

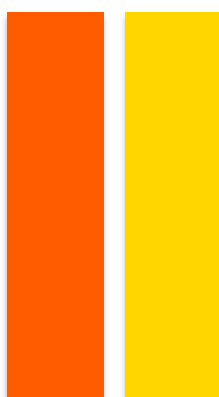
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Web-based interventions to promote health in adolescents

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“I have not failed. I've just found 10,000 ways that won't work.”

— Thomas A. Edison

Acronyms and abbreviations

AIDS – Acquired Immunodeficiency Syndrome

AUDIT – Alcohol Use Disorders Identification Test

BCT – Behaviour Change Techniques

BMI – Body Mass Index

eBAC – Estimated Blood Alcohol Concentration

EM – Expectation Maximization

EPHPP – Effective Public Health Practice Project

FVI – Fruits and Vegetables Intake

GIS – Geographical Information System

HIV – Human Immunodeficiency Virus

MVPA – Moderate to Vigorous Physical Activity

PA – Physical Activity

PAR – Physical Activity Recall

PLATE – Programa de Literacia Alimentar de base Tecnológica nas Escolas (Technology driven Food Literacy Program in Schools)

STDs – Sexually Transmitted Diseases

STIs – Sexually Transmitted Infections

TPB – Theory of Planned Behaviour

TTM – The Transtheoretical Model

UK – United Kingdom

USA – United States of America

Abstract

Adolescents' health is, nowadays, an important concern of the public health agenda to all healthcare providers, researchers, and policymakers. Currently, adolescence is being seen as a unique developmental stage rather than as a middle phase between childhood and adulthood. Only by investing in improving the health status of this young group, we will be able to achieve the much-desired goal of the Global Strategy: ensure universal health coverage by 2030. Also, all investments in adolescents' health result in a triple dividend because it will positively impact not only the adolescents of today but also the adults of tomorrow and their future kids.

There is no other development phase that encompasses such drastic and rapid physical, cognitive, social, emotional, and sexual changes, which explains why this is a critical age period. Since adolescents are more autonomous in decision-making regarding their lifestyle habits, it is during this period that most risky or protective behaviours are initiated and reinforced till adulthood. Risky behaviours such as tobacco use, excessive alcohol intake, inadequate food habits, sedentary behaviour, non-safe sexual behaviours, and poor sleep duration are often initiated at this age and contribute to the major causes of morbidity and mortality worldwide.

To prevent these risky behaviours, adolescence demands so much attention and skills from health promotion planners and healthcare professionals seeking to prevent death and morbidity by supporting health behavioural change.

The school setting has been the preferred one to implement health interventions for adolescents. However, despite education is an invaluable component of behaviour change, it is not enough since behaviours are greatly difficult to change and knowing what we should or should not do is not the same as doing it. So, effective behavioural interventions, especially those theory-based, are needed to improve health outcomes in this age group.

Digital health interventions, as web-based interventions still are a field in development, and prior literature is not unanimous since some authors highlight them as a promising approach to health behaviour change, while others emphasize the lack of robust evidence to support their effectiveness.

Because, adolescents reveal a high level of ability to technological devices, the greatest use of the internet, and since they referred to the internet as their main source of health-related information, we hypothesis that the effectiveness of web-based interventions could be greater in this age group.

So, this thesis intended to systematically review the literature to answer the research question: “Are web-based interventions effective to promote health behaviour change in adolescents?”. Additional, it is presented a case study regarding the development of a web-based educational intervention for adolescents in the school setting. This way, we aim to discuss web-based interventions’ development and effectiveness through the point of view of reviewers as well as researcher planners, in order to suggest realistic future directions to research.

The present work encompasses two distinct methodologies. The systematic review was conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and comprise the following steps: formulation of the research question, definition of eligibility criteria, construction of the search strategy and search in databases, selection of studies, assessment of study quality, data extraction and data synthesis. While the development and evaluation of the web-based educational intervention was carried out using a qualitative methodology, including: review of the advantages and disadvantages of games/platforms/social media available in the market; discussion and construction of the educational content of the intervention; the narrative development; intervention prototyping and design; conducting focus groups and usability tests to gather feedback and improve the intervention in accordance with the criticism received.

In this way, it was showed that high-quality evidence is still lacking to reinforce web-based interventions’ effectiveness to induce health behaviour change, realizing that the same challenges are generally felt by researchers’ planners, compromising the quality of research. Namely, usability tests and internal testing could be so time-demanding that often financial resources and time available to conduct the research will end before the intervention is largely tested. Ideally, a multidisciplinary team is needed to ensure the successful development of the web-based intervention, which means more costs in human resources. In the school setting, although web-based interventions are attractive to adolescents, educators may not feel confident enough to conduct an

intervention more familiar to adolescents than to them. Also, since all efforts of researchers' planners are in the development of the intervention, usually they appeal to their contacts within the community rather than select a probabilistic sample. Blinder study design could be difficult to achieve, especially for participants, because the content of these interventions is usually already very intention-revealing. So, these challenges impact the quality of evidence produced by the studies.

We suggest that financial investments in the next years should be applied in large to test web-based interventions, developed before with promising findings, rather than spending time and valuable resources in developing new ones. Researchers need to rely their work on larger randomized controlled trials, trying at least a single-blind design, in non-convenience samples with a larger follow-up time to show that besides health behaviour change achievements, the maintenance is also accomplished.

Resumo

A saúde dos adolescentes é, hoje em dia, uma preocupação importante da agenda de saúde pública para todos os profissionais, investigadores e decisores políticos. Atualmente, a adolescência está a ser vista como uma etapa única do desenvolvimento humano, e não apenas como uma fase intermediária entre a infância e a idade adulta. Sabemos que, somente investindo na melhoria do estado de saúde dos jovens, poderemos atingir a tão desejada meta da Estratégia Global para o Desenvolvimento Sustentável: garantir uma cobertura universal de cuidados de saúde até 2030. Além disso, todos os investimentos na saúde dos adolescentes resultam em um triplo dividendo, dado que o seu impacto positivo não se verifica apenas nos adolescentes de hoje, mas também nos adultos de amanhã e nos seus futuros filhos. Não há outra fase de desenvolvimento que englobe mudanças físicas, cognitivas, sociais, emocionais e sexuais tão drásticas e rápidas como as que ocorrem na adolescência, explicando por que este é um período crítico do desenvolvimento. Sendo os adolescentes mais autónomos na tomada de decisões sobre os seus hábitos de vida do que anteriormente, é durante esse período que quer os comportamentos de risco quer comportamentos preventivos são iniciados e tendem a persistir até a idade adulta. Comportamentos de risco como: tabagismo, consumo excessivo de bebidas alcoólicas, hábitos alimentares inadequados, comportamento sedentário, comportamentos sexuais não seguros e duração insuficiente de sono são frequentemente iniciados nesta idade e contribuem para as principais causas de morbilidade e mortalidade em todo o mundo.

Para eficazmente prevenir ou cessar estes comportamentos de risco, a adolescência exige muita atenção e competências especializadas dos investigadores e profissionais de saúde que procuram melhorar a saúde da população através da mudança de comportamentos.

O ambiente escolar é o contexto maioritariamente eleito para implementar intervenções de saúde dirigidas aos adolescentes, e apesar da educação ser uma componente importante da mudança de comportamento, esta não é suficiente. Isto porque os comportamentos são muito difíceis de mudar e conhecer os comportamentos que devemos ou não ter, não é sinónimo de os colocar em prática. Portanto,

intervenções comportamentais eficazes, especialmente aquelas baseadas em teoria, são extremamente necessárias para melhorar o estado de saúde desta faixa etária.

