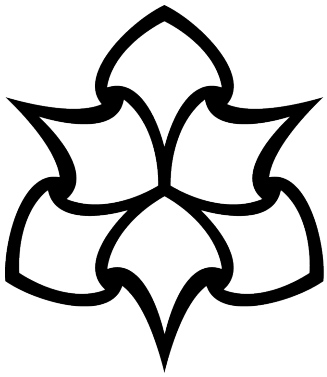

Development and Feasibility Testing of an Animated Cartoon-Based Self-Care Application for Low-Back Pain – a Pilot Study

Opracowanie i testowanie wykonalności aplikacji do samoopieki opartej na animowanych kreskówkach w przypadku dolegliwości bólowych w dolnym odcinku kręgosłupa – badanie pilotażowe

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Keywords
app, cartoon, low-back pain, McKenzie extension

Abstract
Objectives: The use of animated cartoons for pain management is an emerging area, however, in no study has it been explored as a digital platform for the rehabilitation of low-back pain (LBP). This study was aimed to develop and evaluate the feasibility of an animated cartoon-based self-care (ACBSC) app for LBP, and to examine the correlation between the app rating parameters and patients' pain.
Methods: This 2-phase study comprised development and feasibility testing components. Development of the ACBSC app was based on Mckenzie's Mechanical Diagnosis and Therapy (MDT) extension protocol plus back hygiene following standard iteration and prototyping process. Twenty-eight consecutive patients with chronic non-specific LBP with 'direction Preference' for extension based on the MDT screening algorithm participated in the feasibility phase. The participants utilised the cartoon-based app thrice weekly for 2 weeks. Outcomes were assessed in terms of usability, satisfaction and user experience applying the system usability and mobile application rating scales. The Quadruple Visual Analogue Scale (QVAS) was used to assess the participants' pain intensity.
Results: On a unified scale up to 20, functionality (15.4 ± 2.41) and aesthetics 14 ± 2.00 had highest and least objective quality rating on the app parameters. Total objective and subjective quality rating of the app was 16.9 ± 1.97 and 15.6 ± 2.42, respectively. The total impact and usability scores were 24.1 ± 3.39 (out of 30) and 27.8 ± 3.09 (out of 50). Participants reported that the cartoon app for back care mostly affected mindfulness/meditation/relaxation (42.9%), increasing happiness/well-being (46.4%), leading to behavioural changes (60.7%), while targeting physical health (100%). There was no significant correlation between participants' pain characteristics and app rating parameters ($p>0.05$).
Conclusion: The animated cartoon-based self-care LBP app has moderate to high usability, functionality, aesthetics and quality rating, and may serve as an effective mobile-app for self-management of long-term LBP.

The individual division of this paper was as follows: A – research work project; B – data collection; C – statistical analysis; D – data interpretation; E – manuscript compilation; F – publication search

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Słowa kluczowe
aplikacja, kreskówka, ból w dolnym odcinku kręgosłupa, rozciąganie metodą McKenzie

