PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Mobile health–based gamification intervention to increase physical activity participation among patients with coronary heart disease: Study protocol of a randomized controlled trial
AUTHORS	Xu, Linqi; Li, Jinwei; Zhang, Xin; Pang, Yue; Yu, Tianzhuo; Lian, Xiaoqian; Yu, Tianyue; Zhu, Lanyu; Tong, Qian; Li, Feng

VERSION 1 – REVIEW

REVIEWER	Redfern, Julie University of Sydney, Westmead Clinical School
REVIEW RETURNED	25-Jul-2021

GENERAL COMMENTS	Double-blinded three-arm randomized controlled trial with 108 patients with coronary heart disease (Control group: WeChat applet + step goal setting; Individual group: WeChat applet + step goal setting + gamification; Team group: WeChat applet + step goal setting + gamification + collaboration). The primary outcome is the change in daily step count and the proportions of patient-days that step goals were achieved, which will be measured using the smartphone accelerometer. There are several relevant secondary outcomes. It is great to see inclusion of intervention experience in the Methods. Few suggestions for improvement below. • This sentence of page 3 confused me “The study period was 24 weeks; thus, we could not evaluate and maintain the intervention in 12 months” – has the study already been conducted? This is a strange sentence. • Background and aims are well written and appropriate. The CONNECT trial does give a good comparison in terms of the cohort and intervention with behaviour changes strategies designed to enhance engagement and authors consider ref to this paper https://www.nature.com/articles/s41746-020-00325-z • Intervention development is well described as are various clinical trial components such as sample size and randomisation. • It is a multilayer and complex intervention and with the sample size presented it will be challenging to say results will be much more than a pilot study given there will be 3 groups. • Well done including good involvement of patients/consumers. • Doesn’t seem necessary to include abbreviations for AHA, ESC, ACC as there are already a lot of abbreviations in the paper. I also suggest spelling out physical activity each time rather than abbreviating to PA. Similar for “CR center” – does this mean cardiac rehabilitation center? Perhaps no need to abbreviate and best to spell out throughout in this case.

REVIEWER	Fatehi, Farhad University of Queensland
REVIEW RETURNED	20-Oct-2021

GENERAL COMMENTS	Mobile health–based gamification intervention to increase physical activity participation among patients with coronary heart disease: Study protocol of a randomized controlled trial The authors have described the protocol of a randomised controlled trial for assessing the effect of a gamified mobile health system (based on the principles of Behaviour Economics) on physical activity of people with chronic heart diseases. The topic of the paper is interesting and timely, and can address a common problem of low uptake and poor retention with mHealth for chronic conditions. It is an RCT with three arms (control: applet, individual intervention: applet plus gamification, and team intervention: applet plus gamification and teamworking). The study has been clearly described and the paper is well written. Here I would like to offer some places for improvement and more clarity as below: 1. The aim of the study in different parts of the manuscript has been written (slightly) differently. It would be good if the authors state the aim of the study consistently throughout the manuscript. 2. The authors have claimed that this RCT is double blind, and have described the measures that they has in mind to achieve it, but in practice, it is very difficult, if not impossible, to blind an mHealth intervention for the participants since they may meet other patients (especially if the recruitment is arranged in a limited number of clinics) and talk to each other about the intervention. 3. It seems that the trial has been concluded since some of the sentences are in the past tense (e.g. “Personalized goal setting and progress tracking on WeChat applet allowed patients to exercise at home.”) however, for a protocol paper, the sentences concerning the intervention and methods should be written in future tense. 4. The first line of the Conclusion reads “This study will test the usage of a smartphone and WeChat applet-based gamification intervention to increase PA at home.”. It was not clear until the end of the manuscript that the researchers were aiming for increasing physical activity at home. However, in section 2.4, we read “… stratified by the participant baseline step count (<5000, 5001 – 7500, or 7500 steps/day)” It is unlikely that people can achieve 10,000 steps per day at home. Please clarify. 5. In section 2.7, it says “In addition, usability will be tested at the end of the intervention (at 12 weeks) in the two intervention groups.” Please clarify how usability of the system will be measured? 6. In several instance authors mention “perceived enjoyment” and “perceived competence”. As far as the participants in the intervention group concern, these should be “enjoyment” and “competence” because at the end of the study, they have worked with and experienced the system. Those two terms may be applicable for the participants in the control group. 7. In section 2.5, the authors say they will increase the number of steps by 15% per week for the first six weeks for all the participants who are CHD patients. How they make sure that this increase in physical activity is not harmful for the participants? Overall, this is a very well-designed study, and I am looking forward to read the results of this trial in future.

