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a protocol for a systematic review and meta-analyses from the eHealth Junior Consortium

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ABSTRACT

Introduction Young people (aged 10–25 years) with chronic diseases are vulnerable to have reduced social participation and quality of life. It is important to empower young people to engage in their chronic diseases self-management. In comparison with traditional face-to-face care, interventions delivered through the internet and related technologies (eHealth) are less stigmatising and more accessible. Gamified eHealth self-management interventions may be particularly promising for young people. This systematic review aims at identifying (1) the game mechanics that have been implemented in eHealth interventions to support young people's self-management of their chronic (somatic or psychiatric) diseases, (2) the investigators' rationale for implementing such game mechanics and, if possible, (3) the effects of these interventions.

Methods and analysis The Preferred Reporting Items for Systematic reviews and Meta-Analysis statement guidelines will be followed. A systematic search of the literature will be conducted in Embase, Psycinfo and Web of Science from inception until 30 August 2022. Studies will be eligible if focused on (1) young people (aged 10–25 years) with chronic diseases and (2) describing gamified eHealth self-management interventions. When possible, the effects of the gamified interventions will be compared with non-gamified interventions or care-as-usual. Primary quantitative, qualitative or mixed-method studies written in English will be included. Two independent reviewers will (1) select studies, (2) extract and summarise the implemented game mechanics as well as the characteristics of the intervention and study, (3) evaluate their methodological quality and (4) synthesise the evidence. The reviewers will reach a consensus through discussion, and if required, a third researcher will be consulted.

Ethics and dissemination As systematic reviews use publicly available data, no formal ethical review and approval are needed. Findings will be published in peer-reviewed journals, presented at conferences and communicated to relevant stakeholders including patient organisations via the eHealth Junior Consortium.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The main strengths of this protocol rely on its carefully designed search strategy, inclusion/exclusion criteria and time-span coverage.
⇒ The review will be conducted within the eHealth Junior Consortium, ensuring the incorporation of the complementary expertise of researchers from various disciplines including, but not limited to, paediatrics, psychiatry, psychology, game design and industrial design.
⇒ The dissemination of the findings within the consortium will reach a broad public of researchers, clinicians, patient organisations, knowledge centres, game designers, industrial designers, insurance companies and business professionals.
⇒ Although the inclusion of heterogeneous samples and interventions may be seen as a limitation, it may help to identify relevant game mechanics that are universal across eHealth interventions for young people with chronic (somatic or psychiatric) diseases.

INTRODUCTION

Growing up with chronic (somatic or psychiatric) diseases impacts all domains of daily life including one's quality of life and social participation. In adolescents and young adults (hereafter referred to as young people, defined as 10–25 years old[1–3]), chronic diseases are health conditions that last for more than 3 months (eg, asthma, chronic

fatigue and depression) or are potentially life-threatening (eg, cancer).[4] In high-income countries, the prevalence of chronic diseases in young people is increasing, and the mortality rate is decreasing.[5 6] Importantly, 15%–25% of the young people are now living with chronic diseases in high-income countries.[6 7]

Self-management is important to improve young people's health status and alleviate the burden of their chronic diseases.[8] Self-management is the behaviour that people use to manage their chronic diseases and associated effects (eg, symptoms, treatment, physical and psychosocial consequences, and lifestyle changes).[9] This behaviour includes problem solving, decision making, using resources, forming a relationship with a provider and taking action[10] in order to perform medical management, adopt new behaviours or roles, and coping emotionally.[11] In summary, self-management is what young people with chronic diseases do to manage the impact of their conditions on their daily life.[12] Although interventions to support young people with the self-management of their chronic diseases show positive effects, these effects are often short-lived.[12] To achieve long-term benefits, a challenge is sustaining therapy adherence. Interventions delivered through the internet and related technologies (eHealth) are promising for young people because a number of treatment barriers are overcome (eg, increased accessibility and anonymity, which may reduce the stigma commonly experienced by young people) and treatment burden is reduced (eg, time and costs).[13] Furthermore, eHealth can incorporate game mechanics, which are elements of games aimed at improving user experience and user engagement (eg, badges, unlocking milestones and narrative). Game mechanics align with young people's natural interest in play, which is important for their healthy development.[14] Thus, incorporating game mechanics into eHealth self-management interventions for young people with chronic diseases may be a particularly promising approach.