Streszczenie
Cele: Wykorzystanie animowanych kreskówek to rozwijający się obszar w leczeniu bólu, jednak żadne badanie nie analizowało go jako cyfrowej platformy do rehabilitacji bólu w dolnym odcinku kręgosłupa (ang. low-back pain – LBP). Badanie to miało na celu opracowanie i ocenę wykonalności aplikacji do samoopieki opartej na animowanych kreskówkach (ang. Animated Cartoon-Based Self-Care – ACBSC) dla LBP oraz zbadanie korelacji pomiędzy poszczególnymi parametrami aplikacji a bólem odczuwanym przez pacjentów.
Metody: To dwufazowe badanie obejmowało komponenty opracowania i testowania. Rozwój aplikacji ACBSC oparto na protokole Rozciągania Metodą Mechanicznej Diagnozy i Terapii Mckenzie'a (ang. Mechanical Diagnosis and Therapy – MDT), oraz higienie pleców po standardowym procesie iteracji i prototypowania. Do fazy wykonalności włączono 28 kolejnych pacjentów z przewlekłym, niespecyficznym LBP z „preferencją kierunku" do rozciągania w oparciu o algorytm przesiewowy MDT. Uczestnicy korzystali z aplikacji opartej na kreskówkach 3 razy w tygodniu przez dwa tygodnie. Wyniki zostały ocenione pod kątem użyteczności, satysfakcji i doświadczenia użytkownika za pomocą skali użyteczności systemu oraz skali ocen aplikacji mobilnych. Do oceny natężenia bólu uczestników zastosowano poczwórną wizualną skalę analogową (ang. Quadruple Visual Analogue Scale - QVAS).
Wyniki: Na ujednoliconej skali do 20, funkcjonalność (15,4 ± 2,41) i estetyka (14 ± 2,00) miały najwyższą i najmniej obiektywną ocenę jakości parametrów aplikacji. Całkowita obiektywna i subiektywna ocena jakości aplikacji wyniosła odpowiednio 16,9 ± 1,97 i 15,6 ± 2,42. Całkowity wynik oceny wpływu i użyteczności wyniósł 24,1 ± 3,39 (na 30) i 27,8 ± 3,09 (na 50). Uczestnicy zgłaszali, że aplikacja do pielęgnacji pleców wpływa głównie na uważność/medytację/relaks (42,9%), zwiększa uczucie szczęścia/dobrego samopoczucia (46,4%), prowadzi do zmian zachowania (60,7%) i jest ukierunkowana na zdrowie fizyczne (100%). Nie było istotnej korelacji między charakterystyką bólu uczestników a parametrami oceny aplikacji ($p>0,05$).
Wnioski: Animowana, oparta na kreskówce aplikacja do samoopieki LBP ma umiarkowaną lub wysoką użyteczność, funkcjonalność, estetykę i ocenę jakości oraz może służyć jako skuteczna aplikacja mobilna do samodzielnego radzenia sobie z długoterminowym LBP.

BACKGROUND

Mobile technology plays an effective role in improving patients' involvement in areas outside the hospital or clinic environment, and in facilitation of self-care in chronic pain[1,2]. The advent of these technologies has led to a positive revolution in health information sharing on self-management and how patients can improve their quality of life[3,4]. Consequently, there is a proliferation of apps for pain management and they come in different modes depending on the technology[5-7]. However, there is still an apparent mismatch between the numbers of pain apps and studies reporting on their usefulness[2].

Among the plenitude of apps for pain relief, only a minority of them are useful to patients because most apps were designed mainly to obtain information and less for behavioural health interventions[8]. The self-care health apps with pain management guidance are more useful to the patients with chronic pain than those focused on information sharing[8]. In emerging reports, it has been indicated that cartoon or animation-based apps may serve as a viable motivator and/or guidance for function recovery in patient rehabilitation[9], as well as a pain distracter, thus, reducing the behavioral responses to pain[10-12]. To date, there is an apparent dearth of animated cartoon apps for the managment of low-back pain (LBP).

Low-back pain is a significant global public health challenge[13], and it has maintained a defiant stance against most known interventions[14]. Nonetheless, in several studies, exercise has been recommended as a key physical therapy approach for chronic (i.e. long-term) LBP[15-18]. While there is no agreement on the most efficacious type of exercise, the McKenzie exercises are among the most commonly used type of physical therapy for long-term LBP in some claims with substantial data on its effectiveness[19,20]. Characteristically, the McKenzie approach has the potential advantage of encouraging self-help[21], however, appropriate implementation and positive outcomes from this approach are strongly dependent on having specialised training in Mckenzie's Mechanical Diagnosis and Therapy (MDT)[19,22].

There is an inherent problem of access to MDT owing to a lack of skills in techniques, geographical inaccessibility and shortage of services in rural and remote areas[23], therefore, implementing the MDT through a mobile-phone-based digital platform application with an animated cartoon background may help solve this problem. The digital platform, which ensures better continous therapy and coping strategies in chronic pain[24], may help bridge the gap in the non-availability of faculties, especially for MDT. Although it has been stated in reports that digital interventions hold potential in supporting the self-management of LBP, little is known about their content, delivery and benefits[25], thus, inviting the need to explore different digital platforms that will enhance the self-management of LBP. Currently, the use of animated cartoons for pain management is an emerging area. To the knowledge of the researchers, there is no known study in which animated cartoons for LBP rehabilitation have been explored. The over-arching objective of this study was to develop and evaluate the feasibility of an animated cartoon-based self-care (ACBSC) app for LBP, and to examine the correlation between the app rating parameters and patients' pain.

MATERIALS AND METHODS

This 2-phase study comprised development and feasibility testing components. Development of the ACBSC app was based on Mckenzie's MDT

extension protocol plus back hygiene. The development of the ACBSC followed a 12-step iteration and prototyping process described by Naji[26].