VERSION 1 – AUTHOR RESPONSE

Reviewer: 1
Comments to the Author:
Double-blinded three-arm randomized controlled trial with 108 patients with coronary heart disease (Control group: WeChat applet + step goal setting; Individual group: WeChat applet + step goal setting + gamification; Team group: WeChat applet + step goal setting + gamification + collaboration). The primary outcome is the change in daily step count and the proportions of patient-days that step goals were achieved, which will be measured using the smartphone accelerometer. There are several relevant secondary outcomes. It is great to see inclusion of intervention experience in the Methods. Few suggestions for improvement below.
Response: Thank you so much for your valuable suggestions which could greatly help improve our paper. We have uploaded a clean (non-tracked) revised Word document of our manuscript in the submitting system. All revised portion in our manuscript has been stressed with red color both in the following and in the Main Document-marked copy which we would like to submit for your kind consideration. We hope to meet with approval.

• This sentence of page 3 confused me “The study period was 24 weeks; thus, we could not evaluate and maintain the intervention in 12 months” – has the study already been conducted? This is a strange sentence.
Response: We would like to apologize for that unclear statement sincerely. The study has not been conducted yet. We have removed this sentence on Page 3 and in the Limitation section.

• Background and aims are well written and appropriate. The CONNECT trial does give a good comparison in terms of the cohort and intervention with behaviour changes strategies designed to enhance engagement and authors consider ref to this paper https://www.nature.com/articles/s41746-020-00325-z
Response: We are so grateful for your useful suggestion and we think it is very valuable for improving our paper. The CONNECT trial is such a large and multicenter RCT to evaluate the effect of a consumer web-based app linked to primary care electronic health records (EHRs) on guideline-recommended medication adherence, cardiovascular risk factor control and lifestyle behaviors. There were significantly more participants meeting recommended levels for physical activity (87 vs 79.7%, p = 0.02) in the intervention than the control group. This study could really enrich the background of our paper. So we have added “For example, the CONNECT trial examined the impact of digital health interventions on health behaviors and established the correlation between intervention and increased attainment of physical activity targets.” in the Background section on Page 4 line 9-11 of the current submitted revised manuscript.

• Intervention development is well described as are various clinical trial components such as sample size and randomization.
Response: Many thanks for your positive comments.

• It is a multilayer and complex intervention and with the sample size presented it will be challenging to say results will be much more than a pilot study given there will be 3 groups.
Response: Yes. It is really one of the limitations in our study. We have added “Fourth, it is a multilayered and complex intervention, and the projected sample size will make it challenging to say that the results will be much more than a pilot study given there will be three groups.” in the Limitation section on Page 16 line 13-14 of the current submitted revised manuscript.

• Well done including good involvement of patients/consumers.
Response: We really appreciate your positive comments.

• Doesn't seem necessary to include abbreviations for AHA, ESC, ACC as there are already a lot of abbreviations in the paper. I also suggest spelling out physical activity each time rather than abbreviating to PA. Similar for "CR center" – does this mean cardiac rehabilitation center? Perhaps no need to abbreviate and best to spell out throughout in this case.
Response: Thanks a lot for your valuable suggestion. It's very helpful to improve the quality of our paper. We have thoroughly reviewed the article and removed the abbreviations AHA(American Heart Association), ESC(European Society of Cardiology), ACC(the American Society of Cardiology), PA(Physical activity), CRP(Cardiac Rehabilitation Program), CR(Cardiac Rehabilitation), BE(Behavioral Economics) and CR center(Cardiac Rehabilitation center), and we have spelled them out in the current submitted revised manuscript. We hope to meet with approval. Thanks again.

Reviewer: 2
Comments to the Author:
Mobile health–based gamification intervention to increase physical activity participation among patients with coronary heart disease: Study protocol of a randomized controlled trial

The authors have described the protocol of a randomised controlled trial for assessing the effect of a gamified mobile health system (based on the principles of Behaviour Economics) on physical activity of people with chronic heart diseases.

The topic of the paper is interesting and timely, and can address a common problem of low uptake and poor retention with mHealth for chronic conditions. It is an RCT with three arms (control: applet, individual intervention: applet plus gamification, and team intervention: applet plus gamification and teamworking). The study has been clearly described and the paper is well written. Here I would like to offer some places for improvement and more clarity as below:
Response: Many thanks for your positive comments and valuable suggestions. All revised portion in our manuscript has been stressed with red color both in the following and in the text. The "Main document" and the "Main Document - marked copy" have been uploaded which we would like to submit for your kind consideration. Thank you again.