Intervenções digitais de saúde, tais como as intervenções baseadas na web são, ainda, uma área em desenvolvimento crescente, sendo que a literatura existente não é unânime, uma vez que alguns autores as destacam como uma abordagem promissora para a mudança de comportamentos em saúde, enquanto outros enfatizam a falta de evidências robustas para apoiar a sua efetividade.

Dado que os adolescentes revelam alto nível de habilidade para dispositivos tecnológicos, maior uso da internet e referem-se a esta como a sua principal fonte de informações relacionadas à saúde, hipotetizamos que a efetividade das intervenções baseadas na web poderia ser relevante nessa faixa etária.

Assim, esta dissertação visou a realização de uma revisão sistemática da literatura para responder à questão de pesquisa: “As intervenções baseadas na web são efetivas para promover a mudança de comportamentos de saúde em adolescentes?”. Adicionalmente, apresenta-se um estudo-de-caso referente ao desenvolvimento de uma intervenção educativa baseada na web para adolescentes, e implementada em ambiente escolar. Desta forma, pretendemos discutir o desenvolvimento e a efetividade das intervenções baseadas na web através do ponto de vista dos revisores, mas também dos investigadores no terreno, a fim de sugerir futuras direções realistas para o problema.

O presente trabalho engloba duas metodologias distintas. A revisão sistemática que foi conduzida de acordo com as orientações do Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), englobando as seguintes etapas: formulação da questão de pesquisa; definição dos critérios de elegibilidade; construção da estratégia de pesquisa e procura nas bases de dados; seleção dos estudos, avaliação da qualidade dos estudos, extração dos dados e síntese dos dados. Enquanto que, por metodologia qualitativa, procedeu-se ao desenvolvimento e avaliação da intervenção educativa baseada na web, incluindo: revisão das vantagens e desvantagens dos jogos/plataformas/redes sociais disponíveis no mercado; discussão e construção do conteúdo educativo da intervenção adaptado ao currículo escolar; desenvolvimento da narrativa; prototipagem e design da intervenção; realização de grupos focais e testes de

usabilidade para recolha de feedback e melhorias à intervenção em conformidade com o critério recebido.

Desta forma, foi possível demonstrar neste trabalho, que ainda é escassa a evidência científica de alta qualidade que suporte a efetividade das intervenções baseadas na web em induzir a mudança de comportamentos de saúde. Evidencia ainda que muitos investigadores se deparam com desafios semelhantes na construção de evidência mais robusta. Ou seja, a execução dos testes de usabilidade e testes internos é um processo tão demorado, que os recursos financeiros e tempo disponível para conduzir a pesquisa podem esgotar-se antes mesmo da intervenção ser amplamente testada. Também a necessidade de uma equipa multidisciplinar para garantir o desenvolvimento bem sucedido da intervenção baseada na web, significa mais encargos em recursos humanos. No ambiente escolar, embora as intervenções baseadas na web sejam atrativas para os adolescentes, os educadores podem não se sentir suficientemente confiantes em conduzir uma intervenção mais familiar e intuitiva para os adolescentes do que para os próprios. Dado ainda que frequentemente todos os esforços dos investigadores se centralizam no desenvolvimento da intervenção, geralmente amostras de conveniência são mais recrutadas do que amostras probabilísticas. Adicionalmente, implementar um ensaio cego, especialmente para os participantes, pode ser difícil de alcançar já que o conteúdo dessas intervenções frequentemente já é bastante revelador dos objetivos do estudo. Por outro lado, os investigadores parecem desconhecer frequentemente os domínios incluídos nas ferramentas de avaliação da qualidade dos estudos, uma vez que algumas informações importantes não estão descritas ou não são claras.

Desta forma, é sugerido que os investimentos financeiros dos próximos anos sejam aplicados para testar amplamente e com maior rigor científico, intervenções baseadas na web desenvolvidas anteriormente e cujo efeito tenha sido positivo, em vez de despendar tempo e recursos valiosos no desenvolvimento de novas abordagens. A implementação de ensaios clínicos randomizados incluindo, amostras probabilísticas e com um período de follow-up mais extenso, será essencial para provar se a mudança de comportamento de saúde além de iniciada é também mantida ao longo do tempo.

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Introduction

As stated in World Health Organization's guidance report - Global Accelerated Action for the Health of Adolescents (AA-HA!): "This is an exciting time for adolescent health"¹ because in 2016, this age group was, for the very first time, included and even considered essential for the success of 2016 - 2030 agenda of the Global Strategy². Till then adolescents' health was being neglected and robust evidence was missing compared to maternal and children health³. At this moment, researchers and policymakers had started to see adolescent health as an essential component of Universal Health Coverage³.

The importance of investing in adolescents' health promotion is clear and evidence-based^{1, 2, 4-7}. First, because it is suggested a tenfold health, social and economic return for every investment, resulting in health benefits for adolescents now, during their adulthood and for future generations^{1, 3}. Second, because adolescence is a well-known critical period and a window of opportunity for the establishment of health protective behaviours. It is in this age time that young people begin to develop more autonomous decision-making regarding to their health and lifestyle. However, many unhealthy habits and risky behaviours are also initiated during adolescence, which tend to persist into adulthood, resulting in significant morbidity and mortality in the short and long terms⁸. In 2015, it has been estimated that 70% of all preventable deaths from non-communicable diseases in adults are related to risk factors that start in their adolescence². So, we can't deny that nowadays, in high-income countries, the main threats to the health of adolescents are behavioural, and so largely preventable^{4, 9, 10}.

The fact of adolescence is a developmental stage characterized by social role transitions and biological growth with substantial physical, cognitive, emotional and behavioural changes¹¹, contributes to the high rates of enrolment in risky behaviours, including initiation and escalation of alcohol use¹², chronic poor sleep quality and duration¹³, insufficient physical activity and sedentary behaviour¹⁴, unhealthy dietary behaviours¹⁵, use of any tobacco product^{16, 17}, high-risk sex and sexual behaviours¹⁸⁻²⁰, among others.

The literature is also suggesting that these health-risk behaviours often co-occur²¹, specially in vulnerable groups of adolescents. Namely, disabled or with chronic medical conditions; living in rural²² or remote problematic areas; stigmatized because of their sexual orientation, gender identity, or ethnicity; institutionalized, or exposed to violent

family environments; exploited and abused; married or without family support; not able to access health services or social protection; with low education level¹.

That said, it is been proven that this important developmental period should be one of the preferred groups for public health interventions targeting life-style behaviours²³.

Nevertheless, adolescents' health interventions are still challenging since they demand a lot of effort from health professionals and researchers, as specialized skills are required for consultation, interpersonal communication, and interdisciplinary care²⁴.

Others obstacles to the success of those interventions described in the literature include attitudinal barriers (e.g., denial, stigma, afraid of discrimination and marginalization); geographic barriers (e.g., distance, availability of transport, time for transportation); structural barriers (e.g., insufficient transportation, restricted insurance coverage, age-appropriateness of services); financial barriers (e.g., poverty, out-of-pocket costs with service fees, pharmaceuticals and transportation, poor confidentiality with insurance claims, and ineligibility for tax- or insurance-based funding schemes); legislative and legal barriers (e.g., requirements for parental consent, lack of data and lack of adolescents' protective laws); social barriers (e.g., gender norms, roles and relations which inhibit access, other societal norms and traditions, healthcare provider's attitudes and beliefs, lack of privacy, professionals poor training in adolescent health); and adolescent-specific barriers (e.g., age, school status, low health literacy, marital status, and their legal status as minors or as legal independent person)^{3, 24, 25}.