- Step 1: Defining the goal of the app – To develop an animated cartoon-based mobile app that incorporates visual guidance in the management of chronic LBP.
- Step 2: Wire framing with IT experts and clinicians – The key functionalities of the proposed animated cartoon-based mobile app was drafted on paper, followed by digitalising the functionalities and wire framing it in a prototyping tool.
- Step 3: Learning from a number of already existing apps – A number of related apps for chronic pain management on app stores and the Google play store were reviewed to evaluate their strengths and weaknesses.
- Step 4: Story-mapping and gathering requirements – This step requires visualisation of the solution to the problem identified in 'Step 1'.
- Step 5: Defining user scenarios – This step involves finding out if the app is working as envisioned by the developer or meeting the client's/patient's needs.
- Step 6: Update requirements – This step concerns testing the app to identify problems or to make new inclusions or fields.
- Step 7: Building a high fidelity prototype by incorporating stakeholders' comments – At this stage, realistic animations and transitions were added to the existing wireframe to show potential interactions and test the previously hypothesised scenarios.
- Step 8: User testing of prototype on various mobile systems – User testing of the prototype is described as the foundation of making a good mobile app. This testing uncovers bugs and allows to highlight redundant design elements that may have been hidden during the design process.
- Step 9: Validation requirements – At this stage, iterative prototype of the app is checked with service providers and users before moving on to code.
- Step 10: Laying the foundations for the app – At this stage, the groundwork for the developed app is laid by the developer.
- Step 11: Building the user interface skins and cycle feedback – Based on feedback from stakeholders during testing, the prototype screens are transferred into high-fidelity skins.
- Step 12: User testing – At this stage, the app development is finalised and it is transitioned from a dummy to a fully functional app with polished user interface elements.

Components of the Smartphone application include information and guides on extension exercise protocols in the McKenzie method: (1) Extension lying prone (Fig 1), (2) Extension in prone on elbow (Fig 2), Extension in prone lying on hand (Figure 3), and Extension in standing (Figure 4).

Twenty-eight consecutive patients with chronic non-specific LBP indicating 'direction preference' for extension, based on the MDT screening algorithm, participated in the feasibility phase. The participants were patients attending the Physiotherapy Department of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile Ife, Nigeria. Eligibility for inclusion included being diagnosed with non-specific LBP at least 3 months prior to research, having direction preference for extension, and having the ability to comprehend and use the mobile software app. The excluded patients were those with serious spinal pathologies or any obvious spinal deformities or neurological dis-

