A SYSTEMATIC LITERATURE REVIEW FOR INTERFACE DESIGN OF PELVIC FLOOR MUSCLE TRAINING MOBILE APP BASE ON MHEALTH 2017-2022

Zao Yi, Nurul Hanim Romainoor

School of Arts,
Universiti Sains Malaysia, 11800 Penang, Malaysia.

Corresponding Author's Email: hanim.romainoor@usm.my

Article History: Received 29 March; Revised 30 April 2023; Accepted 25 May 2023

ABSTRACT: With the rapid development of information technology, mHealth has been applied to many medical and health fields. Pelvic floor muscle training (PFMT) is the first-line treatment for women with urinary incontinence(UI), and patients can self-manage and practice through the PFMT application. **Objective**: Review the existing research on the PFMT app, to identify what the current research concentrations are on. From which to find and summarize the research on PFMT existing obstacles and future improvement direction for app interface design. **Method**: Keywords were searched in three major citation databases: Web of Science, Scopus, and Dimensions to find the literature published. After screening the titles and abstracts of all retrieved citations with inclusion and exclusion criteria, the researchers need to review the full text and then final discussion and confirm the relevance of all included papers. First, identify the current research area on PFMT application from each paper. Second, the existing suggestion to improve interface design were extracted from certain topic research. Finally, the research topic classification and interface design problem summary are carried out. **Results:** A total of 26 papers and one supplement were included. 7 primary research directions were identified. 6 key issues and 3 crucial pages of interface design are sorted out. **Conclusion**: Many studies have suggested the necessity and estimation of interface redesign, but there is no advanced study and implementation. The interface design of the PFMT app is one of the important directions for future application iteration and upgrading.

KEYWORDS: *SLR; Interface Design; Mobile Application; Pelvic Floor Muscle Training; mHealth.*

1.0 INTRODUCTION

1.1 mHealth

In recent years, the rapid development of intelligent mobile devices and the explosive growth of various mobile applications have penetrated all aspects of our lives. To date, no standardized definition of mHealth has been established. For the survey, the WHO defined mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices [1].

Recent reports show that over 325,000 mHealth apps are available in major app stores, and more than 84,000 mHealth app publishers have entered the market [2]. Statistics currently include more than 165,000 mHealth apps focused on health management apps (such as fitness) and disease management apps (chronic diseases)[3]. The mHealth function in the United States and concentrate on helping patients manage their health and chronic diseases. Evidence suggests that mhealth can facilitate patient health management and help control costs [4]. As these mobile health applications proliferate, designing practical tools is becoming increasingly significant [5]. Despite numerous mobile health apps, a quarter of them are never used after installation; many are of subordinate quality and are not cautiously measured when developing the characteristics of their target user group [2]. Users often do not reuse apps that do not appeal to them immediately, undermining the potential effectiveness of interventions [6]. The environment used by mobile health apps is not fixed, and there is a lack of face-to-face guidance from medical personnel. Therefore, users need a well-designed interface and easy-use self-management tool (mobile app) that will appeal to them to persevere to achieve good intervention results.

1.2 PFMT app

The International Continence Society (ICS) defines urinary incontinence (UI) as an objectively verifiable, unconscious leakage of urine through the urethra that causes problems such as personal hygiene and social activities [7]. It is estimated that more than tens of millions of women worldwide have suffered from this disease, the incidence of which increases with age and has the characteristics of

rapid development and a large number, affecting the quality of life and physical and mental health of patients [8]. Although it does not threaten the life of patients, its high prevalence of medical charges is massive.

Pelvic Floor Muscle Training (PFMT) is the first-line treatment of UI [9], proposed by Dr. Arnold Kegel in the United States, also known as "Kegel Exercise". PFMT refers to repeated voluntary contraction and relaxation of specific pelvic floor muscle groups to recover pelvic floor muscle group and periurethral muscle strength, reinforce its supporting capacity, and refrain from urine leakage, promoting pelvic floor health [10]. The effectiveness of PFMT needs to follow two basic principles: the correctness of training methods and adherence to long-term training [11]. Self-management can effectively reduce incontinence symptoms, improve self-efficacy, and promote quality of life [12]. mHealth reduces the obstacles for UI patients to seek self-management due to its flexibility, convenience, and accessibility, which deliver their access to health information and adherence to treatment [13].

