Development and usability test of a symptom management WeChat Mini Program for parents of children with cancer

Yanyan Liua, Danyu Lia, Haishan Ruanb, Yun Hua,*, Nanping Shen c

a School of Nursing, Shanghai JiaoTong University, Shanghai, China
b Department of Hematology and Oncology, Shanghai Children's Medical Center Affiliated to Shanghai Jiaotong University School of Medicine, Shanghai, China
c Nursing Department, Shanghai Children's Medical Center Affiliated to Shanghai Jiaotong University School of Medicine, Shanghai, China

ARTICLE INFO

Keywords:
Pediatrics
Parents
Oncology
Symptom management
Usability test

ABSTRACT

Objective: Symptom management is a persistent challenge in pediatric oncology. The WeChat Mini Program, a small smartphone application that functions within WeChat, has the potential to assist in symptom management. This study aimed to develop a symptom management WeChat Mini Program for parents and children with cancer aged 5–17 years old and evaluate its usability.

Methods: Based on the semi-structured interviews with parents of children with cancer, experts in pediatric oncology and informatics and a survey of children's symptom experience, multidisciplinary research group meetings were conducted to confirm the structure and main contents of the Mini Program. The iterative method was used to develop the Mini Program. A mixed-method study was conducted to test its usability with 10 pairs of parents and children with cancer. The quantitative data were collected through the Poststudy System Usability Questionnaire, and qualitative data were collected from interviews.

Results: The Mini Program "Child SMILE" was developed, which includes a symptom assessment and management module, an information and emotional support module, a communication module among the parents and medical professionals, and a personal information module. Most users reported that the Mini Program is user-friendly, with satisfaction scores on the Poststudy System Usability Questionnaire ranging from 5.2 to 5.7 (out of 7.0) in four dimensions. In qualitative interviews, most participants thought the Mini Program was convenient, easy to use, and helpful.

Conclusions: It can be concluded that the Mini Program satisfies the needs of parents of children with cancer and has the potential to benefit the symptom management of children with cancer.

Introduction

Cancer threatens the health and lives of children worldwide. The latest childhood cancer report showed that more than 380,000 children and adolescents aged 0–19 years were diagnosed with cancer annually, and the incidence of cancer in children aged 0–14 years was 140.6 per million and in those aged 0–19 years was 155.8 per million.1 The 2012 cancer registration data in China showed that the morbidity of pediatric cancer was 10.78 per 100,000, which is lower than 11.35 per 100,000 in 2009.2,3 Cancer itself and the treatment of cancer have a great impact on the health status and quality of life of children. Common sufferings and symptoms include fatigue, pain, nausea, vomiting, emotional distress, altered sleep quality, and poor social and physical function.4–7 Parents, as the main caregivers of children with cancer, play an important role in managing these cancer or treatment-related symptoms.4–11

Parents who provide care for children with cancer will normally face complex needs, and emotional and informational needs were the two most frequently acknowledged categories of need.12 mHealth intervention is a new solution to help spread knowledge and facilitate communication to meet individualized needs, which can greatly improve disease experience and clinical outcomes, reduce complications and anxiety, and strengthen treatment adherence.13,14 There are limited studies that aim to support the parents of children with cancer in symptom management by mHealth intervention and whether the parents have the specific needs for caring adverse symptoms that children experienced. Therefore, we consider exploring and satisfying the symptom management needs of parents of children with cancer and helping health care providers implement better care for children with cancer.

Our previous studies have verified the usability and efficacy of smartphone-based health management15 and the feasibility of pediatric...
patient-reported outcomes apps.\textsuperscript{16,17} WeChat Mini Programs for health care were considered to have a small file size, low-performance requirements for smartphone hardware, ease of use, and high acceptance,\textsuperscript{18} and we chose this as our platform to develop. In addition, this research was based on our completed study on the experience and need analysis of parents of children with cancer, which showed that parents exerted critical roles in children with cancer's symptom management and had huge informational needs, communication needs, and psychological needs. Therefore, this study aimed to develop a WeChat Mini Program based on previous studies to satisfy the needs of parents of children with cancer and encourage them to participate in symptom management, making it easier for family-centered care.

Development of Symptom Management WeChat Mini Program

Purpose of program development

The purpose of developing the symptom management WeChat Mini Program for parents of children with cancer is to enable parents to better report and manage children's unpleasant symptoms.

