

**LITERATURE REVIEW****Smartphone-Based Kegel Exercises for Stress Urinary Incontinence: A Systematic Review and Meta-Analysis of RCT**

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Abstract

Introduction : To evaluate the effectiveness of smartphone-based applications in supervising Kegel exercises for women with Stress Urinary Incontinence (SUI), specifically in improving treatment adherence and reducing symptom severity as measured by the ICIQ-UI-SF score.

Method : This study compares smartphone-based applications for supervising Kegel exercise in women with SUI. Article retrieved from 3 databases using specific keywords. ICIQ-UI-SF scores and adherence data is the main outcome in this article.

Results : Five RCTs with a total of 475 participants were included. Three studies demonstrated improved adherence among intervention groups using smartphone applications. Meta-analysis revealed that application based supervision resulted in significantly better post-treatment ICIQ-UI-SF Score (SMD: -0.46, CI [-0.65,-0.28], $p < 0.00001$)

Conclusion : Smartphone applications as a supervision tool for SUI patients who underwent Kegel exercise as a conservative treatment is proven to reduce severity and increasing adherence of the therapy.

Keywords: Kegel exercise, pelvic floor muscle training, application, supervision, conservative

INTRODUCTION

Stress Urinary Incontinence (SUI) was defined by International Continence Society (ICS) by complaint of any involuntary loss of urine on effort or physical exertion (e.g. sport activities) or on sneezing or coughing.¹ Globally, 5-70% women reported had a SUI. ² In Asia, a study that was held in China reported prevalence of urinary incontinence at 22.1% among women in China with stress urinary incontinence as the most prevalent (12.9%). ³ Study that was held by Ratuaeni et al. showed that there are 19.90% women with urinary incontinence, with 7.33% are stress urinary incontinence. ⁴ This disease has had a significant impact on women's life, Study from Po-ming et al. shows that Stress Urinary Incontinence (SUI) are affecting women from multiple aspects including reduced quality of life, increased depression and anxiety, and also work difficulties.⁵ According to guidelines by ICS, Pelvic Floor Muscle Training (PFMT) or Kegel Exercises is an initial standard conservative treatment for SUI. To have a significant impact on PFMT, patients need to do it in 6-12 weeks, 2-12 times a day for at least 2-3 times a week.⁶⁻⁸ Aside from repetition, adherence to PFMT is a key to gain effectiveness. Many patients had complaints about forgetting, not prioritising, and not perceiving the benefits of PFMT.^{9,10}

Until now, smartphone availability is increasing. Mobile health apps are growing. giving us a new growing field and era of therapy.¹¹ Mobile health app giving patients an access to healthcare for seeking information and therapy. it's already suggested that health apps can increase patient's adherence for disease management.¹²⁻¹⁴ Driven by a vision to enhance the effectiveness of therapy, particularly Kegel exercises as a conservative management of SUI, utilizing the advancements of technology and information worldwide, this article was written to compare the effectiveness of smartphone applications as a tools to supervising Kegel exercises in patients with SUI. It is hoped that this article will inspire readers to consistently innovate in the management of pelvic floor dysfunction.

METHODS

Search Strategy

Database searching was conducted from November 2024 to January 2025 using three separated databases (Scholar, Scopus, and PubMed). Articles that are included in this study are written in English or Indonesian. The Keyword that was used in literature searching was discussed and finalized by all of the authors at the first meeting. Literature searching was conducted by all of the authors independently. Combination of words used in literature searching is ("Supervised" OR "Application" OR "Book") AND ("Kegel Exercise" OR "Kegel" OR "Pelvic Floor Muscle Training") AND ("Urinary Incontinence" OR "Urine Leak" OR "Stress Urinary Incontinence")

Eligibility Criteria

Inclusion criteria of the systematic review are : (a) Study written in English or Indonesia, (b) article published from 2000-2024, (c) controlled trials, (d) adult female with stress urinary incontinence, (d) studies involving Kegel exercises as a treatment modality, (e) Using mobile phone application as a tool for supervising the treatment. Exclusion criteria are (a) a non-RCT studies, (b)

using surgical intervention, (c) full paper of the abstract that is not available.