Failing to promote adolescent health is compromising the future of the next generations²⁴, thus a guaranty of universal healthcare coverage is needed as well as increased effectiveness in the promotion of health and well-being.

For many years, the prevalent strategy for adolescents' health promotion interventions has been school-based health education for the prevention of risk-taking behaviours. However, the belief that giving them accurate information and knowledge to avoid dangerous situations will be enough to cause behavioural changes could be considered even naïve⁴. In fact, evidence from health education interventions revealed that even successful interventions showed improvements in adolescents' knowledge but not necessarily in their behaviour^{4, 21}.

Researchers usually overestimate the impact of education. This, obviously, does not mean that one should stop providing adolescents with knowledge about how to preserve and promote their health. Instead, it is necessary to figure out which interventions' approaches work best to promote and maintain health behaviour changes in adolescents³.

Knowing how to achieve and support behaviour change in adolescents is an urgent commitment in the public health field. To respond to this demand, the present thesis focuses on the study of health promotion interventions based on the World Wide Web (WWW) to improve health in this important age group.

Objectives

The present dissertation has the following specific main objectives:

1. To describe, through a systematic review, the effectiveness of web-based interventions used in healthcare and behavioural change support in adolescents, regarding physical activity, eating habits, smoking, alcohol use, sexual behaviour, and quality of sleep.
2. To develop and test a pilot web-based intervention to promote food literacy in ninth grade students.

To achieve these objectives, the present dissertation is organized into three distinct parts:

- In the first part, a literature review was conducted to document how web-based interventions can support health behavioural changes in adolescents, as well as to describe the main challenges and potentialities of this type of digital intervention. It is also presented a case study of a web-based intervention to promote food literacy in adolescents (the PLATE project).
- The second part, consists of two manuscripts resulting from each specific objective of this dissertation. The first manuscript is a systematic review about the effectiveness of web-based interventions to promote health behaviour change in adolescents, which will be submitted for publication in a scientific journal. The second is a paper about the challenges found out during

the development and pilot test of the PLATE project, which was accepted as a full paper in the Conference Proceedings of the 15th European Conference on Games Based Learning.

- The third and last part, includes the main findings from the two manuscripts in debate, highlighting recommendations and future directions for health promotion researchers.

I. Theoretical framework

1.1. Health Behaviour Change

Our health is a combination of several mutually dependent variables, and some of them can be modified either by medical interventions or others through educational and information processes²⁶.

Behaviours are examples of those modifiable variables. Since behaviours can change, which can greatly affect our health, health research focuses on initiating and maintaining behavioural change in individuals and communities. Evidence-based literature has suggested not only that the individuals' environment, habits, abilities, and attitudes will impact their behaviour, but also that human behaviour will modify people's environments²⁷.

On the one hand, behaviours can be learned and passed down through social networks. On the other hand, behaviour change is a complex and iterative process that individuals, even knowing what and why they should or should not do, often still do not change their risky behaviour²⁷.

When designing a behaviour change intervention, health researchers need to be fully aware of what their objectives are, which usually encompasses one or more of the following:

- Prevent or stop risky behaviours.
- Reduce the occurrence of risky behaviours and their negative consequences.
- Promote health protection behaviours.
- Promote effective use of health care services.
- Promote effective self-management of diseases²⁸.

Behaviours are highly complex, so to achieve these objectives, health psychology experts have been trying to understand better why behaviour change is so difficult for most individuals and what health professionals can do to support that change²⁹. Over the years, a set of theories, models, and techniques have been developed for explaining and predicting behaviour³⁰, in order to try to overcome the challenges found in research concept, implementation and synthesis of findings in literature reviews³¹.

These theories can be divided into two main groups: social cognition models and stage models.

The term 'social cognition models' refers to a group of similar theories (the Health Belief Model, Social Cognitive Theory, Self-Efficacy Theory, the Theory of Reasoned Action, and the Theory of Planned Behaviour, Information-Motivation-Behavioural-Skills Model) each of which specifies a small number of cognitive and affective factors ('beliefs and attitudes') as the proximal determinants of behaviour.

Stage models change (e.g., the transtheoretical model) involves movement through a sequence of distinct stages.

Theories are intended to systemize the elements and natural occurrences observed in the environment, by giving them an understandable form. In turn, theories intend to explain the factors that influence them, the relationships between variables, and the conditions under which these relationships occur or not. As part of the theories, the models are representations based on hypothetical analogy which scrutinizes in detail the phenomenon³⁰. Whereas a behaviour change technique (BCT) can be defined as "*a systematic procedure included as an active component of an intervention designed to change behaviour*"³².

Bellow we briefly outline these theories and note, their similarities and differences:

Social cognition models

Social cognition models show several important similarities and differences. All the models incorporate to a greater or lesser extent the idea that behavioural beliefs, outcome evaluations, normative beliefs, and motivations to comply are important determinants of behaviour.

Social cognition models are often criticized for offering an overemphasis on decision making rationality, assuming that individuals are future oriented and that they weigh up the costs and benefits of possible future courses of action. However, recently researchers have pointed to the importance of people rapid decisions based on a few salient considerations as well as many may hold incorrect beliefs about the outcomes³⁰. Therefore, social cognition models imply a more limited rationality than is sometimes suggested by their critics.

Social Cognitive Theory

Bandura's Social Cognitive Theory started on the principles of social learning, which suggests that our behaviour reflects our social-cognitive previous experiences. This author defined the human functioning as a triadic interaction between internal factors (cognitive, affective, or biological), behaviour patterns and the environment^{30, 33}.

This theory highlights some variables which probably will influence the behaviour change process: self-efficacy (one's belief in their ability to carry out the behaviour); outcome expectations (prediction of the likely consequences of a behaviour); self-control (individual's capacity to control their behaviour); reinforcements (factors that may impact the likelihood that a behaviour will be repeated); emotional coping (individual's ability to cope with emotional stimuli) and observational learning (acquiring behaviours through observation of others)³⁴.

Theory of Planned Behaviour

The Theory of Planned Behaviour by Ajzen (1988) is based in the previous Theory of Reasoned Action and it adds the perceived behavioural control as new variable used to predict human functioning, along with normative beliefs about a behaviour, as well as attitudes toward the object, all have an impact on behavioural intentions, which predict subsequent behaviour²⁷.

The importance of this last added predictor is justified because in the absence of perceived behavioural control, attitude toward behaviour and normative norms alone are incapable of generating sufficient motivation to trigger an intention²⁷.

Information-Motivation-Behavioural-Skills Model

This model suggests that interventions to reduce risky behaviours are more impactful if based on a conceptual framework specific to the target population and aimed to keep participants informed, motivated, and behaviourally skilled to successfully initiate and maintain the protective behaviour³⁵. Which means all information, motivation, behavioural skills and their relationships are important determinants of health behaviour³⁶.

According to this model, information is a prerequisite to achieve a desired health behaviour and as a facilitator of behaviour-related decision-making. Motivation can be divided into personal motivation (individual's beliefs about the expected outcomes and attitudes toward a health behaviour), and social motivation (perceived social support or social norm for engaging in a behaviour). And behavioural skills are those required to carry out a health behaviour³⁶.

Stages Model of Change

Stage models incorporate a set of different factors for behaviour change that vary according to movement through a sequence of stages. Hence, people in different stages are assumed to require different interventions to encourage or help them to move to the next stage in the sequence.

Transtheoretical Model

This section focuses on the Transtheoretical Model because it is the dominant model in the field.