The theory framework of the program development

The structure of the symptom management mHealth intervention was developed based on the University of California, San Francisco Symptom Management Theory, which depicts symptom management as a multidimensional process occurring in the domains of nursing science.\textsuperscript{19} This theory addressed three interactive components of symptom management: symptom experience, symptom management strategies, and outcomes. The underlying premise of the model was that effective symptom management required consideration of all three components. Based on this theory, this study explored the experience of children and parents who evolved in the symptom management process. Based on their experience, several multidisciplinary research team meetings were conducted to confirm the structure and the main components of parents participating in the symptom report and management. The direct outcomes were to improve the parents' caring knowledge and skills and reduce their anxiety and uncertainty. The final outcome of this program was to reduce the symptoms suffered by children with cancer.

Program development procedure

Step 1: The qualitative interview of parents' experience and needs for symptom management during chemotherapy

To deeply understand and explore the experience and needs of symptom management for parents of children with cancer who underwent chemotherapy, the phenomenological qualitative method was used to conduct semi-structured interviews with 14 parents of children with cancer who were at the stage of chemotherapy in two hospitals.\textsuperscript{20} Open-ended questions were used to conduct interviews that mainly focused on “What were your experiences and feelings during the time your child was cared for in chemotherapy?” Two themes of parents' experiences of caring symptoms and adverse effects were extracted: the process of learning to grow and psychological adjustment and modification. The caring needs of parents can be summarized into three themes: information needs, communication needs, and emotional support needs. Parents continue to learn and grow and have many needs in the process of caring for the symptoms and treatment of children with cancer. Medical staff and nurses should work closely with parents and patients to satisfy parents' need for symptom knowledge, communication, and emotional support, which were the main problems to be solved in the symptom management Mini Program construction procedure.

Step 2: Longitudinal investigation of the multiple symptoms of children with cancer

To describe the current status and experiences of the symptom experience of children and adolescents with cancer in a chemotherapy cycle,\textsuperscript{20} convenience sampling was used to select children with cancer and adolescents aged 5–17 who received chemotherapy in two tertiary hospitals. The survey was conducted at four time points during a chemotherapy cycle. The questionnaires of the Memorial Symptom Assessment Scale (MSAS 10–18) were used to evaluate multiple symptoms that children experienced during one chemotherapy cycle. The results showed that children with cancer most suffered psychological and physical symptoms, which were hair loss, fatigue, pain, lack of appetite, nausea, vomiting, sweating, feeling irritable, dry mouth, and so on.\textsuperscript{21,22} Core symptom adverse events reported by children with cancer included nausea, vomiting, fatigue, abdominal pain, constipation, diarrhea, oral mucositis, anorexia, anxiety, and insomnia, most of which were demonstrated to be symptoms by the National Cancer Institute Patient-Reported Outcomes version of the Common Terminology Criteria for Adverse Events and the Children's Oncology Group Nursing Discipline. With the above article reference,\textsuperscript{21,24} our research team discussed and confirmed the core symptoms in the report sections and identified which should be treated as the main problems to be addressed in symptom management.

Step 3: Individual interviews with experts in pediatric oncology and medical informatics

This section used a qualitative descriptive research method to interview medical staff engaged in the long-term care of children with cancer or IT specialists who have developed medical-related applications. This main topic in the interview focused on the current status and problems that need to be solved in symptom management and caring for children with cancer in clinical practice and recommendations for symptom management using mobile information technology in this population. The interview data were analyzed using content analysis. A total of 15 experts were interviewed, including 9 experts in the field of clinical nursing of childhood cancer, 2 experts in cancer nursing research, 2 doctors in the field of childhood cancer, and 2 IT specialists. Six were summarized as three themes of the current status of symptom management in clinical practice: The symptom management of children with cancer paid more attention to symptom assessment than to the intervention; the visible symptom behaviors of children with cancer, such as vomiting, getting much more concerned and care, and other symptoms mainly depended on active reports by children or their parents; and the symptom health education from nurses and doctors did not match the real-time needs of parents and children. Two themes were summarized for the comments and suggestions of symptom management program development: individualized symptom assessment and management determine the timing of intervention by parents, nurses, and doctors, which promotes cooperative care between children's families and doctors; and mobile health technology (i.e., smartphone application and WeChat Mini Program) for integrated symptom assessment and intervention that can be used as a potential means for children and their parents participating in symptom management. These themes and suggestions give us the true situation of symptom management practice in pediatric cancer patients and provide useful information for symptom assessment and intervention, and these were combined into the symptom management WeChat Mini Program for parents and their children with cancer.