Screening Procedure

Screening Procedure was carried out by all of the authors. First, all of the results from the authors were pooled and then screened for duplication of the article. After duplication was excluded, eligibility criteria were conducted for choosing the articles. When choosing the articles, all of the authors participated. If there is a disagreement on selecting the articles, solved by the first author. After all eligible articles are selected, the full-text availability of each is checked, resulting in the article ready to be synthesized.

Risk of Bias Assessment

Risk of bias assessment conducted using a tool recommended by Cochrane, the "Revised Cochrane Risk-of-Bias Tool for Randomized Trials (RoB 2)."¹⁵ The analysis was performed independently by two reviewers (AK and VH) based on the items in RoB 2, with conclusions categorized into three groups: "Low Risk," "Some Concerns," and "High Risk," following the established guidelines. The results of the risk of bias assessment are presented in graphical form.

Data Extraction and Meta-analysis

The data that has been synthesized from the selected articles includes the author's name, year of publication, sample size, ICIQ-UI score use as a measurement of disease severity (mean and standard deviation) from two categories in pre- and post-intervention, the Kegel application that used in the trial.¹⁶ The synthesized ICIQ-UI scores are used as the base for creating a meta-analysis. The meta-analysis is conducted using RevMan 5.0, with the standardized mean difference calculated based on the mean, standard deviation, and sample size. The meta-analysis data is presented as a forest plot diagram.

Ethical Approval

This article presents a systematic review and meta-analysis of studies that have already been conducted. As this project did not involve human or animal subjects, this article did not need Ethical approval.

RESULT

Literature Searching

From 3 databases, 148 articles were found and screened. 40 articles were excluded from the study due to duplication issues. From 108 articles, screening and retrieval were conducted, resulting in 40 articles not found during the phase. 68 articles were analyzed based on eligibility criteria, 25 articles were found not being written in English or Indonesian, 38 articles were excluded due to lack of full-text availability. Finally, this systematic review and meta-analysis included 5 studies for synthesis. The literature searching flowchart is shown in figure 1.

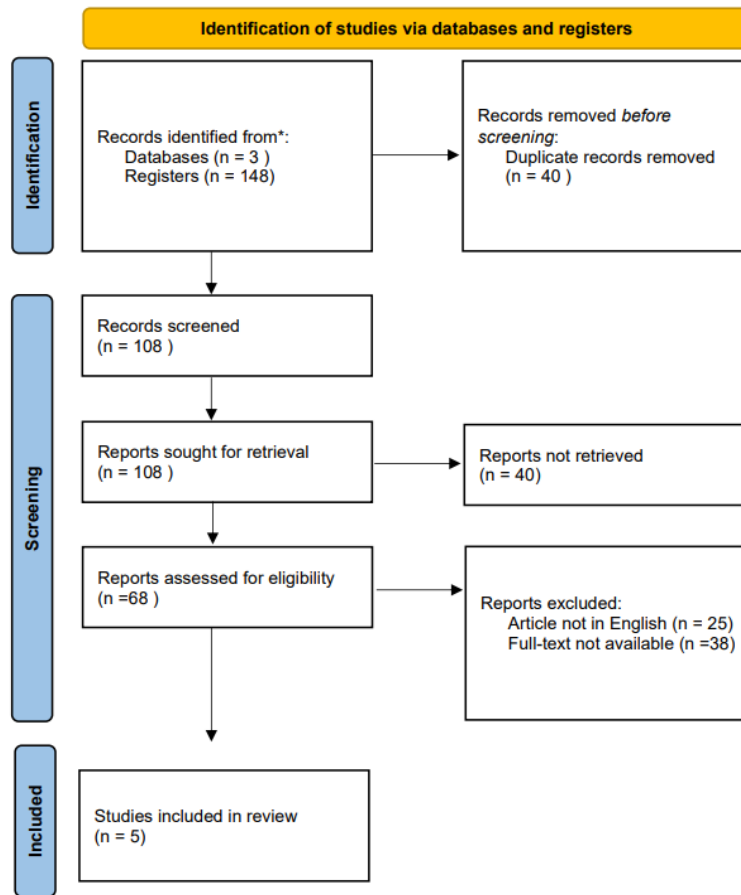


Figure 1. Flowchart of literature searching

Risk of Bias

RoB 2 results are presented in Figure 2 and 3. All of the studies were considered low risk for overall score.¹⁷⁻²¹ From domain 2 analysis, 4 studies considered had some concerns due to deviation from intervention.¹⁷⁻²⁰ Domain 3 analysis 2 studies considered had some concerns due to missing outcome data.²⁰ Domain 4 analysis, 1 studies considered had some concerns due to outcome measurement bias.¹⁷ all of the studies considered low risk on domain 5. Figure 2 showed that there is a significant proportion of studies that had some concerns in domain 2 and domain 3.