1. The aim of the study in different parts of the manuscript has been written (slightly) differently. It would be good if the authors state the aim of the study consistently throughout the manuscript.
Response: We are so grateful for your constructive comment and we think the suggestion is very valuable for improving our paper. This study aims to investigate the effects of the mHealth-based gamification intervention on participation in physical activity and evaluate the effects on biomedical and lifestyle-related risk factors, intrinsic motivation, enjoyment, competence, autonomy, and relatedness,social support and mental health. We have changed the aim in the Method and Discussion section to keep it consistent with it in the Background section. Thank you again.

2. The authors have claimed that this RCT is double blind, and have described the measures that they has in mind to achieve it, but in practice, it is very difficult, if not impossible, to blind an mHealth intervention for the participants since they may meet other patients (especially if the recruitment is arranged in a limited number of clinics) and talk to each other about the intervention.
Response: We really appreciate your useful comments. Yes, we found it is really difficult to blind participants when implementing the intervention. So we have changed "double-blinded" into "single-blinded" in the Methods section, "2.1 study design" on Page 5 line 21. We have also changed "double-blinded" into "single-blinded" accordingly in the Abstract. In addition, we have changed "Participants and data collector will be unaware of patient assignments at the baseline, 12 weeks, and 24 weeks of the study" into "The data collector will be unaware of patient assignments at the baseline, 12 weeks,

and 24 weeks of the study." in the Methods section, "2.4 Randomization, blinding, and concealed allocation" on Page 7 line 19-20 of the current submitted revised main document. Thank you again for your valuable suggestion.

3. It seems that the trial has been concluded since some of the sentences are in the past tense (e.g. "Personalized goal setting and progress tracking on WeChat applet allowed patients to exercise at home.") however, for a protocol paper, the sentences concerning the intervention and methods should be written in future tense.
Response: Thank you so much for your patient guidance! The trial has not been conducted yet and we would like to apologize for that error sincerely. We have changed "Personalized goal setting and progress tracking on WeChat applet allowed patients to exercise at home" into "Personalized goal setting and progress tracking on WeChat applet will allow patients to exercise under supervision" in the Discussion section on Page 15 line 8-9 of the current submitted revised main document. We have thoroughly checked and revised the tense of the article. Furthermore, we have used English language editing service and thoroughly reviewed the article by an English native speaker to improve the language.

4. The first line of the Conclusion reads "This study will test the usage of a smartphone and WeChat applet-based gamification intervention to increase PA at home.". It was not clear until the end of the manuscript that the researchers were aiming for increasing physical activity at home. However, in section 2.4, we read "… stratified by the participant baseline step count (<5000, 5001 – 7500, or 7500 steps/day)" It is unlikely that people can achieve 10,000 steps per day at home. Please clarify.
Response: We really appreciate your constructive comments and we would like to apologize for our unclear statement sincerely. We originally wanted to express that physical activity after discharged from the hospital, physical activity in the garden, supermarket and park are all considered to be "at home". The intervention will not be conducted in the hospital, but outside the hospital, that is, at home. In order to express more clearly, we have removed "at home" in the Discussion section. Thank you again.

5. In section 2.7, it says "In addition, usability will be tested at the end of the intervention (at 12 weeks) in the two intervention groups." Please clarify how usability of the system will be measured?
Response:Thank you a lot for your useful suggestion. In this study, we used System Usability Scale(SUS) to test the usability. we have added "In addition, usability will be tested at the end of the intervention (at 12 weeks) in the two intervention groups using System Usability Scale(SUS)." in the Methods section, "2.7Outcome measures and data collection" on Page 11 line 9 of the current submitted revised main document.

6. In several instance authors mention "perceived enjoyment" and "perceived competence". As far as the participants in the intervention group concern, these should be "enjoyment" and "competence" because at the end of the study, they have worked with and experienced the system. Those two terms may be applicable for the participants in the control group.
Response: We really appreciate for your valuable suggestions. Yes, "enjoyment" and "competence" may be more applicable for the participants in the intervention group. So we have removed "perceived" in the the current submitted revised main document.