To our knowledge, available reviews have identified the game mechanics previously used in eHealth interventions in the general population[15–20] but not in young people with chronic diseases specifically. Importantly, certain game mechanics in eHealth may affect health self-management differently depending on health status.[21] Thus, it is valuable to provide a transdiagnostic overview of game mechanics previously used in gamified eHealth interventions for the self-management of any chronic disease in young people. In particular, the knowledge gained will inform the development of novel gamified eHealth interventions.

In 2021, the eHealth Junior Consortium was established in the Netherlands. The aim of this consortium is to develop, evaluate and implement transdiagnostic and personalised eHealth tools providing personalised behaviour-modifying interventions for young people with chronic diseases. This multidisciplinary consortium includes researchers, paediatricians, psychiatrists, psychologists, patient organisations, knowledge centres, game designers, industrial designers, insurance companies and business professionals. The first aim of the consortium is to gain insights about game mechanics that have been implemented in gamified eHealth self-management interventions for young people with chronic diseases. These insights will inform the development of eHealth tools by the eHealth Junior Consortium.

Objective

This systematic review aims to identify (1) the game mechanics that have been implemented in eHealth interventions to support young people's self-management of their chronic (somatic or psychiatric) diseases, (2) the investigators' rationale for implementing such game mechanics and, if possible, (3) the effects of these interventions.

Review questions

Primary question

Which game mechanics have been implemented in eHealth interventions aimed to support young people in their chronic diseases self-management?

Secondary questions

(1) what was the rationale behind the implementation of each game mechanic? and, if possible, (2) what were the effects of gamified eHealth interventions on self-management and health-related outcomes?

METHODS

Patient and public involvement

The present protocol has been approved by the steering committee of the eHealth Junior Consortium, and preliminary findings will be discussed in a meeting of the consortium. Additionally, we will present our findings to young people with chronic diseases, their families and other relevant stakeholders (eg, giving talks and interacting in social media with local associations of young people with chronic diseases). The general public will be reached through the website of the eHealth Junior Consortium, oral presentations and mass media interviews with the members of the consortium.

Inclusion criteria

According to the PICOS approach, the inclusion criteria will be:

Participants

Adolescents or young adults (aged 10–25 years, as defined by the WHO, United Nations and Society for Adolescent Health and Medicine[1–3]) diagnosed with a chronic disease, defined as a health condition that lasts more than 3 months (eg, asthma, chronic fatigue and depression) or is potentially life-threatening (eg, cancer).[4]

Intervention

Gamified eHealth self-management interventions explicitly mentioning the implemented game mechanics.

Gamified refers to the use of game mechanics such as badges, leaderboards and points.[22–24] eHealth refers to information delivered or enhanced through the internet and related technologies. Self-management refers to the behaviour that people use to manage their chronic diseases and its associated effects (eg, symptoms, treatment, physical and psychosocial consequences, and lifestyle changes).[9] An intervention is considered intended for self-management (even if not explicitly stated), if it addresses at least one of the following behaviours: problem solving, decision making, using resources, forming a relationship with a provider or taking action,[10] performed in the domains of medical management, adopting new behaviours or roles, or psychosocial coping.[11]

Comparator

It applies to the secondary review question only and for studies that included a comparison arm. We will compare (1) gamified eHealth interventions versus usual care (comparator) or (2) gamified versus non-gamified (comparator) versions of eHealth interventions.

Outcome measures

It applies to the secondary review questions only. To assess the effects of the gamified interventions, we will focus on three categories of outcomes. First, self-management behaviours including: problem solving, decision making, using resources, forming a relationship with a provider and taking action,[10] performed in the domains of medical management, adopting new behaviours or roles, and psychosocial coping.[11] Second, consequences of self-management, for example, health outcomes, quality of life and social participation.[25 26] Third, antecedents of self-management, for example, adherence, acceptability, side effects and user's experience.[25 26]

Studies

Peer-reviewed manuscripts or full text conference proceedings reporting primary findings from quantitative, qualitative or mixed-method studies will be included. Studies will be excluded if they are (1) double reporting of the same data, (2) not written in the English language, (3) mixed samples including other than young people with a chronic disease and do not report outcomes separately and (4) reviews. If the full text is not available, the study will be excluded as well. No date restrictions will be applied.

Search strategy for identifying relevant studies

Two independent reviewers will perform a primary electronic search on 30 August 2022. An experienced information specialist (WMB) developed the search strategies in the databases Embase, Psycinfo Ovid and Web of Science Core Collection. See online supplemental appendix 1 for more information on the exact databases used and the full search strategy. The search used Emtree terms for Embase but also searched terms in title or abstract. The search consists of an element with terms for chronic disease, including the most common specific chronic disease, and a second element with terms for eHealth, including terms for devices and applications. These were completed by a third element with terms for self-management or coping and a fourth element containing terms for young people.