Step 4: Symptom management framework development and modification of WeChat Mini Program (Child SMILE)

Based on the literature review, previous parent and expert interviews, and children's symptoms investigation, a multidisciplinary research team
Y. Liu et al. Asia-Pacific Journal of Oncology Nursing 9 (2022) 100166

The framework of the Mini Program. The researchers and subsequently discussed during the session to develop the main module and prototype of the WeChat Mini Program. A draft of the program was constructed, including personal information modules for children and parents, symptom assessment and management modules (core-symptoms and noncore symptoms), information and emotional support modules, and interactive communication modules (Table 2).

The iterative method was applied during the construction of the WeChat Mini Program. All participants who attended group meetings were involved in this process. Based on the module and functions of this program, software engineers developed the initial version of the Mini Program and Web-based administration portal with the basic structure, functions, and interface. The engineer was responsible for registration on the WeChat Mini Program platform, a cloud storage server, and gathering a team to complete the development of the front-end components, the back-end components, and interface design. The initial draft of the Mini Program was completed in approximately 60 days. Critical to the development of the published program were the quality analysis sessions, which were continuously conducted by the development team through various checks and tests of each version of the program. The core group members used and pretested the app and gave feedback on existing bugs, imperfections, or inapt functions, after which the engineers conducted further revisions until all members were satisfied with the Mini Program. The whole development process required six rounds of iterations lasting 4 months. The main structure and information support module contents are listed in Figs. 1 and 2.

Usability test of symptom management WeChat Mini Program “Child SMILE”

Purpose of the study

The purpose of the usability test is to evaluate the usability level of the symptom management WeChat Mini Program.

Table 1
General information of team members.

| No. | Gender | Age (years) | Educational level | Work area | Professional title |
|-----|--------|-------------|-------------------|-----------|--------------------|
| 1   | Female | 51          | Master’s         | Nursing   | Head nurse         |
| 2   | Female | 45          | Bachelor         | Nursing   | Nurse in charge    |
| 3   | Female | 35          | Ph.D.            | Doctor    | Attending doctor   |
| 4   | Male   | 41          | Bachelor         | Informatics engineer | Engineer |
| 5   | Male   | 46          | Ph.D.            | Informatics engineer | Engineer |
| 6   | Female | 37          | Bachelor         | Nursing   | Nurse in charge    |
| 7   | Female | 38          | Ph.D.            | Research  | Associate professor |
| 8   | Female | 34          | Ph.D.            | Research  | Lecturer           |
| 9   | Male   | 30          | Bachelor         | Parents (child with cancer) | / |

(Table 1) including health services researchers, pediatric nurses, and software engineers worked collaboratively in developing the main module and prototype of the WeChat Mini Program. A draft of the program structure, contents, and basic functions was completed by one of the researchers and subsequently discussed during the session to develop the framework of the Mini Program. The first-round discussion was conducted to develop the program for the symptom management program, including an information support module, a communication module, a psychological support module, and a symptom assessment and management module. After two rounds of discussion and improvement, the advantages of developing a WeChat Mini Program, the functions of the Mini Program and its Web-based administration portal, and ways of meeting parents and reporting and managing symptom needs were discussed. Discussions were recorded and continued until the information reached saturation. The structure and main contents of the symptom management WeChat Mini Program were constructed, finally including personal information modules for children and parents, symptom assessment and management modules (core-symptoms and noncore symptoms), information and emotional support modules, and interactive communication modules (Table 2).

The whole development process required six rounds of iterations lasting 4 months. The main structure and information support module contents are listed in Figs. 1 and 2.

Table 2
The structure of the symptom management program.