The transtheoretical model assists researchers in developing interventions based on individual's readiness, motivation, and ability. It is divided into six stages³⁷:

1. Precontemplation — the individual doesn't seem to have any intention to change behaviour within the following six months.
 2. Contemplation — the individual is thinking about doing a behaviour change within the next six months.
 3. Preparation — the individual made some improvements toward making a change and doing so within the next 30 days (e.g., buy a pair of running shoes to start exercising).
 4. Action — the individual reaches an apparent behaviour change for six months or less (e.g., individual increased their physical activity level).
 5. Maintenance — the individual's behaviour changes last for more than six months.
 6. Termination — the individual has no temptation and 100% self-efficacy.
- These stages are not static, and individuals may progress forward or backward³⁷.

Many other theories have been used in behavioural research as showed by Davis, R., et al. (2015) in their scoping review intended to identify theories of behaviour and behaviour change relevant to public health interventions from psychology, sociology, anthropology and economics fields³⁸. Davis and their colleagues found a total of eighty-two theories of behaviour and behaviour change, not being able to categorize each theory into the four intended disciplines since many of them had influences from more than one field. Besides the wide number of theories identified, their findings did not reflect the broader application of these theories to public health-related research as sixty-three per cent of the literature identified in the review applied just the four theories referred above: the Social Cognitive Theory, Transtheoretical/ Stages of Change, Theory of Planned Behaviour and the Information-Motivation-Behavioural-Skills Model³⁸.

Behaviour changing interventions are still often designed with no base in theory despite, as emphasized in previous studies, understanding the theories which ground the behavioural interventions is necessary to increase the interventions' effectiveness, in addition to the appropriate selection of the behaviour change techniques within the interventions³⁶.

Webb, T. L., et al. (2010) found, in their review of internet-based intervention, that both behavioural change techniques “stress management” and “general communication skills training” were the two BCTs associated with higher changes in behaviour, which reinforces the previous affirmation that the BCTs selected can impact the interventions' effectiveness³⁹.

However, the heterogeneity of definitions of BCTs can potentially weaken the behavioural researchers' ability to understand and apply them. So, standardized definitions and labels for interventions' active components are extremely beneficial in replicating research and synthesizing study findings, reducing duplication of effort and increasing the evidence meaning across reviews³¹.

With that in mind, Michie, S., et al. (2013) developed a taxonomy of 93 individual BCTs by consensus with 54 experts in delivering and/or designing behaviour change interventions. Experts from psychology, behavioural medicine, and health promotion made up the counselled team. This taxonomy categorizes clearly defined and non-redundant BCTs into 16 clusters, namely: “Goals and planning”; “Feedback and

*monitoring”; “Social support”; “Shaping knowledge”; “Natural consequences”; “Comparison of behaviour”; “Associations”; “Repetition and substitution”; “Comparison of outcomes”; “Reward and threat”; “Regulation”; “Antecedents”; “Identity”; “Scheduled consequences”; “Self-belief” and “Covert learning”*³¹.

The taxonomy proposed by these authors is document in annex 1 and each BCT's definition can be found in annex 2.

A consensus in using a taxonomy can potentially improve the identification of the active components within interventions, the understanding of predictors of effectiveness, and the doubling of implementations of effective interventions³¹.

When designing health behavioural intervention, there is another essential dimension that behavioural planners need to consider: the delivery of the intervention. Understanding the influence of content delivery (mode, context, and ability of those delivering the intervention) in behaviour outcomes is still a research-goal³¹.

Each intervention can use a combination of several modes of delivery, for example: face-to-face interventions, printed material, digital technology for delivery and digital content⁴⁰. Webb, T. L., et al. (2010) showed that using more than one mode of delivery had greater effects on health-related behaviours, and the same happened for theory-based interventions using a bigger number of BCTs³⁹.

Over the years, the use of digital technology to carry out lifestyle interventions has become increasingly attractive to researchers, who are looking for sustained engagement alongside the use of BCTs.

1.2. Digital Health and Web-Based Interventions

No other field is growing as fast as the digital technology field. According to Schwab, K. (2016) at the World Economic Forum, in 2016 we were at the beginning of the “Fourth Industrial Revolution”, which describes the appearance of new abilities and technologies for people and machines based on previous technologies from the digital revolution. This is an unprecedented historical period in terms of size, speed and scope⁴¹, which has impacted all other knowledge areas including the health field as can be observed by looking at the rapidly development of digital health.

The broader digital health’s scope includes all information and communication technologies used in medicine to manage diseases and health risks and to promote wellness⁴².

Digital health technology has been pointed as especially relevant for large-scale interventions, having the potential to achieve a broader reach at a lower cost as can be understood when looking to internet-reach^{40, 43}. There were 4.80 billion active internet users worldwide, in July 2021, which corresponds to 60.9% of the global population, with China, India and the United States leading the board of internet users⁴⁴. Because of the internet’s wide availability in high income countries, the costs per additional participant are usually very low, which is attractive to large scale interventions⁴³.

Adolescents, in particular, are massive fans of internet and generally show a high level of ability and greater periods of use with this technology⁴⁵. For most of them a world without internet would be unthinkable, reinforcing its potential as a resource for health promotion in this age group.

Park, E. and M. Kwon (2018) in their review reported, that the greater part of young people use internet as their most frequent source of health-related information and considered that positive⁴⁵. The topics most researched by teenagers on the internet include sexual health and violence, exercise and nutrition for healthy participants, and treatment options, support, and networking with other patients for non-healthy group⁴⁵.

Therefore, interventions settled in information and communication technologies have been developed in health areas associated with lifestyle such as smoking cessation,

nutrition/physical activity promotion, alcohol abuse prevention⁴⁶, sexual health promotion⁴⁷ and sleep disorder treatments⁴⁸, among others.

The process of developing digital health interventions is very complex⁴⁹ and despite its exponential growth, it still lacks robust evidence to support its development and justify funding for further research⁴³.

Given the complexity of the development of digital health interventions, Horvath, K. J., et al. (2015) proposed practical tips to help researchers in each stage of the development, which are described in annex 3. Briefly, that practical guidance is related with the following eight best practices⁴⁹:

1. Having a multidisciplinary intervention team with multiple skills and adequate expertise in technology delivery. The coordinator must respond to vendor's solicitations, in addition to being organized and detail oriented to monitor study progress. Other team members should have experience in contract negotiations and at least one should have experience in software programming.
2. Formative research should be addressed to target population needs and preferences for the intervention's content and features. To understand the digital literacy of the target participants and how they will use and interact with the intervention's technology, should be accomplished by previous pilot testing.
3. Do not underestimate the importance of the early steps, taking the time needed for planning before beginning the design could help researchers save time and money in the long run.
4. Make sure that all the involved parties are in tune. Different languages, objectives, and values between the vendors, who are responsible for technology development, and the researchers, who are responsible for content development and intervention implementation, could cause some "miscommunication".
5. When contracting a vendors' team, prepare a really detailed contract establishing the scope, the working relationship and agreement on the budget.
6. Everything needs to be documented. All decisions, development activities and needs should be meticulously documented. Having a shared ongoing basis between the vendors and the research team will offer a framework for clarifying

the specific features and functions wanted for the intervention, as well as help the resolution of potential conflicts.

7. Using a content management system to allow the research team to easily edit and change content on the web-resources.
8. Usually, the time needed for internal testing and bug search is underestimated. Anticipating extra time to identify and fix technical problems will prevent delays in the intervention implementation⁴⁹.

Having these concerns in mind and being aware of the potential difficulties that may arise, will help researchers to deal better and more successfully with the development of internet-based interventions.