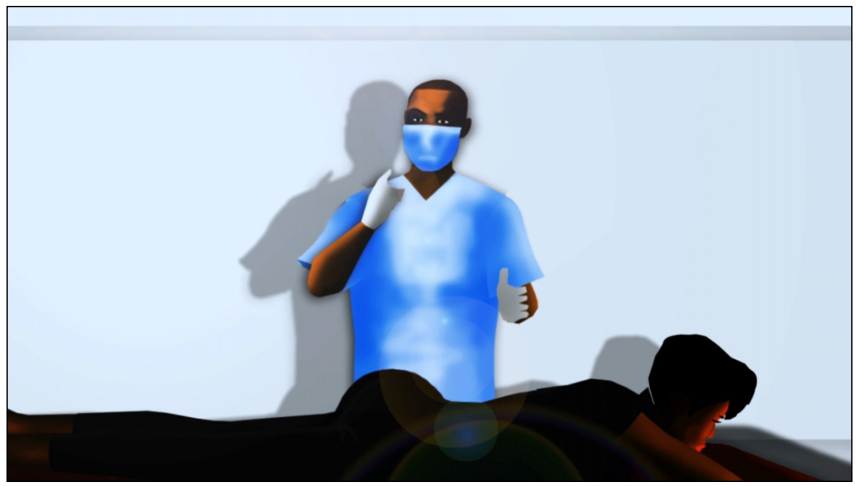

Figure 1

Open user interface

Figure 2

Exercise 1 – Relaxation position

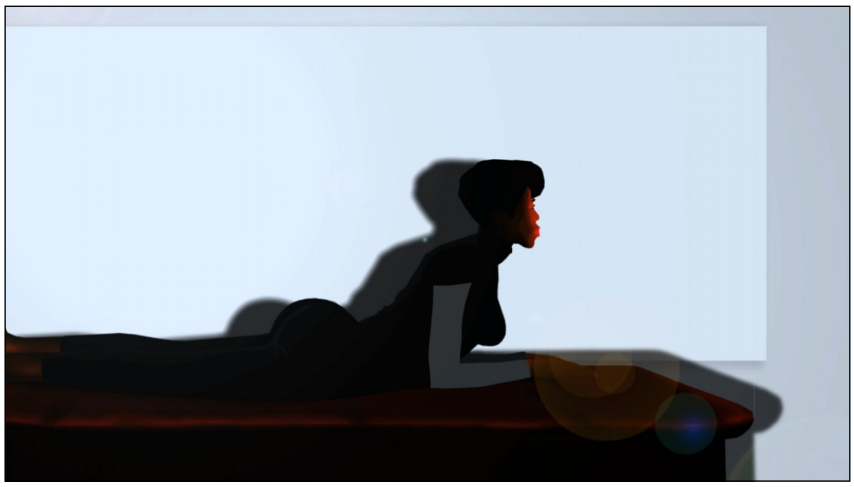

Figure 3
Extension in prone lying elbow 90⁰ flexion

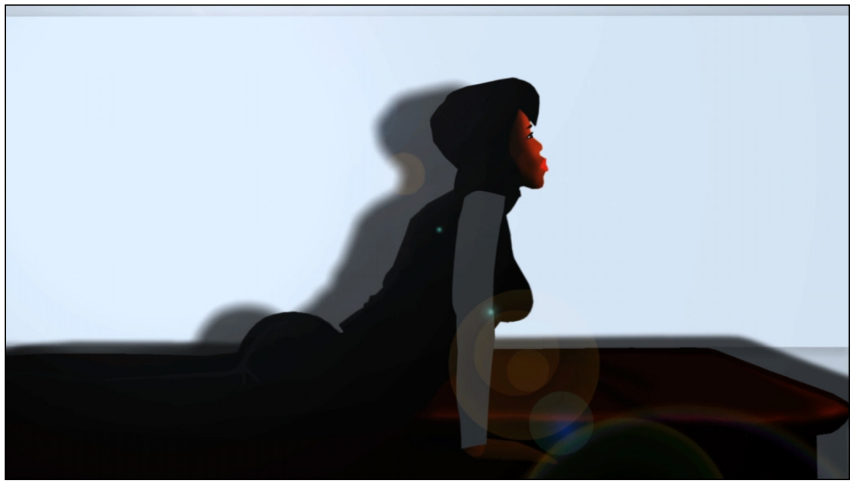

Figure 4
Extension in prone lying elbow fully extended

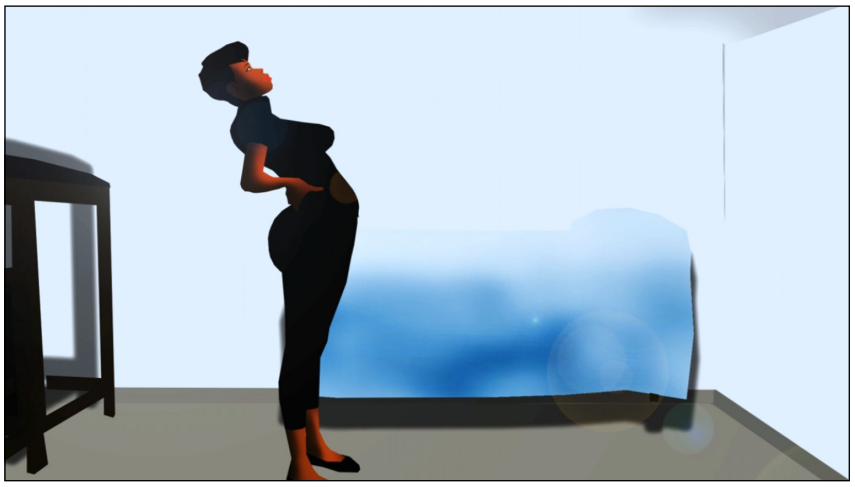

Figure 5
Extension in standing

ease, who were pregnant or have had previous back surgery, and those who were not literate in the English language (as the app was only available in English).

Using the Cohen[27] table (effect size 0.05 and power of 0.05), a minimum of 18 participants was deemed sufficient. In order to accommodate for possible refusal to participate or attrition, 20% of N was added, yielding a total sample of 22. However, 28 patients with non-specific long-term LBP participated in this study.