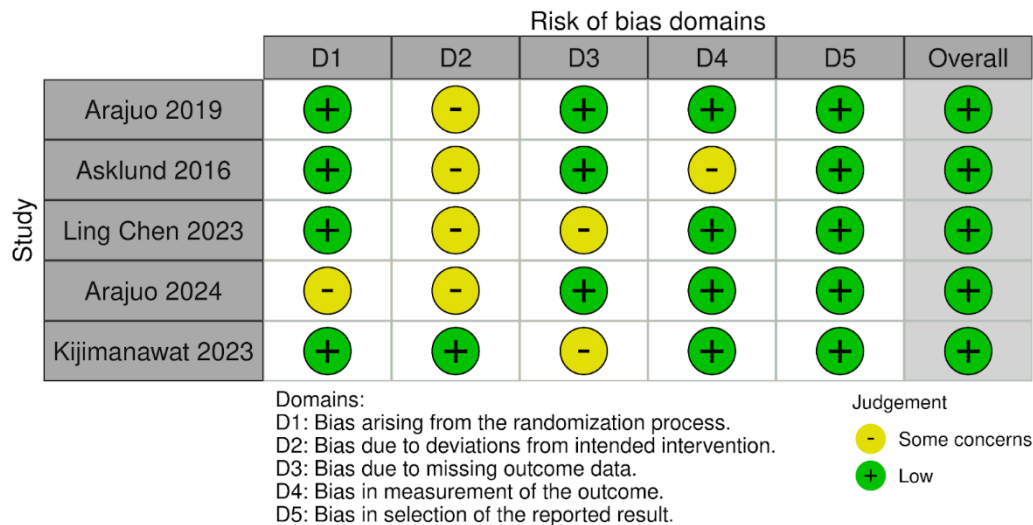


Figure 2. Traffic-light Plot of the bias risk

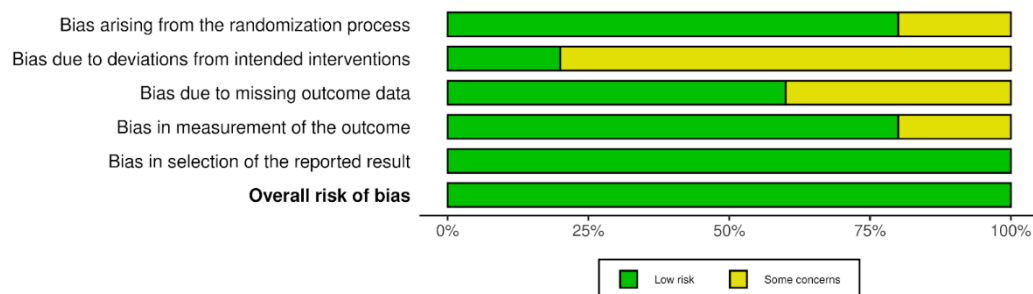


Figure 3. Summary Plot of the Bias Risk

Patient and Study Characteristics

Five of the study that included were an RCT.¹⁷⁻²¹ Four articles assessed an SUI on non-pregnant women,^{17-19,21} one of the articles assessed SUI on pregnant women.²⁰ The focus of those 5 studies is to assess effect of using mobile smartphone application-based Pelvic floor muscle training on the severity of urinary incontinence among female. The severity of UI was assessed by ICIQ-UI form in all articles. Types of smartphone applications are different in every article. From all of the studies included, 475 patients were obtained. Out of 5 studies, 3 studies included the analysis of adherence to pelvic floor muscle training among groups.^{17,19,21} Summary of the study characteristics that included this review was obtained on table 1.