Besides these development challenges, other adversities include the potential increase of health inequalities between those who have and those who have not got access to internet; lack of robust evidence in cost-efficiency; inconsistency between conceptual evaluation and the one applied into practice, and difficulty in the extrapolation of results since health interventions are context-specific⁵⁰. In addition, understanding why some web-based interventions work better than others and how to widely disseminate the intervention⁴³ are still aspects that deserve special attention and a concern for researchers to overcome.

Despite all the challenges, web-based interventions can be very appealing both to researchers, due to their potential cost-effectiveness by combining scalability of public health interventions with the effectiveness of tailored interventions, and to users because web-based interventions are convenient, easy to access, and easily maintain anonymity/privacy⁴³.

Gaskin, G. L., et al. (2012) had estimated that youth access to internet occurs mostly through personal computers or laptops (65%) or by cell phones or other mobile internet-enabled devices (42%)⁵¹. In addition, Henderson, E. M., et al. (2013) found that 83% of adolescents (11 to 18 years) use to spend 1 to 4 hours/day using the internet⁵².

Specially for young people who spend such great time online, the virtual elements of web-based interventions are both engaging and motivating, as well as easily and promptly accessed and often portable⁴⁵.

Health web-based interventions are powered via a website and used for self-management of long-term conditions, health promotion and mental health, using health content, multimedia, interactive online activities, and/or supportive feedback⁵³.

By associating the potential of web-based technologies to health behaviour change techniques, one may enhance health interventions' effectiveness by better fitting to users' needs, collecting effective data and information in a safe environment, more interacting and responsive programs, continuous self-monitoring and/or information exchange⁵⁴.

As observed in a meta-analysis from Wantland, D. J., et al. (2004), web-based interventions seem to be beneficial to improve behavioural change outcomes. The main reported reasons include its efficacy in increasing exercise time, improving knowledge about nutritional status and asthma treatment, raising participation in healthcare, as well as slowing health decline, improving body shape perception, and weight loss maintenance⁵⁴.

1.3. PLATE - Technology driven Food Literacy Program in Schools, as a case-study of a web-based intervention for adolescents

De Sousa, Daniela integrated the development team of the PLATE project between March of 2020 and March 2021 and participated in the following activities:

- Multidisciplinary meetings to develop the nutrition content and the technology-based communication and education strategy.*
- Performing user design studies and tests.*
- Collecting and analysing feedback from teachers about the educational content and technological implementation.*
- Preliminary user testing with students.*
- Recruitment and implementation meetings with teachers and school boards.*
- Presenting the PLATE to students and conducting the implementation process.*
- Providing support to teachers and students during the intervention.*
- Planning, conducting, and interpreting the interviews at the end of the intervention.*
- Writing of the technical reports and a scientific publication.*

Case Presentation

The pilot project PLATE - Technology driven Food Literacy Program in Schools, is a Minecraft-based learning project that aimed to foster food literacy in 9th grade students. The development and implementation of this research project was funding through national funding from Ciência Viva - Agência Nacional para a Cultura Científica e Tecnológica, under the program Comunicar Saúde.

For the development of this project, a multidisciplinary team was created, which included researchers in the areas of Educational Sciences, Social Sciences, Nutritional Sciences, Digital Media, and Public Health.

The PLATE project based on the use of Minecraft Education® and Microsoft Teams® platforms was implemented from early October till December of 2020, in three schools

from the North Region of Portugal to improve the food literacy of adolescents and facilitating the learning process about the importance of healthy eating.

Background

Obesity is a major health problem particularly in adolescence given its vast array of negative repercussions for the overall health, such as: the increased risk of the occurrence of comorbidities like arterial hypertension, dyslipidaemia⁵⁵, cardiovascular diseases, type 2 mellitus diabetes, some oncological diseases⁵⁶⁻⁵⁸ and the compromise of the musculoskeletal system, among others. These complications are significantly more prevalent among young people with obesity than amongst their normal weight peers⁵⁶.

Obesity is a serious public health problem also because of its high prevalence. Overweight and obesity affect more than 340 million children and adolescents (5-19 years old) across the globe, which corresponds to a prevalence of more than 18%, contrasting with the value of 1975, where only 4% of children and teens were overweight or obese⁵⁹.

Over the years, allied to an increase in energy-dense food consumption, it has been noted a decrease in the aptitude and physical activity levels of the population, resulting in a chronic positive energy balance culminating in the development of obesity⁶⁰.

Therefore, the aetiology of obesity is mostly environmental, mainly due to the two factors mentioned above^{61, 62}, which means that it is widely preventable by choosing healthier eating patterns and adopting a physically active lifestyle.

For public health researchers, adolescence is a window of opportunity for the establishment of health-promoting behaviours, since lifestyle habits adopted during this age tend to remain throughout the adulthood⁸. That is the reason for being suggested that young people should be a preferred target group for interventions aiming to improve health literacy²³.

Health literacy can be an instrument in the fight against risky behaviours. As example, greater nutritional knowledge has been found to have positive associations with healthier eating habits⁶³. Also, health literacy has been showed to be a predictor of successful cardiovascular disease prevention and recovery⁶⁴. And in a sample of people with diabetes, it was observed as well that poor health literacy was associated with

greater sedentary behaviour and worst dietary habits⁶⁵. Even though it is not sufficient, education to increase awareness and improve skills is, undoubtedly, a necessary component for behaviour change. It is important to note that tailored education is more likely to induce health behaviour change by raising individuals' awareness about their health status and personal negative experiences⁶⁶.

Therefore, this data supports the idea that increasing population's health literacy will potentially promote the acquisition of healthier behaviours. Although knowledge and information are indispensable for making more conscious decisions in health, we cannot simply assume that well-informed people will make the right choices⁴. Besides public health researchers need to understand how to improve the effectiveness of health education interventions, there is also a need to implement a more holistic approach, by implementing measures that change the environment⁴. Those include creating a favourable environment for practicing sports, ensuring the accessibility to healthy foods in schools, among others⁶⁷.

The use of digital technologies and tools has been pointed as a strategy to increase the success of health interventions among the younger population since they are motivators and familiar to them⁶⁸⁻⁷⁰.

The wide use of digital technologies contributed to the increased use of an innovative health educational approach called gamification which seems to be a relevant pedagogical strategy for the promotion of health education when compared to the conventional educational approach⁶⁹. Gamification is the application of typical elements of game playing (e.g. point scoring, competition with others, rules of play) to other areas of activity, in our case typically as an online technique to encourage engagement with a behaviour change⁷¹.

Gamification makes learning more accessible and attractive to a wide range of the population, especially the younger ones because interactivity achieved by digital games creates opportunities for sharing experiences, simulate real decision-making situations, promote social integration, auto-satisfaction, self-esteem, and pride. This method also stimulates brain activity, promotes knowledge, increases the players' intrinsic motivation to change their habits and has the potential to keep the user's engagement⁷¹⁻⁷⁵.

In this way, by hypothesizing that replacing traditional interventions by gamified

web-based interventions would emphasize motivation for behaviour change, the pilot program PLATE – Technology driven Food Literacy Program in Schools was developed.

Description of PLATE's intervention

Briefly, PLATE is a pilot program intended to design and test a gamified technology-based communication and education strategy to promote food literacy in 9th grade students. It consists in using both online platforms Minecraft Education® and Microsoft Teams®, as well as other web resources (multimedia videos, video and audio recordings, and online activities) to enhance the learning process about the importance of diet to a healthy life. PLATE is a proposal of gamification in classroom which aims to increase the student's engagement with nutrition content and motivate a behaviour change when needed. The intervention was intended to be conducted by teachers, with guidance from the research team and from teachers' support materials that were made available.