Instruments

1. Animated cartoon-based self-care app that was developed on the basis of McKenzie's MDT extension exercises.
2. Smart phone or android phone with 4.0 Operating System was required for the installation of the app.
3. System Usability Scale (SUS) – This was used to assess user experience in terms of engagement, satisfaction, level of motivation and complexity of the ACBSC app for LBP. ISO 9241-210 defines user's experience as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service. The SUS presented 10 statements about the perceived usability of the application[28]. On a scale from 0-4, patients could indicate to what extent the presented statements were true for them.
4. Mobile App Rating Scale (MARS) – This is a reliable multidimensional scale for classifying and rating the information quality of a mobile app. This scale was employed to rate the ACBSC. The 23-item MARS contains 4 objective quality subscales – engagement, functionality, aesthetics and information quality, as well as a subjective quality rating.
5. The Quadruple Visual Analogue Scale (QVAS) – This scale was used to evaluate pain intensity experienced by the participants at the time of assessment, typical or average pain, pain at its best and worst, respectively. The scale has been reported to have good validity and reliability[29]. The scores from the subscales are averaged and then multiplied by 10 to yield a score from 0 to 100.

Procedures

Ethical approval for the study was obtained from the Health Research Ethics Committee of the Institute of

Public Health, Obafemi Awolowo University, Ile-Ife, Nigeria. Consent was obtained from each participant. The subjects performed the therapeutic activities in the ACBSC app. The protocol involved a course of specific lumbosacral repeated movements in extension that cause the symptoms to centralise, decrease or abolish[30]. The extension activities include: "Extension lying prone", "Extension in prone", and "Extension in standing": repeated up to 10 times[30,31]. The details of the protocol have been described elsewhere[32].

Using the single-group repeated measures approach, the outcomes of the app's feasibility testing were assessed in terms of usability, satisfaction and user experience on the system usability and mobile application rating scales after using the app thrice weekly for 2 weeks. This was in tandem with previous studies on feasibility testing of apps, where 7 to 14 days were used as a test window[33]. The QVAS was also implemented to assess the participants' pain intensity pre- and post- CBSC app usage.

Data Analysis

Descriptive statistics of frequency mean and standard deviation were used to summarise the data. Inferential statistics of the paired *t*-test were used to compare pre- and post-ACBSC app usage outcomes. Pearson's product-moment correlation coefficient analysis was applied to test the correlation between app rating parameters and patients' pain. The alpha level was set at $p<0.05$. The data analyses were carried out using the SPSS 160 software (SPSS Inc., Chicago, Illinois, USA).

RESULTS

The mean age, height, weight and BMI of the participants were 44.6±17.3 years, 1.68 ±0.09 m, 70.9 ± 13.7 Kg, and 25.1 ± 4.59 Kg/m^2, respectively. The pain characteristics of the participants are presented on the basis of the QVAS. The total pain score of the participants yielded a mean score of 5.48 ± 1.59 (Table 1). App quality rating score for the animated cartoon-based self-care app is presented in Table 2. The total app quality mean score and app subjective quality mean score were 16.9 ± 1.97 out of 22.5 and 15.6 ± 2.42 out of 20.

The mean scores and frequency distribution with regard to perceived impact of the ACBSC app on user knowledge, attitudes, intentions and behavioural changes on the significance of extension movements are presented in Tables 3 and 4 respectively. The total mean score was24.1 ± 3.39 out of 30. The results allow to indicate that the app mostly led to increased rates of help-seeking and behavioural changes (78.6%), intention to change (78.5%), on the importance of extension movement of the back in LBP. Responses on perception in the area of focus of the app are presented in Table 5. From the result, the participants stated that the app influenced mindfulness/meditation/relaxation (42.9%), increased happiness/well-being (46.4%), led to behavioural changes (60.7%) and targeted physical health (100%).

Table 1

General physical and pain characteristics of all the participants (n=28)

Variable	Physical characteristics			Pain characteristics ($\bar{x}$ ± *SD*)	
	Minimum	Maximum	$\bar{x}$ ± *SD*		
Age [y]	20.0	68.0	44.6 ± 17.3	Current pain	5.07 ± 2.05
Height [m]	1.48	1.88	1.68 ± 0.09	Average pain	4.68 ± 1.42
Weight [Kg]	54.0	120	70.9 ± 13.7	Best pain	3.39 ± 1.89
BMI [Kg/m^2]	17.4	39.2	25.1 ± 4.59	Worst pain	6.86 ± 1.80
				Total QVAS	5.48 ± 1.59

