of Connecticut, Storrs, Connecticut, USA
[4] School of Nursing, University of Maryland, Baltimore, USA
[5] University of Florida College of Nursing, Gainesville, USA
[6] College of Nursing, Korea University, 145 Anam-ro, Seongbuk-Gu, Seoul, South Korea
[7] Nursing Research Institute, Korea University, Seoul, South Korea
[8] BK21 FOUR R&E Center for Learning Health Systems, Korea University, Seoul, South Korea

**Background** Chronic low back pain can lead to individual suffering, high medical expenditures, and impaired social well-being. Although the role of physical activity in pain management is well established, the underlying mechanisms of biological and clinical outcomes are unknown. This study aimed to assess the feasibility and acceptability of a pain self-management intervention, Problem-Solving Pain to Enhance Living Well, which employs wearable activity tracking technology and nurse consultations for people with chronic low back pain.

**Methods** This one-arm longitudinal study recruited 40 adults aged 18–60 years with chronic low back pain. Over 12 weeks, participants watched 10 short video modules, wore activity trackers, and participated in nurse consultations every 2 weeks. At baseline and the 12-week follow-up, they completed study questionnaires, quantitative sensory testing, and blood sample collection.

**Results** Forty participants were recruited, and their mean age was 29.8. Thirty-two participants completed the survey questionnaire, quantitative sensory testing, Fitbit activity tracker, and bi-weekly nurse consultation, and 25 completed the evaluation of biological markers. The overall satisfaction with the Problem-Solving Pain to Enhance Living Well video modules, nurse consultations, and Fitbit in pain management was rated as excellent. No adverse events were reported. Between the baseline and 12-week follow-up, there was a significant decrease in pain intensity and interference and an increase in the warm detection threshold at the pain site.

**Conclusions** Despite concerns about the participant burden due to multidimensional assessment and intensive education, the feasibility of the Problem-Solving Pain to Enhance Living Well intervention was favorable. Technology based self-management interventions can offer personalized strategies by integrating pain phenotypes, genetic markers, and physical activity types affecting pain conditions.

**Trial registration** This pilot study was registered with ClinicalTrials.gov [NCT03637998, August 20, 2018]. The first participant was enrolled on September 21, 2018.

**Keywords** Activity tracking, Chronic low back pain, Self-management

* *Address reprint requests to : Kyounghae Kim*
College of Nursing, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul 02841, South Korea.
E-mail: kyounghaekim@korea.ac.kr

**간호학 논집** 제 25권

인 쇄 : 2023. 12. 31.

발 행 : 2023. 12. 31.

발행처 : 고려대학교 간호학연구소
서울시 성북구 안암로 145 (02841)
Tel: 02-3290-4697, Fax: 02-928-9108
E-mail: nursing_research@korea.ac.kr

발행인 : 신 나 미