| Structure                       | Objectives                                                                 | Main Contents                                                                 |
|---------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Personal information module     | To provide parents and children with the ability to record their personal information, reading and symptom report records | Child and parent personal information                                        |
|                                 |                                                                            | Disease record (blood count, chemo days, etc.)                                |
|                                 |                                                                            | Symptom report record                                                         |
|                                 |                                                                            | Information Browsing record and favorites                                    |
| Symptom assessment and management module | To provide the instruments for children and their parents to report symptoms and get individualized information and communication support | Adopted from the Memorial Symptom Assessment Scale (MSAS 10–18), there were 31 symptoms to assess. (If the child was 5–9 years old, the parent would report symptoms; if the child was 10 and above, the child would report the feelings and symptoms). Once the assessment frequency was defined, there would be auto assessment reminders when the time comes |
|                                 |                                                                            | • Core symptoms (15 symptoms): Pain, fatigue, loss of appetite, lack of energy, hair loss, nausea, vomiting, fever, etc. If these symptoms were reported, individualized support information would be provided immediately |
|                                 |                                                                            | • Noncore symptom (16 symptoms): If these symptoms were reported, suggestions were to communicate with other parents or ask nurses or doctors in this program |
|                                 |                                                                            | Eight sections                                                                |
|                                 |                                                                            | • Personal recommendation: this section’s information was provided based on their symptom report or the information they were most interested in. |
|                                 |                                                                            | • Disease and treatment                                                        |
|                                 |                                                                            | • Commonly used drugs                                                          |
|                                 |                                                                            | • Blood count and bone marrow suppression                                      |
|                                 |                                                                            | • Caring support for unpleasant symptoms                                      |
|                                 |                                                                            | • Caring at home                                                               |
|                                 |                                                                            | • Emotional support for the child                                              |
|                                 |                                                                            | • Psychosocial support for parent                                              |
| Information and emotional support module | To meet the information and emotional needs of parents of children with cancer when caring for unpleasant symptoms | There are two sections                                                        |
|                                 |                                                                            | One platform was for parents to communicate with each other; and nurses and doctors also have the opportunity to join different topics, which were before chemotherapy, during chemotherapy, after chemotherapy and other topics. The other platform was a channel for the parents to ask questions related to the child’s adverse symptoms, and there were nurses or doctors to answer questions or give the advice to the hospital. |
| Communication module            | To provide a platform for parents to communicate the caring experience, ask questions and communicate with nurses or doctors | |
**Program evaluation procedure**

**Participants**

The convenience sampling method was used to recruit a total of 10 pairs of parents and children from two children’s hospitals in Shanghai. The inclusion criteria were as follows: (1) parents whose children were 5–17 years old, whose first to third courses of chemotherapy were planned and who would begin chemotherapy within two days; (2) parents who had a junior high school education level or above and had a smartphone that could run WeChat; and (3) parents and children who agreed to participate in this study. The exclusion criteria were as follows: Parent who had mental disorders or other circumstances that prevented them from participating or the child was under bone marrow transplantation or too ill to participate.

**Timing of data collection**

Data collection was conducted from September to October 2021.

**Data collection method and content**

The usability test procedure was conducted by a multidisciplinary team, including two nurses, one doctor, two researchers, one IT specialist, and one parent who was experienced in caring for the child and willing to participate in this study. The parent volunteer would give the parent care suggestions, and nurses and doctors would provide the other communication feedback; if the nurse could not answer, the doctor would give suggestions. The researchers and IT specialist worked collaboratively to guarantee the working of the Mini Program and to keep checking the tracks used from the web-based administration portal. All eligible participants were recruited from the hospitals. After the parents fully understood the aim of the study and signed the informed consent, the researchers helped the participants register the Mini Program accounts and gave them a brief introduction on how to use it. There was also a User Guide listed on the “Child SMILE” homepage for them to learn and check. They started to use the Mini Program for 1 month and were required to complete at least four symptom assessments based on their treatment situation and retrieve the tailored health information. Once the participant enrolled in this study, the assessment time was defined, and there were autoreminders if the patients did not report at the end of the timepoint. If the parents wanted to report during other times and receive feedback, they could choose and finish at any time. During the 1-month usage period, users could communicate with nurses and other parents of children with cancer via the Mini Program communicate.
module anytime they needed. If they had any program-used questions, the participants were entitled to contact the researchers through mobile phone calls or WeChat messages for more guidance or help.

Quantitative data were collected during one monthly usability test. One piece of data from the web-based administration portal contained tracks on how the parents performed and the time duration and frequency of the browsing on each page. The other was the Poststudy System Usability Questionnaire (PSSUQ) used to investigate satisfaction after one month of use. The 16-item PSSUQ evaluated the Mini Program’s overall usability and user satisfaction with relatively high reliability (Cronbach alpha was 0.94). The questionnaire was a seven-point Likert scale in which point 1 indicated “totally disagree,” and point 7 indicated “totally agree.” There were four dimensions: system usefulness, information quality, interface quality, and overall evaluation.

Qualitative data were collected through face-to-face semi-structured interviews at the end of the 1-month usage period. The interview questions included the following: (1) How do you feel about using the Mini Program generally? (2) How has this Mini Program helped you with child symptom care? (3) What do you think are the shortcomings or points of improvement of this Mini Program, any suggestions? (4) Would you like to continue using this Mini Program?