BMI – Body Mass Index; $\bar{x}$ – Mean; *SD* – Standard deviation; QVAS – Quadruple Visual Analogue Scale

Table 2

App quality rating score for animated cartoon-based self-care app

Section	Participants' mean scores	
	($\bar{x}$ ± *SD*)	Total scale score
App quality scores		
Engagement	19.0±2.86	25
Functionality	15.4±2.41	20
Aesthetics	10.5±2.00	15
Information	22.8±2.79	30
Total App Quality Mean Score	16.9±1.97	22.5
Subjective quality rating		
App subjective quality mean score	15.6±2.42	20

$\bar{x}$ – Mean; *SD* – Standard deviation

Table 3

Perceived impact of the app regarding user knowledge, attitudes, intentions and behavioural changes on significance of extension movement (n=28)

Section	Minimum	Minimum	Participants' mean scores ($\bar{x}$ ± *SD*)
Awareness	3	5	3.75 ± 0.75
Knowledge	3	5	3.86 ± 0.76
Attitudes	3	5	3.89 ± 0.88
Intention to change	3	5	4.11 ± 0.74
Help-seeking	3	5	4.21 ± 0.79
Behavioural changes	3	5	4.29 ± 0.81
Total mean score	18	30	24.1 ± 3.39

$\bar{x}$ – Mean; *SD* – Standard Deviation

Table 4

Frequency distribution regarding perceived impact of the app on user knowledge, attitudes, intentions and behaviour changes on significance of extension movement (n=28)

Section	Strongly disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly agree n (%)
Awareness	0(0)	0(0)	12(42.9)	11(39.3)	5(17.9)
Knowledge	0(0)	0(0)	10(35.7)	12(42.9)	6(21.4)
Attitudes	0(0)	0(0)	12(42.9)	7(25.0)	9(32.1)
Intention to change	0(0)	0(0)	6(21.4)	13(46.4)	9(32.1)
Help-seeking	0(0)	0(0)	6(21.4)	10(35.7)	12(42.9)
Behavioural changes	0(0)	0(0)	6(21.4)	6(28.6)	14(50.0)

% – percentage

Table 5

Frequency distribution responses on area of app focus App (n=28)

Target	Yes n (%)	No n (%)
Increasing happiness/well-being	13 (46.4)	15 (53.6)
Mindfulness/meditation/relaxation	12 (42.9)	16 (57.1)
Reducing negative impression	0 (0)	28 (100)
Depression	0 (0)	28 (100)
Anxiety/stress	0 (0)	28 (100)
Anger	0 (0)	28 (100)
Behavioural changes	17 (60.7)	11 (39.3)
Alcohol/substance use	0 (0) = 10 (35.7)	18 (64.3)
Relationships	0 (0)	28 (100)
Physical health	28 (100)	0 (0)
Other	4 (14.3)	24 (85.7)

The mean score for app rating was 3.61 ± 0.83 (out of 5 in total). The app usability score was 27.8 ± 3.09 (out of 33). Based on the System Usability Scale comprising 10 statements about application usage, the mean score was 27.8 ± 3.09 out of 50, and frequent usability of app (82.1%), integration of app function (64.3%), and ease of use (60.7%) were mostly positively rated. The correlation of the participants' pain scores and app quality rating scores is presented in Table 6. The correlation co-efficient between the total app quality score and initial and post intervention QVAS was 0.337 (0.080) and 0.352 (0.066), respectively. Also, the app subjective quality scores and initial and post-trial QVAS were 0.262 (0.178) and 0.313 (0.105), respectively. There was no significant correlation between app rating parameters and pain charac-

Table 6

Correlation between app rating scores and patients' pain characteristics pre- and post- ACBSC app use		
Total pain rating score		
Section	**Pre r (p)**	**Post r (p)**
	Objective quality rating	
Engagement	0.0956 (0.630)	0.195 (0.320)
Functionality	0.297 (0.125)	0.323 (0.094)
Aesthetics	0.200 (0.306)	0.146 (0.457)
Information	0.243 (0.214)	0.300 (0.120)
App Quality Score	0.337(0.080)	0.352 (0.066)
	Subjective quality rating	
App subjective quality score	0.262 (0.178)	0.313 (0.105)

teristics ($p>0.05$). The correlation co-efficient between the total app quality score and participant's app rating was 0.55 (0.002). There was a significant correlation between the total app quality score and the participant's app rating ($p<0.05$).