The pilot of PLATE intervention was made available in three schools selected through contacts with the community and after obtaining authorization by each school's board (appendix 1). The implementation occurs in first trimester of school year.

The intervention begins with a presentation in each class by the research team. At that moment a free game template through Minecraft Education® was made available and students were invited to participate in the game as groups of 4-5 students. In that meeting, researchers guided the students through the game's tutorial to make the narrative and game mechanics more familiar to them (Figure 1).

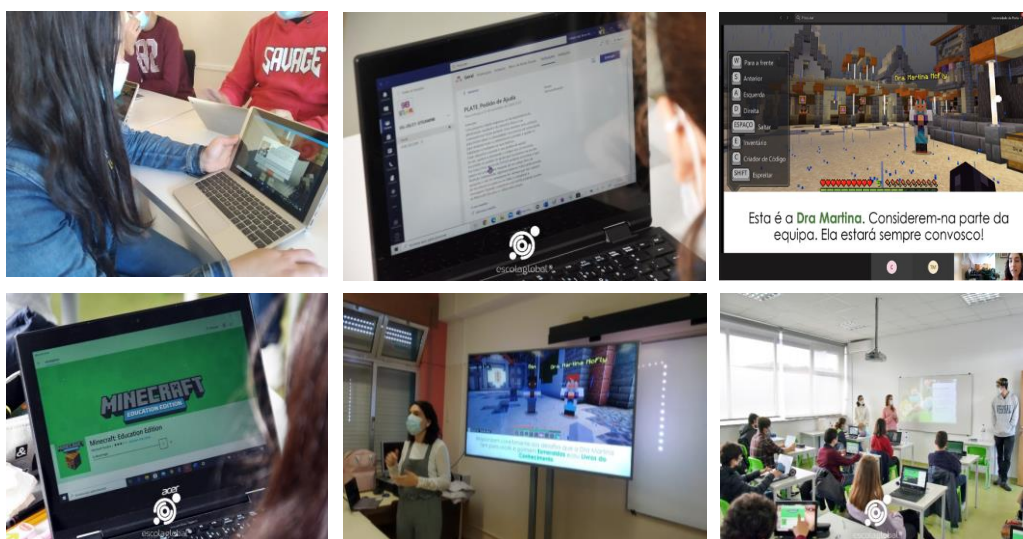


Figure 1- Photographic records from the presentation of PLATE to students and playing the tutorial game.

Students continued to play in multiple sessions across several weeks. The following sessions were conducted by the responsible teacher in each class period. In our game template, players face a dystopian world where its inhabitants are sedentary and practice a very unbalanced diet. In this virtual world, all knowledge about food and health was forgotten. Players are therefore invited to explore the world, responding to the challenges correctly to collect game coins (emeralds) and “books of knowledge”. To illustrate the return of knowledge to the game world, players must fill an empty library with the 15 books they find during the game.

Our proposed intervention combined gamified activities that take place in Minecraft Education® with real-life tasks through Microsoft Teams®, such as creating a recipe with legumes, doing an information leaflet on the importance of food in cancer prevention, recording an audio report on eating disorders, analysing food labels, among others.

Learnings from the field

From the four schools contacted to participate in this pilot project, three accepted to participate and provided their formal authorization. However, only two of them had successfully concluded the intervention, since one school decided to drop-out after few sessions without guidance from the research team members. The teachers mentioned the following reasons for their decision:

- The android tablets used usually by students during classes were not compatible with the installation of Minecraft Education®. To play, students needed to use the only computer’s room of the school, which was only available by reservation and was shared with all other grades in the school. The teacher reported that between sessions the Minecraft® was erased from some devices and some students lost their in-game progress, causing frustration.

- Due to the identification of a positive case of COVID-19, school computers were lent to students who had to have classes from home during the prophylactic confinement, forcing a pause in the intervention period because of the lack of equipment. One of the teachers responsible for intervention in this school also had to do prophylactic isolation, guiding the students’ sessions from home via Microsoft Teams®.

- Since this was the first contact that the two responsible teachers had with

Minecraft Education®, they reported a lot of difficulty in guiding students in interacting with the game.

- The teachers reported difficulty in controlling excessive noise during game experimentation because of the volume of electronic devices and the game's music. The two schools where the intervention was completed in its totality were both Microsoft Showcase Schools, where teachers were more technological skilled, and had already contact with the Minecraft, some even for educational purposes. It is relevant to mention that both schools could provide one compatible device for each student. Thus, it is also important to researchers to ensure that recruited schools met all the technical requirements prior to the intervention and to provide training to educators who are not skilled in technology delivery. Against our initial intention, training teachers was not possible because of their restricted agendas due to COVID-19 constrains in educational institutions. The provided tutorials and support materials given to teachers were proved to be indispensable but were not enough to give all teachers the confidence in using Minecraft to continue the intervention.

In schools who completed the intervention, the post-intervention preliminary results from this pilot were collected from individual interviews with three teachers and eight students who volunteered.

From the teachers' point of view, all reported satisfaction with the intervention and with the support materials provided by the research team. They described as positive findings the enthusiasm shown by the students using the game and the detail of the support materials and the clarity of the tutorial instructions. Teachers also highlighted that more than the knowledge acquisition, the intervention promoted other students' skills, such as critical thinking and mutual help. The fact that the game's content went beyond the science textbook subjects was also perceived as a positive to educators. When asked if they would participate in a similar project or in a new edition of PLATE, all responded positively.

From the students' point of view, they acknowledged the involvement and fun with the project's activities, noting that the narrative and aesthetics of the game contributed to this. All respondents liked the multiplayer strategy since they noted differences on students' ability to play. When asked what their favourite activities were, some preferred Minecraft tasks, especially more talented players while less dexterous

students named the Microsoft Teams' activities.

Some students reported better grades achieved in natural science and noted improvements in some health behaviours such as: greater intake of water and fruit, more attention to food labels, less consumption of sugary foods. However, not all attributed these changes to the intervention.

As negative findings, teachers mentioned that the project was more time demanding than the traditional teaching method of exposing the content. The lack of linearity in the game was not compatible with the typical sequential learning process. Despite our internal testing, students faced some bugs during the game that frustrated them. Moreover, they found out that some challenges were possible to accomplish by chance, compromising their motivation. Lastly, the content explained in the "books of knowledge" was also reported as sometimes being neglected by students.

Even though it was classified as positive for the learning process, the synergic use of Minecraft® and Teams® was also pointed as mitigating factor to the in-game immersion. Some Teams' activities were also considered too time-demanding by some students.

Overall, this gamification experience was considered beneficial as a complementary pedagogical strategy but not as a substitute to traditional methods.

More detailed description of PLATE's development, usability testing and preliminary results are documented in Manuscript 2.

II. Manuscripts

Manuscript 1 - The effectiveness of web-based interventions to promote health behaviour change in adolescents: a Systematic Review

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Abstract:*Objective:*

Systematically review the effectiveness of web-based interventions used to support and maintain health behavioural change in adolescents (10-24 years), regarding physical activity, eating habits, tobacco and alcohol use, sexual behaviour, and quality of sleep.

Data Source:

PubMed/MEDLINE, Scopus, PsycINFO/APA PsycNet, Web of Science and SAGE Journal were searched from May to June 2021 for web-based interventions to promote health behaviour change in adolescents, that evaluated its effectiveness.