Data analysis

Descriptive analysis was used to describe the characteristics of parents and their children and the average score of each dimension of the PSSUQ. Qualitative data were recorded and transcribed after interview completion. Content analysis was used to extract significant information and suggestions.

Results

Participants and quantitative results

A total of 10 parents and 6 children (aged 10 or above) were included and kept using the Mini Program for 1 month, including 7 mothers and 3 fathers. The ages ranged from 5 to 14 years, and the main disease types were lymphoma and neuroblastoma (Table 3).

There were no system errors or interruptions reported, and there were 23 interactive posts. Communication occurred between parents and parents with nurses. All the questions or posts were answered within 24 h by researchers or nurses. Eleven of them were questions that occurred during the treatment intervals at home, and there were 5 posts during the treatment in hospitals and 3 before the chemotherapy sections and 4 other topic posts. The topics they were most concerned with were diet care, home care, and symptom self-care (eg, oral mucositis). The parents and child who finished the symptom reported 33 times (out of at least 40 times). There were no reported errors or interruptions in the symptom report or feedback section.

Quantitative usage data (Table 4) showed that the frequency of browsing the information support module was 895 times, and the browsing time was 904 min. The contents parents were most concerned...
about were caring support for unpleasant symptoms, education and guidance on home care, and blood count and bone marrow suppression. The quantitative data of the PSSQU (Table 5) showed that the parents of the children had a good evaluation of system usefulness, information quality, interface quality, and overall satisfaction.

### Qualitative result

The qualitative data showed that the general feelings of parents using the Mini Program were that it was useful and convenient and beneficial for managing the symptoms. There were also some suggestions that were adapted by the software for further improvement.

#### The feelings of parents using the Mini Program

1) **All the parents said the content of the Mini Program is quite professional and can be beneficial for managing the symptoms of cancer in children.** P10: Whenever my child is feeling bad, I will search the internet or ask for help in WeChat groups. However, the information on the internet is confusing, and sometimes parents' opinions in the group are not the same. Considering this Mini Program is developed by professionals, I trust the knowledge and reply there. P02: The Mini Program is good. I have read the content carefully and even took some screenshots to save the content. I think it is very beneficial and always leads to the correct actions to care for children. P03: The content is very useful. There is some important knowledge about blood and myelosuppression, which is hard for us to understand by just asking doctors but can gradually be absorbed by reading repeatedly.

2) **The Mini Program runs smoothly and is very convenient.** P02: It is very easy to use and never freezes … P09: The design of the interface is very reasonable. I like the search function which always gives me the answer quickly. P10: It is very convenient and has clear and detailed content. Although I cannot understand it the first time, I think it takes time.

3) **The interface is very friendly and interactive.** P07: The design of the interface is very reasonable and concise. I can easily find what I want to read. P09: The design of information classification is the information support module is very good. It makes it quite easy to find what I am interested in, and there is a search function. I think it is good. P05: The Mini Program is very good, which facilitates communication among parents and makes it possible for instant patient-clinician communications. I have posted something and always get the reply.

4) **All the participants expressed that they would keep using the Mini Program.** P03: I will still use the Mini Program because I think it is useful. If I have time, I would log on and read the content. I recommend it to other parents.

### Disadvantages and advice for further improvements of the Mini Program

1) **Add the postsharing function and more interaction modules.** P02: If there is any update in the content, it is more convenient to use the sharing function and send the link directly to us for fear that I cannot see the updates on time. (This function was added in the updated ?? version.) P10: I think the font is a little bit small as well as the texting area. It should make some modifications. P09: I want to have a recipe-sharing module. I want to learn to cook tasty food for my kid whenever he has no appetite. If there is any experience or good recipe, I want to know. (The text area was modified with the suggestion, and after team discussion, we think this was a good topic in the communication module. We encourage the parents to set up this topic and communicate with this.)

2) **Enrich the contents and forms of information support.** P09: My kid is suffering from medulloblastoma, and information about this disease is quite rare. I am wondering if you can add some of it. P02: My children and I both get anxious after he has the disease. If there is any positive message, like photos or videos of kids going to school after the end of treatment, we will be encouraged a lot and can see the brightness of the future. (The disease and updated information would be further developed in our future version, and the children who recovered from cancer would be a good example to give emotional support.)