7. In section 2.5, the authors say they will increase the number of steps by 15% per week for the first six weeks for all the participants who are CHD patients. How they make sure that this increase in physical activity is not harmful for the participants?
Response: Thank you so much for you constructive comment. We referred to a previous study by Chokshi NP. Et al[41] which described this personalized step goal setting method for patients with cardiovascular disease. We have added "To ensure the increase in physical activity is not harmful to participants, the rehabilitation therapists in our research group will assess the condition of each

patient and make appropriate adjustments of the step goals. Participants could contact us at any time to make an adjustment if it is due to physical conditions. ” in the Methods section, “2.5 Control” on Page 8 line 5-7 of the current submitted revised main document.

Overall, this is a very well-designed study, and I am looking forward to read the results of this trial in future.
Response: Thank you so much for these valuable suggestions. We will do our best to improve and implement this trial!

VERSION 2 – REVIEW

REVIEWER	Redfern, Julie University of Sydney, Westmead Clinical School
REVIEW RETURNED	24-Nov-2021

GENERAL COMMENTS	Overall a very well constructed study and well-written paper. The gamification and concept of individuals and teams is novel and of interest. Minor revisions as per below are suggested. 1. “study duration will be between July 1, 2021 and November 30, 2022.” What is current status of the trial? 2. Provide more explicit detail about when and where participants will be recruited and how data will be collected. It is a large batch of data that the authors propose to collect. 3. How will loss to follow-up and missing data be handled?

REVIEWER	Fatehi, Farhad University of Queensland
REVIEW RETURNED	20-Dec-2021

GENERAL COMMENTS	The authors have addressed all my comments. I have no further comments.

VERSION 2 – AUTHOR RESPONSE

Reviewer: 1

Comments to the Author:

Overall a very well constructed study and well-written paper. The gamification and concept of individuals and teams is novel and of interest. Minor revisions as per below are suggested.

1. “study duration will be between July 1, 2021 and November 30, 2022.” What is current status of the trial?

Response: Thank you very much for your comment. We recruited participants from July 1,2021 and we completed the recruitment on November 12, 2021. Now most of the patients are in the intervention period and some patients have gone into the follow-up period (for example, patients were recruited in July). We used a block randomization (block 6) method to prevent uneven distribution of time for

enrollment.We hope we could complete the outcome data collection in July 2022 and plan to complete the data analysis and paper writing in November 2022.

2. Provide more explicit detail about when and where participants will be recruited and how data will be collected. It is a large batch of data that the authors propose to collect.

Response: We really appreciate your valuable suggestions. The First hospital of Jilin University is a large-scale hospital, every day, there are 10-20 patients after PCI referred to the cardiac rehabilitation center which is adjacent to the wards to receive physical activity counseling and obtain the follow-up booklet before discharge. The follow-up booklet will remind patients to return for review in 4 weeks, 12 weeks, 24 weeks, and 12 months after discharge, which is very helpful to avoid patients' loss to follow-up. In the rehabilitation center, researchers will screen the eligible patients and then inform the patients about the details of the study. If they agree to participate in the study, they will have to sign the written consent form and complete the questionnaires using a traditional pen and paper method. We will mark the specific date of 12 and 24 weeks of his returning to complete the outcome measurement on his follow-up booklet and tell him if he is not available on that day; he could contact us to change the date accordingly.

Patients recruited in the trial will be asked to complete the questionnaires and outcome measurements in the cardiac rehabilitation clinic when they return to hospital for a review. The follow-up booklet will remind patients to return to the hospital for review and the Wechat applet will remind patients to complete the outcome measurements in 12 weeks and 24 weeks.If the patient does not return on time, researchers will telephonically inquire about the reasons. We will also report the numbers and reasons of patients lost to follow-up.

We have described the details in the revised manuscript and we hope it is clear. Thank you again!

3. How will loss to follow-up and missing data be handled?

Response: Thank you so much for your question. It's really an important issue. We will report the number of patients lost to follow-up and use intentional analysis to analyze the reasons. We think it would also be interesting to compare the baseline differences between patients lost to follow up and patients who adhere to follow-up. So in the statistical analysis section, we proposed to use two methods (main analysis with multiple imputations and second analysis without imputations). "In the main analysis, the analysis of outcomes will be conducted per the intention-to-treat principle. In addition, multiple imputations for data will be used that are missing and with step values <1000 because evidence indicates that these values are unlikely to represent the capture of actual activity. In the secondary analysis, data analysis will be conducted without multiple imputations, both with and without step values <1000. " We hope it is clear in the revised manuscript, thank you!

Reviewer: 2

Comments to the Author:

The authors have addressed all my comments. I have no further comments.

Response: We really appreciate your review. Best wishes.