Study Inclusion and Exclusion Criteria:

The inclusion criteria were: (1) published from 2016 till present; (2) full-text in english, portuguese or spanish; (3) experimental studies, quasi-experimental studies, pre-post-test studies, clinical trials, and randomized controlled trials, using quantitative or mixed methods; (4) target directly to participants aged 10 to 24 years or possible to isolate the age group; (5) participants without a major disability or irreversible clinical conditions or major chronic diseases; (6) a web-based intervention as a stand-alone or multicomponent intervention; (7) health promotion interventions not targeting screening, management and/or control of diseases; (8) evaluating the effectiveness of the intervention to promote health behaviour change (regarding physical activity, eating habits, smoking, alcohol use, sexual behaviour, and quality of sleep).

Data Extraction:

The articles found by databases search were early screening by one author and full text assessment against eligibility criteria was performed by two independent authors. Resulting in 18 papers, about 14 studies being included. Two reviewers independently performed the risk of bias assessment using the Effective Public Health

Practice Project – Quality Assessment Tool for Quantitative Studies (EPHPP). Data extraction was performed by the main reviewer and validated by a second reviewer.

Data Synthesis:

We conduct a qualitative synthesis to summarize the extracted data due to substantial heterogeneity between studies. We systematically review six main topics of the web-based interventions related to health behaviour change: description of studies (setting, study design and aims); recruitment and participants (sample description, recruitment strategies and incentives); web-based intervention description; behaviour change theory used; outcomes of health behaviour change, and other outcomes related to users' experience.

Results:

Most of the studies were based in the US (43%), within the school setting (71%) with non-probabilistic (100%) and relatively small samples (71%). Most interventions had more white (50%) and more female participants (64%). All interventions were theory-driven studies, with a wide range of health behaviour theories and models being used. Among the 14 included studies, 13 showed significant positive findings to support web-based intervention's effectiveness in promoting health behaviour change among adolescents, while one had observed a crude non-significant reduction in risky behaviours in the experimental group compared to the control group. From critical appraisal of quality assessment, we found 86% included studies classified as low evidence quality.

Conclusions:

This review contributes to prove that web-based interventions have a significant positive impact to achieve health behaviour change among adolescents with reasonable levels of acceptability and feasibility. Although, more evidence is needed to support their effectiveness in long-term maintenance (> 6-month). These findings rely on low quality evidence, so it is urgent to test these web-based interventions in larger controlled trials.

Keywords and indexing key words:

Web-based interventions, systematic review, behaviour change, behaviour change theories, health promotion, healthy lifestyles, public health, adolescents

Introduction

A major concern to public health researchers is lifestyle behaviours. Risky behaviours such as tobacco and alcohol use, unhealthy food habits, physical inactivity, risky sexual practices, and insufficient sleep duration, play a significant role in many of the leading causes of death worldwide¹. According with data from 2015, 70% of all preventable deaths from non-communicable diseases in adults are related to life-style risk factors adopted during adolescence².

Adolescence is a critical period since many unhealthy habits and risky behaviours begin in this age. But it is also a window of opportunity for the development of health-protective behaviours, since health-related habits adopted in this age tend to persist into adulthood³. For this reason, it is suggested that public health intervention aimed to prevent or stop risky behaviours should target this life period⁴, knowing that improving adolescents' health now is also ensuring a better future for next generations^{5, 6}.

A positive aspect for health promotion is that, since behaviours are modifiable health-related variables, the threat they represent is greatly preventable⁷⁻⁹ and even minor changes in human behaviours can improve the overall population's health¹. However, the drawback is that behaviour change is a very complex and iterative process, in which even individuals who are aware of better health practices still fall short in adjusting their behaviour¹⁰.

Therefore, focus on how to achieve and maintain a successful behavioural change in individuals and communities is a key question for health researching¹⁰. Throughout the years, theories, models, and techniques have been suggested to understand and predict behaviour¹¹, contributing to the support of planners in handling challenges in research concept, implementation, and evaluation to improve the effectiveness of behavioural interventions¹².

However, up until this moment there is not a consensus about the key role those behavioural interventions can play in health at a population-level, it is already agreed upon that understanding behavioural change theories is an essential element of successful health-related interventions¹³.

The relationship between the healthcare provider and the patient is now much more different than it was before, and at the end of the 20th century, researchers and health professionals began to realize how important is shared decision making in healthcare service. Also, a growing interest in participatory approaches to health promotion has been observed, especially in interventions targeting children and adolescents. So, as the medical paradigm was changing, digital technologies able to raise patient empowerment were also becoming more readily available¹⁴.

Thus, digital health promotion interventions, especially internet-based technologies have been suggested as important tools to improve individuals' health and the quality of healthcare services, and to reduce health inequalities due to its large-scale availability. Although there is a lack of robust evidence to support the effectiveness of web-based interventions, it seems to be a promising approach to support behavioural health change¹⁵, that is becoming increasingly attractive to researchers¹⁶.

The interest in using web-based interventions in the health field is still growing. The number of publications reveals this interest since this amount increased from 770 in 2016 till 1464 in 2020. In the last 5-year period, from 2016 till present 2021, there was an increase of 742,5% in MEDLINE publication results for "health AND web-based Intervention" (Figure 1).

Although web-based interventions may be attractive to both users and researchers, it is crucial to summarize evidence about their effectiveness. It is essential to identify which are the delivery modes and the behavioural change theories and techniques most frequently used to promote positive health behavioural change and its maintenance in long terms¹³.

Even though systematic reviews, focusing on some of these issues, have already been published, they are limited to self-management of clinical conditions or symptoms instead of focusing on health promotion¹⁷⁻²¹; or try to understand only one major health outcome change such as nutrition related behaviours²²⁻²⁵, sedentary behaviours²⁶ and physical activity²⁷, depression²⁸ and mental health, alcohol-related problems²⁹ or their target population is other than adolescents such as adults³⁰ and older adults³¹. And none of the previous focused specifically web-based interventions.

In addition to the diversity of health outcomes, there is a wide range of digital technologies (e.g. social media, telemedicine, data analytics, artificial intelligence,

personalized medicine, wearables, mobile apps, electronic medical records, web-resources for health education, among others) and each of them has unique capabilities and specificities³². Therefore, characterizing each one individually will help researchers construct more robust evidence to better explain their impact on different health outcomes.

Focusing on web-based intervention, one review and meta-analysis performed by Wantland, D. J., et al. (2004) had found substantial evidence that the use of Web-based interventions could improve knowledge and/or behavioural change outcomes when compared with non-web-based interventions³³. In opposition to the work from Wantland, D.J., et al. (2004) which focused in general population³³, our review intends to know the effectiveness of web-based interventions in health behaviour change in adolescents since we presume that its effectiveness will be more relevant in a very digital-skilled population, such as young people. Also, due to the rapid growth of the technological field, it is justified an update of that review.

Therefore, the main objective of this study was to systematically review the effectiveness of web-based interventions used to support and maintain health behavioural change in adolescents aged 10-24 years, regarding physical activity, eating habits, smoking, alcohol use, sexual behaviour, and quality of sleep.

Methods

Data Sources

This systematic review was prepared in accordance with the protocol submitted on the International Prospective Register of Systematic Reviews (PROSPERO) and according with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (<http://www.prisma-statement.org/>)³⁴ (Table S1).

The electronic databases of PubMed/MEDLINE, Scopus, PsycINFO/APA PsycNet, Web of Science and SAGE Journal were searched from May to June 2021. The search terms used were organized in three main sections: population, intervention, and health outcomes, each illustrated by keywords and synonyms. All the terms were connected by the Boolean operator AND, between each main section, and OR, within each section (Table S2). The search strategy for each database (Table S3) was saved and we set the

alerts for new added results. Additional articles were identified from the reference list of retrieved articles applying a reverse snowballing search.