### Discussion

**Appropriateness and usefulness of the “Child SMILE” WeChat Mini Program

This study described the process for the development and usability testing of symptom management WeChat Mini Program “Child SMILE”, which enables parents of children with cancer to better report and
manage unpleasant symptoms. In China, the WeChat application has more than 1.2 billion active users in 2022, and studies based on WeChat Mini Programs in health care have become more generalized and widespread. In our previous study, the parents also expressed that the WeChat app is a very popular way for them to obtain information and communicate with parents and medical professionals.17

Patient-centered design and iterative methods as rigorous methodology were used in the development process of this mini program. Patient-centered design is one of the most common principles in digital health-related product development.27,28 In pediatric health care studies, the patient-centered approach is recognized as a “family-centered design” as parents play a very important role in children’s health care and promotion. In this study, the patient-centered design was implemented and informed by the target user interviews, including interviews with parents and investigation of the symptom experiences of children with cancer. Historically, multiple studies on mHealth product development based on patient-centered design proved the products to be reasonable and acceptable.27 The patient-centered design should be grounded in both user and clinical realities to avoid inconsistency between the products and target user characteristics or requirements and clinical practice.29

Early involvement of medical professionals with patients in the product design process, development, and testing was the most likely approach for improving health outcomes.30,31 This study further confirmed that information directly from parents’ needs and children’s experiences would ensure the feasibility, validity, and future compliance of using the software among users. Based on the related expert interview, the “Child SMILE” Mini Program was developed by a multidisciplinary team through several rounds of discussion, assessments, and revisions, which ensured its professionalism, scientificity, and clinical applicability. The iterative method was used during the entire development process, which is also mainstream in digital health development,32 and it is a great way to save development time and ensure software quality.16

The “Child SMILE” Mini Program usability was tested in parents of children with cancer by using quantitative and qualitative methods. The first-step results of parent interviews showed that parents whose children were undergoing the first to third courses of chemotherapy had the highest demand for symptom management support.30 As this study aimed to develop the Mini Program with maximum support for the parents, these participants who were in the first three chemotherapy courses in this usability test participated. As shown in the usability test results, the Mini Program was acceptable and useful for parents to report and record children’s symptoms, meet the parents’ informational needs related to symptom caring during the chemotherapy cycle and be used both inside and outside the hospital. In addition, one of the research highlights of this program was the individualized symptom report, the automatic supportive information feedback and the communication between the parent and medical professional, which allowed the parent to receive real-time and intelligent feedback. It will be tested in a larger sample to obtain better utilization. In addition, although there were 23 interactive posts among parents and nurses and we also gave feedback within 24 h, some parents also worried at the time and chose to ask doctors or nurses immediately. After the usability test, this program was further improved based on the suggestions and comments. Next, the effects of the symptom management WeChat Mini Program will be conducted with parents of children with cancer to provide evidence for better family-centered symptom care.

| Limitations and future issues |
|-----------------------------|

One limitation of this app was the communication module. We have qualified clinical professionals to answer questions online, but we would suggest that if there is an emergency, parents should go to the hospital immediately. This limitation will be discussed and improved in future research and clinical applications. The other limitation is the limited samples and treatment restriction in the usability section. No children older than 14 years participated, and we will enlarge the sample and treatment phase in future studies.

Conclusions

The WeChat Mini Program “Child SMILE” and its administration website were designed based on interviews with parents and pediatric oncology experts and children’s symptom experiences. It was developed with multidisciplinary team meetings and discussions and underwent several iterative rounds. It was proven to have been accepted by parents of children with cancer aged 5–17 years old. The Mini Program had good usability and was well accepted by parents and children with cancer for reporting and managing children’s symptoms during cancer treatment, meeting parents’ needs and having the potential to promote symptom management in children with cancer.

Acknowledgements

The authors would like to express our gratitude to all the parents and children for their cooperation in this research.

Author contributions

Yanyan Liu: Conceptualization, Methodology, Investigation and Software development and usability test; Danyu Li: Quantitative and qualitative data analysis and, Writing – original draft preparation; Haishan Ruan: Data collection in interviews, investigation, usability test; Yun Hu: Methodology, Software development and usability test, Writing – original draft preparation and reviewing and editing. Nanping Shen: Give the guidance and support for all the study design and conduction. Such as conceptualization, methodology, Software development.

Declaration of competing interest

None declared.

Funding

This work was supported by the National Natural Science Foundation of China (Youth Program) (Grant No. 71704106), Shanghai JiaoTong University School of Medicine, the Nursing Development Program and the Innovative Research Team of High-level Local Universities in Shanghai (SHSMU-ZDCX20212800).