An interface is the contact point between humans and machines. A user interface on a computer, smartphone, tablet, or game console consists of a 'front-end' visually interactive face that communicates with a programmed delivery system 'back-end'. Through visual components, users can interact and achieve the results they want. A successful user interface design combines good usability, functionality based on user needs and expectations, and aesthetics that promote successful results [14]. The quality of the interface directly affects the user experience(UX), which determines whether the user will use the program persistently. To realize the business value of the product's life cycle, the UX is the key to the product's success [15]. UX core components include valuable and desirable content, usability, accessibility, credibility, visual pleasure, and enjoyment [16]. Therefore, designing an outstanding user interface can assist users in building up correctness and adherence to using the health application. The purpose of this paper is to collect the research suggestions that need to be improved in the interface design of the PFMT app, as evidence for interface design iteration, through the update of the interface design to create more novel and well-operated programs to help increase user stickiness, thereby guarantee the effectiveness of interventions.

2.0 LITERATURE SEARCH STRATEGY

This article follows the steps and methods of systematic literature review [17]. a). To begin with, identify the topic and research questions of the study, and limit the scope of the source. Obtain material for the PFMT app by searching for qualified keywords and timing. b). Furthermore, the source material was filtered and sorted out by the extracted criteria to obtain the concentrated area of the current PFMT app and organized into code. c). Finally, these studies can extract and evaluate interface design demand, organized into proposals and reports.

2.1 Research Questions:

This paper aims to investigate the interface design iteration direction of PFMT applications; we need to identify the following two questions:

RQ1： What are the main topics of the current research on the PFMT app?

RQ2： What are the significant improvement needs for the interface of the PFMT app?

2.2 Search strategy:

The object of this study was specifically a mobile application for pelvic floor muscle training. Synonyms and abbreviations will be used to generate a specific search term for the subject title and abstract. The search strategy outlined below will be modified according to each database's specifications and combined using the Boolean operators 'OR' and 'AND.' The key word set to (PFMT app) OR (Kegel app) OR (PFMT application) OR (Kegel application).

2.3 Data selection:

The search at least 2 different databases, the average and the median of 3 databases [18]. Scientology research frequently uses two well-known traditional academic data, Web of Science or Scopus, mainly covering the fields of life sciences, physical science, and technology. On the other hand, Dimension has better coverage of the social sciences, humanities,

and arts as promising sources. Research shows that Dimensions provides broader and more detailed coverage. Therefore, searching for keywords in databases Scopus, Web of Science, and Dimensions.

i. Inclusion Criteria:
This article selects the literature on the PFMT app in the past 6 years: from 1 January 2017 to 01 December 2022. The research was limited to a mobile app for self-management of UI in women.

ii. Exclusion Criteria:
Exclusion criteria studies in languages other than English, papers on trials that presented only mobile apps for pelvic floor muscle rehabilitation, and no specific applications were excluded. Papers studying pelvic floor muscle applications in men were also excluded. Studies investigating urinary incontinence in older adults were excluded. Studies of Kegel training applied for other symptoms, such as fecal incontinence, were excluded. Other studies observed only training devices and did not mention mobile applications were excluded.

2.4 Extraction of data:

At the end of the search, all the duplicates and invalid items were removed, titles and abstracts were screened by investigators according to inclusion/exclusion criteria to find papers that might conform to the needs, and then the researchers reviewed and evaluated the full text. If there is uncertainty about the inclusion of a paper, it is resolved in consultation with a senior investigator; ultimately, the senior researcher checks and confirms the relevance of all included papers. Papers for inclusion were finalized, and data extraction and classification were carried out.

The search and study inclusion process results will be presented using a flowchart. Data extraction and classification of data elements were extracted from selected articles, including author, date of publication, and target subject area of the PFMT application. Each article and content is then analyzed and tried to find the portion of interface

research and suggestion, identifying subtopics of interface research. A new criterion is added whenever a criterion does not match an existing classification. The sections on interface improvement and recommendations found in each of the included studies are listed progressively.