Grey literature will be addressed by emailing (1) the authors of the protocols recovered from our primary electronic search to include their findings in this review and (2) all the members of the eHealth Junior Consortium to provide, if available, unpublished additional eligible studies.

Selection of studies for inclusion in the review

Metadata will be imported into Mendeley Desktop, where duplicates will be automatically deleted. Two independent researchers will screen records retrieved by the electronic search for identifying potential studies and their suitability. First, the studies will be screened by title and abstract. Second, the selected studies will be examined in full text to decide their definitive inclusion. When disagreements emerge between the two independent researchers, consensus will be obtained through discussion, or when required, the opinion of a third researcher will be considered.

Risk of bias (quality) assessment

Two researchers will independently assess the risk of bias of each eligible study using the Mixed Methods Appraisal Tool (MMAT).[27] The MMAT allows to appraise the methodological quality of five study categories: (1) qualitative research, (2) randomised controlled trials, (3) non-randomised trials, (4) quantitative descriptive studies and (5) mixed methods studies. Disagreements on these assessments will be solved in a consensus meeting between the independent reviewers with another member of the team.

Data extraction and management

Two independent reviewers will extract the following data for each study: (1) reference, (2) characteristics of participants (total sample number, sex, age and chronic disease(s)), (3) characteristics of the intervention including implemented game mechanics, the rationale for implementing each game mechanic and the self-management behaviours that were addressed by the intervention, (4) design of the study, (5) if applicable, details of the comparator group, (6) if applicable, outcome measures and findings, (7) methodological quality of individual studies and (8) funding sources. When discrepancies emerge in the coding between the two researchers' results, these will be discussed with a third reviewer to reach a consensus.

Data synthesis and analysis

A narrative (descriptive) synthesis will be conducted for the primary and secondary review questions. Additionally, the preliminary findings of the secondary review question will be presented in eHealth Junior Consortium meetings, where we will discuss the possibility of performing meta-analyses of the included randomised trials including

a comparator group. We will conduct meta-analyses if at least 10 studies having a comparator group are included. The quantitative synthesis would be as follows: random-effect models will be conducted using Review Manager V.5.3 (RevMan, Cochrane Collaboration, Copenhagen, Denmark). Statistical significance would be set at $p<0.05$. Because different continuous outcomes would be pooled, standardised mean differences (SMDs) would be calculated. SMD effect sizes would be calculated using Hedges' g method (similar to Cohen's d). Effect sizes of 0.2, 0.4 and 0.8 would be considered small, moderate and large, respectively. Heterogeneity would be measured using the I^2 statistic (the percentage of total variability attributed to between-study heterogeneity). In case of observing high heterogeneity ($I^2 \geq 50\%$), potential effect moderators would be explored with post hoc analyses. Finally, the presence of publication bias would be assessed using visual inspection of funnel plots.

Presentation and reporting of results

The findings of the present systematic review will be reported following the Preferred Reporting Items for Systematic reviews and Meta-Analyses statement.[28] We will illustrate the process of study selection using a flow diagram. A table with the main characteristics of each study will also be provided. For transparency purposes, supplementary files will show which studies were excluded at every stage of the review. If the present protocol needs amendments, they will be publicly available along with their rationale on the website of the eHealth Junior Consortium (http://ehealthjunior.nl/).

Ethics and dissemination

As systematic reviews use publicly available data, no formal ethical review and approval are needed. Findings will be published in peer-reviewed journal and presented at conferences.

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Contributors FE-L and LL designed the protocol after discussions with RCV, Jv'tV, MMH, VTV, WMB, MHJH, EMvdP and SLN. WMB developed the search strategy. FE-L and LL wrote the first draft and revised subsequent drafts. RCV, Jv'tV, MMH, VTV, WMB, MHJH, EMvdP and SLN revised and approved the final version of the manuscript. FE-L and LL will be the guarantors of the review.