Table 1. Summary of Patients and Study Characteristic

Article	Study Design	Country	Number Participants	of	Applicati on Name	Study Population
Arajuo (2019)	Randomized Controlled Trial	Brazil	21		Diario Saude®	Women with self reported SUI symptoms, Cough test positive Women ages 18 years and older who had symptoms of SUI mere than 1 episodes/week for the last 6 month (urine leakage upon coughing, sneezing, or physical activity, without urge symptoms).
Asklund (2016)	Randomized Controlled Trial	Sweden	123		Tat®	Singleton pregnant women without incontinence before pregnancy who were aged ≥18 years and between 24 and 28 weeks of gestation women ages 18 years and older who exhibited symptoms of SUI defined by ICS
Ling Chen (2023)	Randomized Controlled Trial	China	126		Urinary incontine nce for Women (UIW)®	
Arajuo (2024)	Randomized Controlled Trial	Brazil	154		Diario Saude®	
Kijmanawat (2023)	Randomized Controlled Trial	Thailand	51		Not Stated	SUI Patients confirmed with one hour pad test, post void residual volume, and urine analysis

Results of Adherence to PFMT

3 studies analyzed the adherence of PFMT in the women with and without application.^{17,19,21} Arajuo et al. measured the adherence among the intervention group using its application and counted the number of protocols that were accessed. In the control group, adherence was assessed by counting the number protocols that were repeated using self-reported diary paper. Among the intervention group, 43.8 protocols were done. On the other hand the control group had done 17.7 protocols. More protocols that are performed show more adherence to the PFMT.¹⁹ Asklund et al. measured the adherence using follow-up interviews in both groups. 41% of the patients in

intervention groups were doing PFMT daily, 42% doing PFMT weekly, and 14.8% sporadically. On the control group, 3.3% doing PFMT daily, 13.3% weekly, 56.7% sporadically, and 26.7% was not performed PFMT.¹⁷ Kijmanawat et al. assessing the adherence using the application itself in the intervention group and self-reported paper in the control group. Numbers of contraction that are performed are calculated using formula (contraction performed / expected number x 100%) resulting in the percentage of adherence. 59.1% was obtained in the intervention groups after 12 weeks of intervention. 37.8% was obtained in the control group after 12 weeks of intervention.²¹

Meta-analysis Results

5 studies were included in meta-analysis. ICIQ-UI score post-treatment with PFMT in two groups are pooled. Baseline and results ICIQ-UI scores from all studies are pooled on Table 2. Asklund et al and Chen et al. show that application based significantly more performed on the post treatment ICIQ-UI score rather than the standard method (SMD: -0.95; CI [-1.32,-0.57]); (SMD : -0.68; CI [-1.04,-0.32]).^{17,20} On the other hand, three studies have not shown significant differences in ICIQ-UI Score in both groups.^{18,19,21} Pooled effect size, represented by the diamond at the bottom, showed moderate statistically significant advantages for app-based supervision and therapy on post-treatment ICIQ-UI score rather than standard method groups (SMD : -0.46, CI [-0.65,-0.28]). From the Z score and P value, we can see that application-based supervision and therapy is more favourable than the standard method (Z=4.92, P <0.00001). However, The analysis highlights the heterogeneity among the studies that included, with an I^2 value of 73%, there is a high heterogeneity on this analysis (figure 4). Subgroup analysis was conducted to analyze the outcome based on the region of study (inside and outside Asia). From the subgroup analysis, both subgroups showed significantly higher ICIQ-UI scores in the groups that received an app as a supervision tool for Kegel exercises (Outside Asia: SMD: -0.44, CI [-0.67, -0.20]; Asia: SMD: -0.5, CI [-0.81, -0.20]) (Figure 5–6). Both study groups demonstrated significantly moderate-to-high heterogeneity. In the subgroup of studies conducted outside Asia, there was an increase in heterogeneity compared to the main analysis (I^2 = 83%). In contrast, the subgroup of studies conducted in Asia showed a decrease in data heterogeneity compared to the main analysis (I^2 = 67%).

Table 2. Pooled ICIQ-UI Score Across included Studies

Article	Pre-Intervention ICIQ-UI Score (Mean $\pm$ SD)		Post-Intervention ICIQ-UI Score (Mean $\pm$ SD)	
	Control	Intervention	Control	Intervention
Arajuo 2019	15.9 $\pm$ 4.7	16.3 $\pm$ 4	9.7 $\pm$ 6.6	9.1 $\pm$ 6.6
Chen (2023)	4.30 $\pm$ 4.09	4.98 $\pm$ 4.04	4.30 $\pm$ 4,38	1.85 $\pm$ 2.66
Arajuo (2024)	14.4 $\pm$ 3.6	14.7 $\pm$ 3.7	12.1 $\pm$ 4.7	11.5 $\pm$ 5
Asklund (2016)	11.0 $\pm$ 2.6	11.1 $\pm$ 3.0	10.2 $\pm$ 3.2	7.0 $\pm$ 3.5
Kijmanawat (2023)	8.0 $\pm$ 2.3	8.5 $\pm$ 2.6	5 $\pm$ 5.5	4.5 $\pm$ 5