DISCUSSION

In this study, the feasibility of the ACBSC app, built on the principles of the McKenzie MDT extension exercises plus back hygiene education, was developed and tested. The development of the ACBSC app followed 12-step technological stereotypes, as described by Naji[26]. Video-staging was used as the template for cartoon animation development in this trial. For feasibility testing of the app, a minimum of 6 sessions over a 14-day period was deemed sufficient to elicit users' experience. This was in tandem with previous studies on feasibility testing of apps, where 7 to 14 days were used as a test window[33].

Based on the MARS subscale and total scores in this study, the ACBSC app obtained a good to satisfactory rating that is comparable with Lower Back Pain App-V2.2, 3 Steps to Cure Back Pain-V1.1 and Backache-V2.0.6, which are among the most popularly and positively rated apps for the self-management of LBP, based on their being interesting, entertaining, interactive and customisable, as well as having a high level of visual appeal and content[25]. Similar to the ACBSC app, the Lower Back Pain App-V2.2, 3 Steps to Cure Back Pain-V1.1 and Backache-V2.0.6 apps were based on biomechanical exercises (e.g. strengthening, stretching, core stability or McKenzie exercises).

Zhao et al.[34] suggests the need to assess the quality and effectiveness of apps as a requirement to know their usefulness for behavioural changes in health. Findings regarding the perceived impact of the ACBSC app on likelihood of change in the targeted health behaviour shows that the app mostly led to an increase rate in help-seeking and behavioural change, intention to change, and the importance of extension movement of the back in LBP. These results indicate that the ACBSC app can serve as a viable mean to impact health behaviour[34]. These perceived effects should be further investigated since 2 weeks may not be sufficient to demonstrate changes in many of these variables. It is suffice to say that 2 weeks were adequate to assess the feasibility of a new tool, which was the primary focus of this study. Furthermore, frequent usability of the app, integration of app function and ease of use are the most highly rated on the usability scale. These findings are consistent with users' rating of apps in feasibility studies for the majority of apps perceived as good[33]. Moreover, the ACBSC app total quality score and pain intensity were not significantly correlated. Thus, the usability of the app seems not to be predicated based on the level of pain experienced by the patients. It is implied that the worst or best pain scenarios do not affect the use of the app.

CONCLUSIONS

The animated cartoon-based self-care LBP app has moderate to high usability, functionality, aesthetics and quality rating, and may serve as an effective mobile-app for self-management in long-term LBP.

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Competing interests
The authors declare no competing interests.

References

1. Alexander J.C., Joshi G.P. Smartphone applications for chronic pain management: a critical appraisal. J Pain Res 2016; 9: 731-734.
2. Sundararaman L.V., Edwards R.R., Ross E.L., Jamison R.N. Integration of Mobile Health Technology in the Treatment of Chronic Pain: A Critical Review. Reg Anesth Pain Med 2017; 42(4): 488-498.
3. Marceau L.D., Link C., Jamison R.N., Carolan S. Electronic diaries as a tool to improve pain management: is there any evidence? Pain Med 2007; 8(Suppl 3): S101-S109.
4. Chuna Y.J., Patterson P.E. A suggestion for future research on interface design of an Internet-based telemedicine system for the elderly. Work 2012; 41(Suppl 1): 353-356.
5. MobiHealth News. 2010. The world of health and medical apps. Available at: http://mobihealthnews.com/research/the-worldof-health-and-medicalapps.
6. Douglas K.H., Wojcik B.W., Thompson J.R. Is There an App for That? JSET 2012; 27(2): 59-70.
7. Nussbaum R., Kelly C., Quinby E. et al. Systematic Review of Mobile Health Applications in Rehabilitation. Arch Phys Med Rehabil 2019; 100(1) :115-127.
8. Jamison R.N., Jurcik D.C., Edwards R.R. et al. A Pilot Comparison of a Smartphone App