3.0 RESULTS AND FINDINGS

A search of 417 records was carried out by searching the three databases mentioned earlier. After removing duplicate articles 308 remain. Based on a review of the titles and abstracts, 42 articles met the initial selection criteria. After reviewing the full text, 26 articles met the inclusion criteria and were included in the final review. See Figure 1; 71.5% of the articles were published from 2020 to the present nearly 3 years.

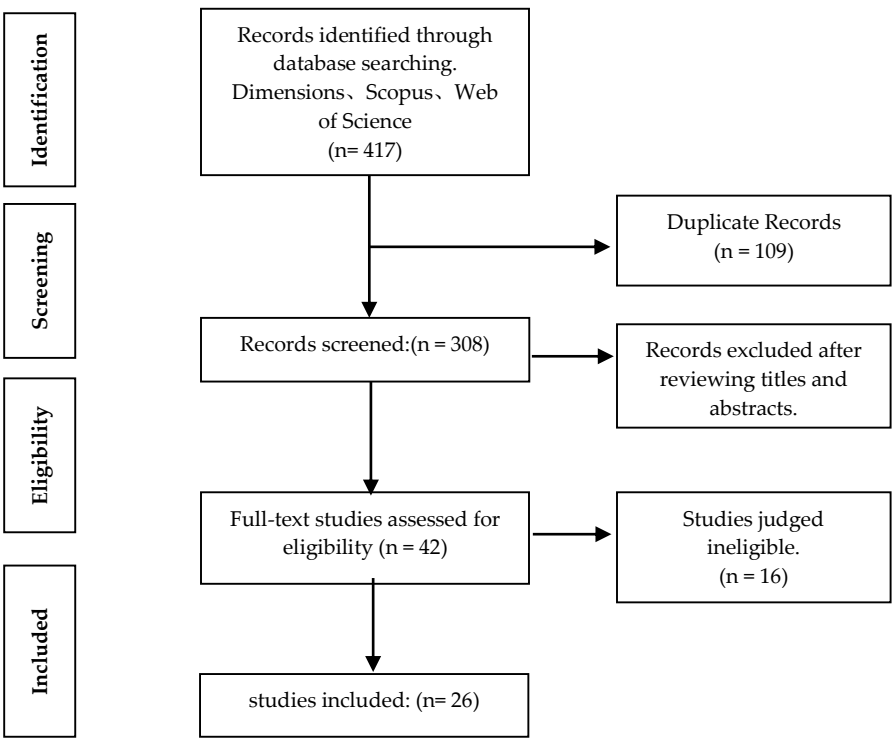

Figure 1: Process flow of searching articles

Due to the different algorithms, the Dimensions database has more comprehensive coverage and shows a visual graph that helps us comprehend QR1. The VOSviewer visualization image can be observed in Figure 2.