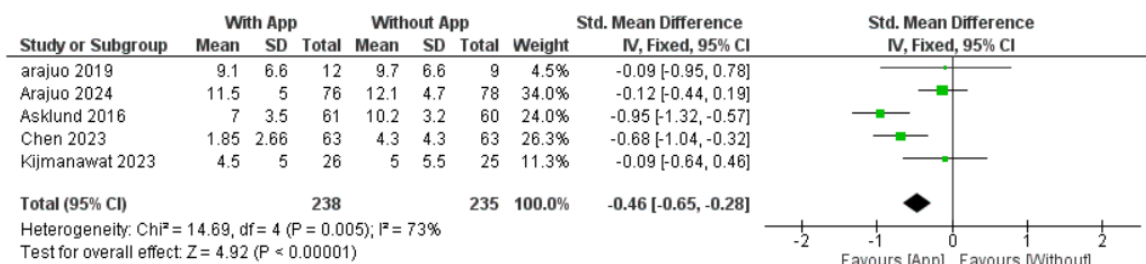


Figure 4. Forest-plot of the post-treatment ICIQ-UI score of groups with and without App-based PFMT.

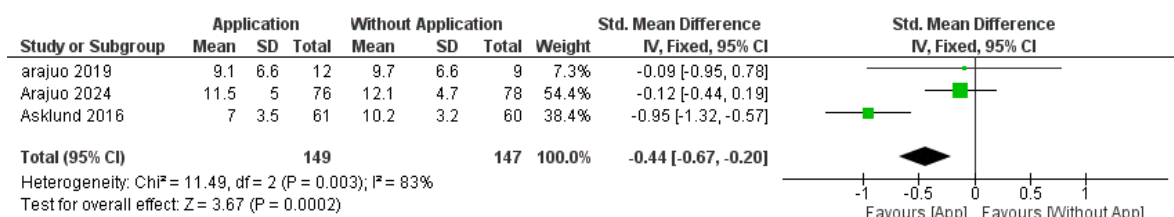


Figure 5. Forest-plot of the post-treatment ICIQ-UI score in both groups which studies conducted outside Asia

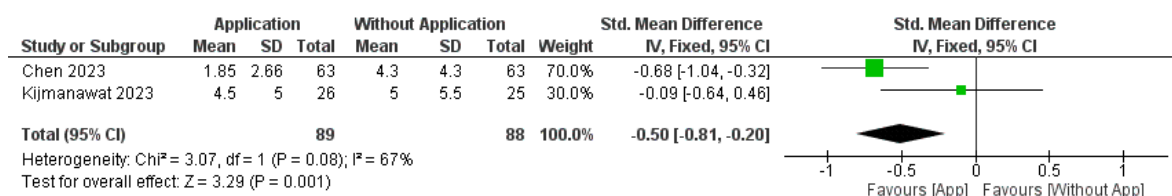


Figure 6. Forest-plot of the post-treatment ICIQ-UI score in both groups which studies conducted in Asia

DISCUSSION

Stress urinary Incontinence has been a burden globally. Chong et al (2011) analyzed that over 12 billion dollars has been spent for management of SUI in the United States, and the number is still growing due to the aging phenomenon in the population.²² Pelvic floor muscle training is one of the conservative treatments that are cost effective, Some literature said that pelvic floor muscle training / Kegel Exercises is as effective as surgery alone on half of women with SUI.²³ By strengthen the pelvic floor muscle, Stress urinary incontinence symptoms will be reduced.³³ Although it has good effectiveness, it takes time and good adherence for achieving good outcomes. Until now, It remains a challenge to make patients have a good adherence to Kegel Exercises.^{24,25,26}

It's undeniable that the development of information and technology worldwide has experienced rapid growth. In terms of healthcare fields, The use of smartphone applications as a platform for monitoring and supervising therapy has been employed in several previous studies.²⁷⁻³⁰ A meta-analysis study conducted to assess the effects of smartphone application use on patient adherence who had a chronic disease and need to take a routine medication. It's explained that smartphone-based application help patients, particularly in managing their medication use, providing reports, and offering education related to their condition.³⁰