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REFERENCES

1 Society for Adolescent Health and Medicine. Young adult health and well-being: a position statement of the Society for adolescent health and medicine. *J Adolesc Health* 2017;60:758–9.
2 World Health Organization. Adolescence: A period needing special attention. Health for the World's adolescents report, 2014. Available: http://apps.who.int/adolescent/second-decade/section2/page1/recognizing -adolescence.html
3 United Nations. Global issues: youth. Available: https://www.un.org/en/global-issues/youth
4 van HL, Tierolf B, van RM. *Een actueel perspectief OP kinderen en jongeren Met EEN chronische aandoening in Nederland. Omvang, samenstelling en participatie*, 2019.
5 Liu L, Oza S, Hogan D, *et al*. Global, regional, and national causes of child mortality in 2000-13, with projections to inform post-2015 priorities: an updated systematic analysis. *Lancet* 2015;385:430–40.
6 Van Cleave J, Gortmaker SL, Perrin JM. Dynamics of obesity and chronic health conditions among children and youth. *JAMA* 2010;303:623–30.
7 van der Lee JH, Mokkink LB, Grootenhuis MA, *et al*. Definitions and measurement of chronic health conditions in childhood: a systematic review. *JAMA* 2007;297:2741–51.
8 Lozano P, Houtrow A. Supporting self-management in children and adolescents with complex chronic conditions. *Pediatrics* 2018;141:S233–41.
9 Lorig K. Self-Management education: more than a NICE extra. *Med Care* 2003;41:699–701.
10 Lorig KR, Ritter P, Stewart AL, *et al*. Chronic disease self-management program: 2-year health status and health care utilization outcomes. *Med Care* 2001;39:1217–23.

11 Corbin J, Strauss A. *Unending work and care: managing chronic illness at home*. Jossey-Bass, 1988.
12 Gauci J, Bloomfield J, Lawn S, *et al*. Effectiveness of self-management programmes for adolescents with a chronic illness: a systematic review. *J Adv Nurs* 2021;77:3585–99.
13 Thabrew H, Stasiak K, Kumar H, *et al*. A cognitive behavioral Therapy-, Biofeedback-, and Game-Based eHealth intervention to treat anxiety in children and young people with long-term physical conditions (Starship rescue): Co-design and open trial. *JMIR Serious Games* 2021;9:e26084.
14 Nijhof SL, Vinkers CH, van Geelen SM, *et al*. Healthy play, better coping: the importance of play for the development of children in health and disease. *Neurosci Biobehav Rev* 2018;95:421–9.
15 Auf H, Dagman J, Renström S. Gamification and nudging techniques for improving user engagement in mental health and well-being apps. *Proceedings of the Design Society*, 2021:1647–56.
16 Cheng VWS, Davenport T, Johnson D, *et al*. Gamification in apps and technologies for improving mental health and well-being: systematic review. *JMIR Ment Health* 2019;6:e13717.
17 Garett R, Young SD. Health care Gamification: a study of game mechanics and elements. *Technology, Knowledge and Learning* 2019;24:341–53.
18 Muangsrinoon S, Boonbrahm P. Game elements from literature review of gamification in healthcare context. *J Technol Sci Educ* 2019;9:20–31.
19 Pereira P, Duarte E, Rebelo F, *et al*. LNCS 8518 - A Review of Gamification for Health-Related Contexts, 2014. Available: http://clubpsych.usanetwork.com/
20 Sardi L, Idri A, Fernández-Alemán JL. A systematic review of gamification in e-health. *J Biomed Inform* 2017;71:31–48.
21 Yang H, Li D. Exploring the inverted-U relationship between gamification achievement and health management performance. *Comput Human Behav* 2021;121:106805.
22 Deterding S, Dixon D, Khaled R. From Game Design Elements to Gamefulness: Defining "Gamification". *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, New York, NY, USA: Association for Computing Machinery, 2011:9–15.
23 Cugelman B. Gamification: what it is and why it matters to digital health behavior change developers. *JMIR Serious Games* 2013;1:e3.
24 Schell J, Schell J. *The art of game design: a book of lenses*. 1st ed. CRC Press, 2008.
25 Van de Velde D, De Zutter F, Satink T, *et al*. Delineating the concept of self-management in chronic conditions: a concept analysis. *BMJ Open* 2019;9:e027775.
26 Gosak L, Vrbnjak D, Pajnkihar M. Self-management of chronic diseases: a concept analysis. In: *Pielegniarstwo XXI wieku / nursing in the 21st century*, 2022: 1–7.
27 Hong QN, Pluye P, Fàbregues S, *et al*. Improving the content validity of the mixed methods appraisal tool: a modified e-Delphi study. *J Clin Epidemiol* 2019;111:49–59.
28 Page MJ, McKenzie JE, Bossuyt PM, *et al*. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Syst Rev* 2021;10.