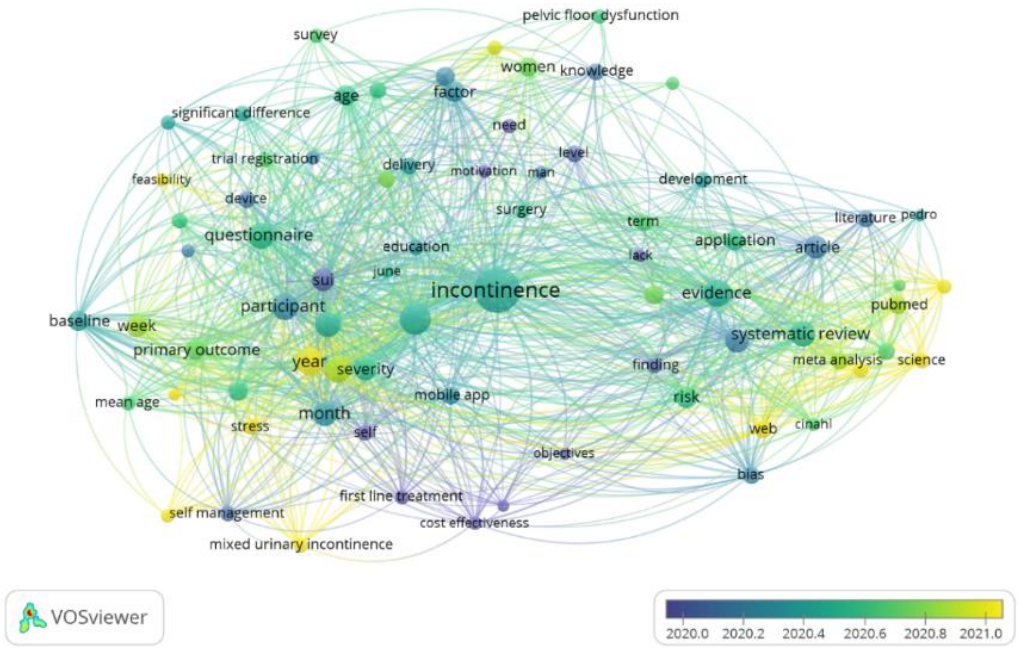

Figure 2: Visualization of Algorithms

RQ1：What are the main topics of the current research on the PFMT app?

Regarding the main study area of the PFMT app in the 26 filtrated papers: 7 types of current main research topics were identified. To sum up, the 7 categories of topics are included. See Table 1:

Table 1: Research topics on PFMT Apps

Topic	Quantity
1 Intervention Experiments and Effects	7
2 Cost-benefit	2
3 Development and Construction	6
4 Adherence	3
5 MARS evaluation	2
6 Feasibility and Usability	3
7 User Experience & Satisfaction	3
Total	26

In summary, this section elaborates on the findings of the literature review to answer the second research question:

RQ2: What are the significant improvement needs for the interface of the PFMT app?

Although there is minimal independent research on the interface design of the PFMT app, a comprehensive review of the selected articles can identify some areas for user interface design. The results found that most apps scored low on trustworthiness, user interface, experience, and user stickiness. Innovative User-Center apps need to be created [19].

Database research is the most used method of study identification, but back research is the second most popular method among other complementary strategies [18]. In [20] research, the interface was designed by Mahkaila Jones. Therefore, we accept the dissertation of Jones [21]. Very few papers are devoted to the interface of the PFMT app; therefore, it is included as a supplement to the review. By identifying the QR1, we can obtain the iterative requirements of interface design, which are summarized in the Table 2：

Table 2: Criteria for Interface Design

No.	Improve	Benefit
1	Visualization	Usability
2	Icons	Perception
3	Graphics	lessen stigma
4	Interaction	Self-efficacy
5	Consistency and simplicity	Ease of use
6	Gamification	Adherence and reduced stigma
7	Function	Correctness and Adherence

3.1 Visualization

In a study of Tät® user experiences, users particularly appreciated how the app visualized training by providing moving graphs for each contraction. This visual helps them see how long muscles should contract and relax and at what intensity. While participants can be proficient in exercises, they generally choose to look at the app (screen) while performing tasks because it helps them stay focused on the movement. Therefore, visual support and visualization can be universally important because they can help different populations and diseases [22].

3.2 Icons

The lack of clarity on the training model, and the inferior function and visibility design of icons were the central concern of the experts, which undermines understanding of the training process. The lucidity design of the icons is helpful in users' percept of an app's functionality, especially behavioral aspects, such as apps for exercise or physical training [23].

3.3 Graphics

Interviewees argue that the interface's stylishness should avoid excessive medical and scientific. Females prefer more visual feedback during the training process, and metaphorical graphic design can assist them in alleviating shame; abstract graphics are more acceptable than figurative graphics [21]. User present that designing a humorous cartoon image encourages users to diminish embarrassment and taboos and lessen negative emotions while using the app [24]. The study from a consumer preference and stigma perspective, the most successful designs are humor, playful, and potentially sexual, and the research hopes to increase empowerment in ways to reduce stigma and help women with PFMT [20].

3.4 Interaction

Biofeedback in PFMT is a direct audiovisual feedback system to pelvic floor muscle activity that improves clinical outcomes [25]. An essential component of mobile applications is voice commands, which determine adherence. The audio messages can help users generate many self-efficacy, show the patient's progress positively, promote the patient's quality of life, put pressure on the patient to adhere and comply with the empathetic way, help the patient face health problems, and call on the patient's responsibility for training. For example, give the user voice support during training: "Come on, contract!" Hold! Hold! And relax! Well done!" [24].