Ethics statement

Ethical approval of this study was approved by the Ethics Committee, School of Medicine, Shanghai Jiaotong University (Approval No. SJUPN-201704).

Table 5

| Dimension               | N   | Maximum | Minimum | Mean  | Standard deviation | Confidence Interval |
|-------------------------|-----|---------|---------|-------|-------------------|--------------------|
| System usefulness       | 10  | 4.00    | 7.00    | 5.57  | 1.22              | 4.70-6.44          |
| Information quality     | 10  | 3.83    | 7.00    | 5.22  | 1.05              | 4.46-5.97          |
| Interface quality       | 10  | 4.33    | 7.00    | 5.53  | 1.03              | 4.79-6.27          |
| Overall evaluation      | 10  | 4.00    | 7.00    | 5.60  | 1.17              | 4.76-6.44          |
References

1. Steliarova-Foucher E, Colombet M, Ries LAG, et al. International incidence of childhood cancer, 2001–10: a population-based registry study. Lancet Oncol. 2017; 18(6):719–731. https://doi.org/10.1016/S1470-2045(17)30186-9.

2. Chen W, Zheng R, Zuo T, Zeng H, Zhang S, He J. National cancer incidence and mortality in China, 2012. Chin J Cancer Res. 2016;28(1):1–11. https://doi.org/10.3978/j.issn.1000-9604.2016.02.08.

3. Chen W, Zheng R, Zhang S, et al. Report of incidence and mortality in China cancer registries, 2009. Chin J Cancer Res. 2013;25(1):10–21. https://doi.org/10.3978/j.issn.1000-9604.2012.12.84.

4. Hockenberry MJ, Hinds PS, Barrera P, et al. Three instruments to assess fatigue in children with cancer: the child, parent, and staff perspectives. J Pain Symptom Manag. 2003;25(4):319–328. https://doi.org/10.1016/s0885-3924(02)00680-2.

5. Hinds PS, Billups CA, Cao X, et al. Health-related quality of life in adolescents at the time of diagnosis with osteosarcoma or acute myeloid leukemia. Eur J Oncol Nurs. 2009;13(3):156–163. https://doi.org/10.1016/j.ejon.2008.08.003.

6. Baggott C, Dodd M, Kennedy C, Marina N, Miskowski C. Multiple symptoms in pediatric oncology patients: a systematic review. J Pediatr Oncol Nurs. 2009;26(6):325–339. https://doi.org/10.1177/1043454209340224.

7. Trotti A, Colevas AD, Setser A, Basch E. Patient-reported outcomes and the evolution of adverse event reporting in oncology. J Clin Oncol. 2007;25(32):5121–5127. https://doi.org/10.1200/JCO.2007.12.4794.

8. Twycross A, Parker R, Williams A, Gibson F. Cancer-related pain and pain management: sources, prevalence, and the experiences of children and parents. J Pediatr Oncol Nurs. 2015;32(6):369–384. https://doi.org/10.1177/104345421563751.

9. Ulh K, Burns M, Hale A, Coakley R. The critical role of parents in pediatric cancer-related pain management: a review and call to action. J Oncol Pract. 2018;34(5):198–206. https://doi.org/10.1200/JOP.2018.00501.

10. Tutelman PR, Chambers CT, Stinson JN, et al. Pain in children with cancer: prevalence, characteristics, and parent management. Clin J Pain. 2018;34(3):198–206. https://doi.org/10.1097/AJP.0000000000000531.

11. Parker RS, McKeever S, Twycross A, Wiseeman T. Understanding the toolbox: a mixed methods study of attitudes, barriers and facilitators in parental intervention of children’s cancer pain at home. J Child Health Care. 2021;25(1):126–145. https://doi.org/10.1177/1367493520912144.

12. Kerr LM, Harrison MB, Medves J, Tranmer JE, Fitch ML. Understanding the supportive care needs of parents of children with cancer: an approach to local needs assessment. J Pediatr Oncol Nurs. 2007;24(5):279–293. https://doi.org/10.1177/1043454207304907.

13. Wang J, Yao NA, Liu Y, et al. Development of a smartphone application to monitor pediatric patient-reported outcomes. Comput Inform Nurs. 2017;35(11):596–598. https://doi.org/10.1097/CIN.0000000000000257.

14. Tang L, Chen D, Shao J, Zhang H, Wu J, Ye Z. Design and development of a Wechat applet for intelligent health management of metabolic syndrome. J Zhejiang Univ. 2022;51(1):115–121. https://doi.org/10.3724/spjxdbyb-2021-0386.