With or Without 2-Way Messaging Among Chronic Pain Patients: Who Benefits From a Pain App? Clin J Pain 2017; 33(8): 676-686.
9. Perry J.C., Zabaleta H., Belloso A. et al: A low-cost device for telerehabiltation of post-stroke arm deficits. In World Congress on Medical Physics and Biomedical Engineering. September 7-12, 2009, Munich, Germany. Springer, Berlin, Heidelberg. 2009: 64-67.
10. Gandhar S.S., Deshpande J., Borude S. Effectiveness of Cartoon Movies as Distracter on Pain among Children Undergoing Venipuncture. IJSR 2016; 5(6): 2241-2244.
11. Feng Z., Tang Q., Lin J. et al. Application of animated cartoons in reducing the pain of dressing changes in children with burn injuries. IJBT 2018; 8(5): 106-113.
12. Hartati S., Mediani H.S., Rahmayanti S.D. et al. The effect of distraction techniques watching cartoon animation to pain response during infusion of preschool children's in Rsud Sayang Kabupaten Cianjur. IOSR-JNHS 2018; 7(5): 1-7.
13. Deyo R.A., Mirza S.K., Martin B.I. Back pain prevalence and visit rates: estimates from U.S. national surveys, 2002. Spine (Phila Pa 1976) 2006; 31(23): 2724-2727.
14. Andersson G.B. Epidemiological features of chronic low-back pain. Lancet 1999; 354: 581-585.
15. Bigos S., Bowyer O., Braen G. et al. Acute Low Back Problems in Adults. Clinical Practice Guideline No. 14. AHCPR Publication No. 95-0642. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services. December 1994.
16. Hayden J.A., van Tulder M.W., Malmivaara A.V., Koes B.W. Meta-analysis: exercise therapy for nonspecific low back pain. Ann Intern Med 2005; 142(9): 765-775.
17. Rainville J., Jouve C.A., Hartigan C. et al. Comparison of short- and long-term outcomes for aggressive spine rehabilitation delivered two versus three times per week. Spine J 2002; 2(6): 402-407.
18. Hartigan C., Rainvilee J., Sobel J.B., Hipona M. Long-term exercise adherence after intensive rehabilitation for chronic low back pain. Med Sci Sports Exerc 2000; 32(3): 551-557.
19. Clare H.A., Adams R., Maher C.G. A systematic review of efficacy of McKenzie therapy for spinal pain. Aust J Physiother 2004; 50(4): 209-216.
20. Machado L.A., de Souza Mv., Ferreira P.H., Ferreira M.L. The McKenzie method for low back pain: a systematic review of the literature with a meta-analysis approach. Spine (Phila Pa 1976) 2006; 31(9): E254-E262.
21. Moffett J., McLean S. The role of physiotherapy in the management of non-specific back pain and neck pain. Rheumatology 2005; 45(4): 371-378.
22. Czajka M., Truszczyńska-Baszak A., Kowalczyk M. The effectiveness of McKenzie method in diagnosis and treatment of low back pain – a literature review. Adv Rehab 2018; 32(1): 5-11.
23. Dansky K.H., Palmer L., Shea D., Bowles K.H. Cost analysis of telehomecare. Telemed J E Health 2001; 7(3): 225-232.
24. Marceglia S., Conti C. A technology ecosystem for chronic pain: promises, challenges, and future research. Mhealth 2017; 3: 6.
25. Machado G.C., Maher C.G., Ferreira P.H. et al. Non-steroidal anti-inflammatory drugs for spinal pain: a systematic review and meta-analysis. Ann Rheum Dis 2017; 76(7): 1269-1278.
26. Naji C. Iterative Prototyping in the Mobile App Development Process - 12 steps to iterative mobile app development. Available at: https://www.infoq.com/articles/mobile-app-prototyping/.
27. Cohen S.P., Argoff C.E., Carragee E.J. Management of low back pain. BMJ 2008; 337: a2718.
28. Lewis J.R., Sauro J. The factor structure of the system usability scale. International conference (HCII 2009), San Diego CA, USA.
29. Von Korff M., Deyo R.A., Cherkin D., Barlow W. Back pain in primary care. Outcomes at 1 year. Spine (Phila Pa 1976) 1993; 18(7): 855-862.
30. Mckenzie, R.A. Treatyourown back. Waikanae: New Zealand. Spinal Publication Limited 1990: 37-48.
31. McKenzie R.A., May S. The lumbar spine: mechanical diagnosis and therapy. Waikanae, New Zealand: Spinal Publications 2003.
32. Mbada C.E., Makinde M.O., Odole A.C. et al. Comparative effects of clinic-and virtual reality-based McKenzie extension therapy in chronic non-specific low-back pain. Hum Mov 2019; 20(3): 66-79.
33. Stoyanov S.R., Hides L., Kavanagh D.J. et al. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. JMIR Mhealth Uhealth 2015; 3(1): e27.
34. Zhao J., Freeman B., Li M. Can Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review. J Med Internet Res 2016; 18(11): e287.

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