3.5 Consistency and simplicity

In a previous study that consistency is, without doubt, the essential feature of the design. Without consistency, the application's flow is disrupted and frustrates the user [23]. In subsequent investigations, experts raised the issue that terms of simplicity, zero interruption, data recording capability, and consistency are significant modifications for interface design [26]. Perform interviews, females said they would like

the app to have a clear, concise deliverable which the researchers underestimated. There was some feedback that biofeedback data was overly complex and attempted to convey too much information instantaneously [27].

3.6 Gamification

Humor and entertaining designs that help users motivate training. The abstract visual design has respectable acceptance, but apps that turn exercises into games get more positive reviews in terms of motivation than those that provide visualizations [20]. Gamified information is the app's features that encourage motivation and adherence [27] such as:

i. Function

Factors that affect adherence may include improper training; doubts about the effectiveness and users often forgetting about training [28]. In order to ensure the correctness of training and improve compliance, the following three main interfaces need to be improved: information provision, training mode, and reminders and records.

ii. Information Provision

Most applications provide knowledge of PFMT because users need some anatomy and physiology. When they start using the app Pathology and other underlying knowledge, they can better understand and trust the app's help [24]. A study on Kept app points out that the lack of a user manual to explain the function of the icons and application mechanisms affects the comprehensibility of use. The user instruction is necessary to provide an overview of the application and guidance [23]. The feasibility and usability of Kept emphasize again that adding brief descriptions and commonly asked questions within the APP can enhance the correctness of training [26]. Women face barriers to adequate information and education on performing proper PFMT contraction, which hinders their participation in and maintenance. Women who command education and training in PFMT after childbirth are advised to combine PFMT training and applications [29].

iii. Training mode

To investigate for guaranteed daily use, the training mode needs to be redesigned to improve clarity. It is difficult for them to recognize the training interface set up according to the user's ability. Therefore, they recommend keeping the training mode interface simple and easy to

understand, as users favor observing at the screen while training to improve concentration [23].

iv. Reminders and Records

Except in terms of knowledge acquisition and training timers, there are also reminders and calendar features [30]. The main reason participants choose to use an app is that they may receive reminders, considering that reminders are what they need to integrate daily training into their daily routines. Most users utilized reminders and described how they worked to complete the exercise as planned [31].

4.0 DISCUSSION

PFMT mobile health app research has increased since 2017, a relatively new research field while there are few studies on interface design. However, some recommendations can be drawn from previous feasibility, usability, and user experience studies. Since the design of the interface affect the correctness and adherence of users in training, the interface design of the PFMT app is one of the directions for the provision and improvement of future applications because most of the research puts forward the improvement opinions of users and experts. However, there is no further exploration and practice. In addition, it is necessary to take care of the user's visual aesthetic and reduce stigma.

To begin with, in some surveys, visual design was mentioned, and some users used "to see" to describe app training, but there was no in-depth discussion and research on visual design. Visualization can to a great extent in helping to focus and train correctly. For women's psychological feelings, what kind of graphics to use to make female users have pleasant psychological feelings and help reduce shame, which is worth exploring. Metaphorical and humorous graphic design is more acceptable and supportive for users. In terms of interaction methods, in addition to visual guidance, voice and auditory guidance are also of great help, and users hope to have more interactive feedback to them.

Moreover, one of the main reasons why many PFMT apps score low in the MARS score is the interface's inferior aesthetic design, which affects the user's experience. Consequently, the visual aesthetic of the supplementary interface research is desired. Last but not least, the main pages that need to be improved are information provision, training mode, and reminders and records. The provision of

information is multifaceted, and splash pages, guide pages, and specialized functions pages can also be utilized. Training mode is the focus of interface design, which can be combined with visualization, abstraction, and metaphor with multiple modes of interaction. The recording page helps users record the time, intensity, and frequency of training, and the calendar function makes it easy to self-monitor the number of exercises.

5.0 CONCLUSION

This paper comprehensively sorts out the research results and scope of the PFMT app in recent years. The problem of the current PFMT App interface design is visual design, graphic metaphor, gamification, and humor, promoting to lessen stigma, consistency, and simplicity. Refining and improving the app's interface design can progress adherence to the app therapy, which would be valuable.

ACKNOWLEDGMENTS

None

REFERENCES

[1] World Health Organization, 'MHealth: New horizons for health through mobile technologies', vol. 3. Pp. 1-102, 2011.