In this article, Adherence systematic analysis was conducted and resulted in consistent with previous studies. Based on the three studies that included in this article, it was found that all studies reported increased adherence in patients undergoing Kegel exercise supervision using a smartphone application. The documentation feature in the application proved to be beneficial for both doctors and patients. This feature reduces the likelihood of patients forgetting to record their Kegel Exercises repetitions. For physicians, The exercise documentation can provide patient exercise data that can be used to evaluate adherence and the outcomes of the therapy regimen. This data can later be used to explain the progress of the therapy to the patients.

Previous research showed that patient adherence is one of the predictors for the outcomes in conservative treatment of SUI, Specially Kegel exercise. Poor adherence can results in suboptimal outcomes from Kegel exercise.⁹ Consistent with previous findings in this review regarding the increasing patients adherence using smartphone application as a tool, the meta-analysis results showed that post-intervention ICIQ-UI-SF scores were significantly better in the intervention group, which using the application. These findings strengthen the theory that adherence is directly proportional to the outcomes. In this study, the use of the app was proven to improve patient adherence, which had a positive impact on patients outcomes.

Currently in Indonesia, there is a supervision and monitoring tool for patients with Stress Urinary Incontinence (SUI) undergoing Kegel exercises as a conservative treatment. Surahman et al. in 2023 developed a Kegel exercises guidebook for women with SUI. This guidebook contains comprehensive information about SUI and Kegel exercises. Additionally, it includes questionnaires and documentation tools for Kegel exercises, as well as supplementary assessments for each SUI patient. The book features a follow-up sheet that allows documentation of both subjective and objective parameters. Subjective parameters are measured using the UDI-6 and IIQ-7

questionnaires, while objective parameters are assessed using the pad test and levator ani muscle tone measured via perineometer. Subsequent research by Surahman et al. demonstrated that patients who received the guidebook formulated as a supervision and monitoring tool showed better adherence and significant improvement in disease status based on objective measures compared to those who did not receive the guidebook.^{31,32}

Interestingly, subgroup analysis from recent studies showed that the use of smartphone applications as supervisory tools for Kegel exercises resulted in significantly improved outcomes, particularly in studies conducted in Asia (SMD: -0.5, 95% CI [-0.81, -0.20]). Moreover, these studies reported a reduction in heterogeneity ($I^2 = 67\%$) compared to the main analysis, indicating more consistent and applicable results within this region. This suggests that digital health tools, such as smartphone applications, may be more culturally and contextually compatible in Asian populations, including Indonesia. Considering this, Indonesia has the potential to further develop the existing guidebook into a smartphone-based application to enhance supervision and monitoring of SUI patients undergoing Kegel exercise therapy, thereby improving treatment adherence and clinical outcomes.

This study has a limitation in that it does not assess other aspects, particularly the risk factors for pelvic floor weakness, which is the underlying cause of stress urinary incontinence. As stated by Ermawati et al., the occurrence of pelvic floor weakness is strongly influenced by age, body mass index, and the number of childbirths a woman has experienced.³⁴ In addition, this study only evaluates the condition using subjective measures and does not utilize objective assessments such as pad tests or the daily urinary frequency of women. The strength of this article lies in the use of technological advancements as a solution to the management issues faced by patients, as well as in the findings of the study, which may serve as a recommendation for implementing the research in Indonesia.

CONCLUSION

Smartphone applications as a supervision tool for SUI patients who underwent Kegel exercise as a conservative treatment is proven to reduce severity and increasing adherence of the therapy.

LIMITATION

Research with current topics is still limited. Results from this paper had a persistent heterogeneity among studies. From the article that included, age hasn't yet to be considered as a factor influencing adherence. Another limitation was the improvement only assessed by ICIQ-UI-SF score which is only assessing subjective symptoms in patients.

RECOMMENDATION

The Idea of smartphone application as a supervision tool for women with SUI that undergo Kegel exercises as an management can be recommended in Indonesia. The app should be designed to be highly user-friendly and straightforward, considering the age and cognitive capabilities of both patients and caregivers. With those application that's developed, The opportunity for Future research with objective parameters can be done.

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