15. Hudis CA, Castells A, Carrasco S, et al. Postoperative pain: a systematic review of current knowledge and consensus recommendations to improve postoperative pain management. Cancer. 2009;115(12):2813–2829. https://doi.org/10.1002/cncr.24622.

16. Hudis CA, Castells A, Carrasco S, et al. Postoperative pain: a systematic review of current knowledge and consensus recommendations to improve postoperative pain management. Cancer. 2009;115(12):2813–2829. https://doi.org/10.1002/cncr.24622.

17. Wang J, Yao NA, Liu Y, et al. Development of a smartphone application to monitor pediatric patient-reported outcomes. Comput Inform Nurs. 2017;35(11):596–598. https://doi.org/10.1097/CIN.0000000000000257.

18. Liu Y, Chen D, Shao J, Zhang H, Wu J, Ye Z. Design and development of a Wechat applet for intelligent health management of metabolic syndrome. J Zhejiang Univ. 2022;51(1):115–121. https://doi.org/10.3724/spjxdbyb-2021-0386.

19. Hudis CA, Castells A, Carrasco S, et al. Postoperative pain: a systematic review of current knowledge and consensus recommendations to improve postoperative pain management. Cancer. 2009;115(12):2813–2829. https://doi.org/10.1002/cncr.24622.

20. Liu Y, Shen N, Sun J, Ruan H, Liu Y. Experience and needs of symptom management care for parents of children with cancer during chemotherapy: a qualitative study [J]. Chin J Med Nurs. 2020;26(35):491–498. https://doi.org/10.3760/cma.j.cn115602-20200721-04513.

21. Liu Y, Ruan H, Sun J, Wang X, Shen N. Multiple symptoms in children and adolescents with malignant solid tumors during radiotherapy [J]. Chinese Nursing Management. 2021;21(7):1009–1013. https://doi.org/10.3969/j.issn.1672-1756.2021.07.011.

22. Liu Y, Sun J. Investigation and analysis of multiple symptoms in children and adolescents with malignant solid tumors during radiotherapy [J]. Chinese Nursing Management. 2021;21(7):1009–1013. https://doi.org/10.3969/j.issn.1672-1756.2021.07.011.

23. Reeve BB, McFatrich M, Mack JW, et al. Validity and reliability of the pediatric patient-reported outcomes version of the common Terminology criteria for adverse events [J]. J Natl Cancer Inst. 2020;112(11):1143–1152. https://doi.org/10.1093/jnci/djaa016.

24. Linder LA, Hooke MC. Symptoms in children receiving treatment for cancer–Part II: pain, sadness, and symptom clusters. J Pediatr Oncol Nurs. 2019;36(4):262–279. https://doi.org/10.1177/104345421945978.

25. Lewis JR. IBM computer usability satisfaction questionnaires: psychometric evaluation and instructions for use. Int J Hum Comput Interact. 1995(7):57–78. https://doi.org/10.1080/10447319509526110.

26. Li Z. Liu Y, Nursing Research Methods[J]. 2nd ed. Beijing: People’s Health Publishing House; 2018:286–289.

27. Mitchell KM, Holtz BE, McCarroll A. Patient-centered methods for designing and developing health information communication technologies: a systematic review. Telemed J e Health. 2019;25(11):1012–1021. https://doi.org/10.1089/ tmj.2018.0236.

28. Vaisson G, Provencher T, Dugas M, et al. User involvement in the design and development of patient decision aids and other personal health tools: a systematic review. Med Decis Making. 2021;41(3):261–274. https://doi.org/10.1177/0272989X20984134.

29. Comert VP, Dagle C, Bolchini D, Toscos T, Mirro MJ, Holden RJ. Patient-centered Design Grounded in User and Clinical Realities: Towards Valid Digital Health. Los Angeles, CA: SAGE Publications Sage CA; 2019:100–104.

30. De Vito Dabbs A, Myers BA, Mc Carry KR, et al. User-centered design and interactive health technologies for patients. Comput Inform Nurs. 2009;27(3):175–183. https://doi.org/10.1097/NCII.0b013e31819f7c7.

31. Epstein RM, Ferrick K, Lesser CS, Stange KC. Why the nation needs a policy push on patient-centered health care. Health Aff. 2010;29(8):1489–1495. https://doi.org/10.1377/hlthaff.2009.106241.