[2] R. Nouri, S.R.N. Kalhori, M. Ghazisaeedi, G. Marchand, M. Yasini, 'Criteria for assessing the quality of mHealth apps: a systematic review'. *Journal of the American Medical Informatics Association*, vol. 25, no. 8, pp. 1089-1098, 2018. [Online]. Available: https://academic.oup.com/jamia/article/25/8/1089/4996915.

[3] H. Gong, W. Yan, X. Yang, 'Current Status and Outlook of Mobile Health APPs', *Chinese General Practice*, vol. 21, no. 33, pp. 4157-4162, 2018.

[4] T. Wang, Y. Du, Y. Gong, K. Choo, Y. Guo, "Applications of Federated Learning in Mobile Health: Scoping Review", *Journal of Medical Internet Research*, vol. 25, pp. 1-12, 2022.

[5] R. Schnall, M. Rojas, S. Bakken, W. Brown, A. Carballo-Dieguez, M. Carry, et al., 'A user-centered model for designing consumer mobile health (mHealth) applications (apps)', *J Biomedical Informatics*, vol. 60, pp. 243-251, 2016.

[6] Y. Koumpouros, Y, "User-Centric Design Methodology for mHealth Apps: The PainApp Paradigm for Chronic Pain", *Technologies*, MDPI, vol. 10, no. 25, pp. 1-17, 2022.

[7] K.A. Kenne, L. Wendt, and J. Brooks Jackson, "Prevalence of pelvic floor disorders in adult women being seen in a primary care setting and associated risk factors", Scientific Reports, vol. 12, no. 9878, pp. 1-6, 2022.

[8] Y. Baruch, S. Manodoro, M. Barba, A. Cola, I. Re, M. Frigerio, "Prevalence and Severity of Pelvic Floor Disorders during Pregnancy: Does the Trimester Make a Difference?" *Healthcare*, MDPI, vol. 11, no. 1096, pp. 1-9, 2023.

[9] A.B. Terefe, T.G. Gudeta, G.T. Mengistu, and S.A. Sori, "Determinants of Pelvic Floor Disorders among Women Visiting the Gynecology Outpatient Departmentin Wolkite University Specialized Center, Wolkite, Ethiopia", *Obstetrics and Gynecology International*, Hindawi, vol. 2022, articleID 6949700, pp. 1-10, 2022.

[10] A.H. Kegel, "The physiologic treatment of urinary stress incontinence", *Journal of Urology*, vol. 63, No. 5, 1950.

[11] E.R. Trowbridge and E. F. Hoover, *Evaluation and Treatment of Urinary Incontinence in Women*, Department of Obstetrics and Gynecology, University of Virginia, Wiley, 2021.

[12] Y. Fu Y, E.A. Nelson, L. McGowan, "Multifaceted self-management interventions for older women with urinary incontinence: a systematic review and narrative synthesis", British Medical Journal (BMJ Open), vol. 9, pp. 1-17, 2019.

[13] K. Fan and Y. Zhao, "Mobile health technology: a novel tool in chronic disease management", *Intelligent Medicine*, vol. 2, no. 1, pp. 41-47, 2022.

[14] K. Wang and C. Kuang, "Visual Communication Design Model for New Media and Public Health Environment and New Communication Mode", *Journal of Environmental and Public Health*, Hindawi, vol. 22, ArticleID 1177677, pp. 1-10, 2022.

[15] N. Rösch and V. Tiberius, "Design thinking for innovation: context factors, process, and outcomes", *European Journal of Innovation Management*, Emerald, vol. 26, no. 7, pp. 160-176, 2023.

[16] L.F. da Silva, P.A. Parreira Junior, Freire, and A.P. Freire, "Mobile User Interaction Design Patterns: A Systematic Mapping Study", *Information*, vol. 13, no. 236, pp. 1-27, 2022.

[17] J. Paul, W.M. Lim, A. O'Cass, A.W. Hao, S. Bresciani, "Scientific procedures and rationales for systematic literature reviews (SPAR-4=SLR)", International Journal of Consumer Studies, Wiley, vol. 2021, pp. 1-16, 2021.

[18] M.B. Harari, H.R. Parola, C.J. Hartwell, A. Riegelman, "Literature searches in systematic reviews and meta-analyses: A review, evaluation, and recommendations", Journal of Vocational Behavior, vol. 118, 2020.

[19] L.O. Dantas, C. Carvalho, B.L. de J Santos, C.H.J. Ferreira, K. Bø, P. Driusso, "Mobile health technologies for the management of urinary incontinence: A systematic review of online stores in Brazil", *Brazilian Journal of Physical Therapy*, vol. 25, no. 4, pp. 387–395, 2021.

[20] E.R. Ramirez, H. Andreae, M. Lemke, "Addressing stigma in the design of a physical device and digital app for pelvic floor exercises", *Design Journal*, vol. 22, no. 1, pp. 517–37, 2019.

[21] M. Jones, "Designing A Personalised Mobile Application to Improve Engagement with PFMT Amongst Women from Pregnancy Up to One Year After Delivery", Master thesis, Victoria University of Wellington, 2018.

[22] I. Asklund, E. Samuelsson, K. Hamberg, G. Umefjord, M. Sjöström, "User experience of an app-based treatment for stress urinary incontinence: Qualitative interview study", *Journal of Medical Internet Research*, vol. 21, no. 3, 2019.

[23] A. Jaffar, S. Mohd Sidik, N. Admodisastro, E.I. Mansor, L.C. Fong, "Expert's Usability Evaluation of the Pelvic Floor Muscle Training mHealth App for Pregnant Women", *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 10, pp. 165-173, 2021.

[24] G.F.S. Latorre, R. de Fraga, M.R. Seleme, C. V. Mueller, B. Berghmans, "An ideal e-health system for pelvic floor muscle training adherence: Systematic review", *Neurourology and Urodynamics*, John Wiley and Sons, vol. 38, no. 1, pp. 63–80. 2019.

[25] S. Anglès-Acedo, L. López-Frías, V. Soler, J.F. Alonso, A.W. Kastelein, B.C. de Graaf et. al., "The women-up solution, a patient-centered innovative e-health tool for pelvic floor muscle training: Qualitative and usability study during early-stage development", *International Journal Environment Research Public Health*, vol. 18, no. 15, pp. 1-15, 2021.

[26] A. Jaffar, N.A. Muhammad, S.M. Sidik, N. Admodisastro, R.A. Manaf, C.N. Foo, et al., "Feasibility and Usability of Kegel Exercise Pregnancy Training App (KEPT App) among Pregnant Women with Urinary Incontinence" *International Journal Environment Research Public Health*, vol. 19, no. 6, pp. 1-12, 2022.

[27] L. Pedofsky, P.M.F. Nielsen, D. Budgett, K. Nemec, C. Dumoulin, J..Kruger, "Using codesign to develop a mobile application for pelvic floor muscle training with an intravaginal device (femfit®)", *Neurourology Urodynamics*, vol. 40, no. 26, pp. 1900-1907, 2021.

[28] D. Borello-France, K.L. Burgio, P.S. Goode, W. Ye, A.C. Weidner, E.S. Lukacz, et al., "Adherence to Behavioral Interventions for Stress Incontinence: Rates, Barriers, and Predictors Background. First-line conservative treatment for stress urinary incontinence", Physical Therapy, vol. 93, no. 6, pp. 757-773, 2013.

[29] A. Grant and S. Currie, "Qualitative exploration of the acceptability of a postnatal pelvic floor muscle training intervention to prevent urinary incontinence", *BMC Womens Health*, Springer, vol. 20, no. 1, pp. 1-8, 2020.

[30] A. Jaffar, S. Mohd Sidik, C.N. Foo, N.A. Muhammad, R. Abdul Manaf, N. Suhaili, "Preliminary Effectiveness of mHealth App-Based Pelvic Floor Muscle Training among Pregnant Women to Improve Their Exercise Adherence: A Pilot Randomised Control Trial", *International Journal Environment Research Public Health*, vol. 19, no. 4, 2022.

[31] I. Asklund, E. Samuelsson, K. Hamberg, G. Umefjord, M. Sjöström, "User experience of an app-based treatment for stress urinary incontinence: Qualitative interview study", *Journal of Medical Internet Research*, vol. 21, no. 3, 2019.