Inclusion and Exclusion Criteria

Studies were eligible for inclusion if its full text was published in scientific journals in English, Portuguese, or Spanish. Only studies published from 2016 till June of 2021 were included since the first was the year in which it was established the “Fourth Industrial Revolution” as the exponential and rapid development of digital technology in all fields, per the World Economic Forum³⁵.

Considering the PICO-S framework (population, intervention, comparison, outcomes, study design), we defined the other inclusion and exclusion criteria that we described below. Articles that cover all inclusion criteria were considered in this systematic review.

Participants/Population

Inclusion criteria

The population included only adolescents according to the definition used by Sawyer et al. (2018) which corresponds to people between 10 and 24 years old³⁶, and who have participated in web-based health interventions.

Exclusion criteria

Interventions targeting not directly to participants aged 10 to 24 years old but that targeted their parents or educators, or their healthcare professionals were excluded. Interventions targeting to multiple ages were excluded, if it was not possible to isolate the desired target age group.

Specific subgroups such as disabled people or people with irreversible clinical conditions or major chronic diseases were excluded since the review focused on the general adolescents.

Intervention/Exposure

Inclusion criteria

In our review we considered the definition described by Barak et al. (2009) which mentions that a web-based intervention is “a primarily self-guided intervention

programme that is executed by means of a prescriptive online programme operated through a website and used by consumers seeking health and mental-health related assistance. The intervention programme itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive Web-based components”³⁷. We considered web-based interventions developed for health promotion, which aimed to improve and/or maintain positive health behaviours. To be included, the web-based intervention can be a stand-alone intervention or a multicomponent intervention where the use of web-based resources is one of the intervention’s components.

Exclusion criteria

We excluded articles if they do not report a web-based intervention, or if the intervention does not aim to reduce lifestyle risk factors (non-health promotion interventions) or if the interventions aim to improve disease screening or to control major chronic diseases.

Comparator(s)/control

Inclusion criteria

Studies which compare the proposed intervention/exposure to another intervention or to a non-intervention group, as well as studies having a pre-test and post-test design, were considered in this review.

Exclusion criteria

Studies with no control group and only with a post-test design were excluded.

Outcome(s)

Inclusion criteria

Regarding the main objective of this systematic review, we included studies if they analysed the effectiveness of the intervention to promote desired behavioural change using quantitative or mixed methods. This may include outcomes such as the extent and maintenance of behaviour changes, risk reduction, cognitions and attitudes, behavioural intention, subjective norm, self-efficacy, perceived behavioural control and pre-conditions for practising and maintaining the desired behaviours (regarding physical activity, eating habits and weight control, smoking, alcohol use, sexual behaviour, and

quality of sleep). Secondary outcomes such as adoption and adherence rates of the web-based intervention, patient-reported experience, feasibility and usability assessments, and coherence of the technology with behavioural change techniques will also be analysed when available.

Exclusion criteria

Articles only evaluating the effectiveness of the intervention by qualitative methods were excluded, as well as those not having a measurement of the effectiveness. Also, studies not evaluating health outcomes related at least with one of these health behaviours: physical activity, eating habits and weight control, smoking, alcohol use, sexual behaviour, and quality of sleep were excluded.

Study design

Inclusion criteria

The final set of included studies were limited to quantitative or mixed methods studies as experimental studies, quasi-experimental studies, before-and-after studies/pre-post-test studies, clinical trials, and randomized control trials.

Exclusion criteria

Other types of publications, such as case studies, systematic reviews, meta-analysis, case reports and series, ideas, editorials, opinions, study protocols and studies using only qualitative methods were not included.

Data Extraction

The main author (DS) performed the electronic databases search. The articles found by databases search, after applying the filters, were imported into Endnote TM20 software and the duplicate records were removed by automation tools and manual search. Early screening by titles and abstracts was performed by one author (DS) based on the aim of the study and the eligibility criteria. Those articles identified as being potentially eligible were fully examined by two researchers (DS and AF) separately to make sure they met the inclusion criteria. In case of discrepancies the decision was discussed and deliberated by both reviewers. If the disagreement persisted, it was solved by two other authors (PP and JA). The reasons for exclusion are documented in Figure 2.

The articles which met the specified inclusion criteria had their data extracted by the main reviewer (DS) and validated by a second reviewer (AF) using a table developed in Microsoft® Excel by the study team. The summary of the narrative synthesis of included studies is documented in Table 1. More detailed data extracted for each study is described in Table S4, including authors, publication year, country or region, objective(s), sample characteristics and size, web-based technology intervention description and duration, behaviour change theories, and behavioural change outcome(s)/ health outcomes, secondary outcomes (adoption and adherence rates of the web-based intervention, patient-reported experience, feasibility and usability assessments, coherence of the technology with behavioural change techniques) when applied and main findings. Studies without control group were described as nonapplicable for description of comparators, as well as those not measuring any secondary outcome. Missing data was coded as (?). The data extracted reflect only the published information.

Two researchers (DS and AF) independently performed the risk of bias assessment for all included studies using the Effective Public Health Practice Project – Quality Assessment Tool for Quantitative Studies (EPHPP), which has been validated for use in public health research³⁸.

The global rating for each article is documented in Table 2 and was assessed by evaluation as weak, moderate, or strong regarding six domain ratings: selection bias, study design, confounders, blinding, data collection methods, withdrawals and drop-outs, according to a standardized guide and dictionary. Those with no weak ratings and at least four strong ratings were considered strong. Those with less than four strong ratings and one weak rating were considered moderate. Finally, those with two or more weak ratings were considered weak. Two other domains were included in the assessment, but they were not included in the overall score (integrity of the intervention and analysis)³⁹. After classifying all dimensions, both reviewers (DS and AF) discussed and compared their assessment, when discrepancies occur, the reason was identified as oversight, differences in interpretation of criteria or differences in interpretation of the study. After discussion, both researchers agreed in a final decision. Table S5 describes the EPHPP assessment in detail.

Data Synthesis

Considering the broad health behaviours included in our research question, a substantial heterogeneity between studies was found, regarding their aims, methods and reported outcomes. Thus, we decided to perform a qualitative synthesis to summarize the extracted data rather than performing a meta-analysis. By doing so, we intended to systematically review of web-based intervention related to health behaviour change, to interpret the results and draw conclusions about their effectiveness, feasibility, usability and use of behaviour changing techniques. Furthermore, we also identified the limitations and proposed directions for future research.

Results

Study selection

As described in the PRISMA flowchart (Figure 2) 449 results were found through the search in the five electronic databases. Of those, 189 results were marked as ineligible by automated tools of the databases, the remaining articles were imported into Endnote TM20 software, and 77 results were found to be duplicate records. In total, 266 results were removed before screening. One of the authors (DS) screened the title and abstracts of 183 studies and based on the purpose of the study and the inclusion and exclusion criteria, DS identified 65 studies sought for retrieval. The full text of those studies potentially eligible were independently assessed by two reviewers (DS and AF) using the inclusion and exclusion criteria. In case of discrepancies the decision was discussed and deliberated by both reviewers. If the disagreement persisted, it was solved by two other authors (PP and JA).

The reference list of retrieved articles were searched which resulted in 11 articles added to be assessed for eligibility, two others were identified from databases' alerts and three were found by searching the interventions name of the articles excluded because they did not evaluate the effectiveness of the intervention. In total, 16 records were identified via other methods, and their full texts were compared with our eligibility

criteria, of those, 12 were excluded. Table S6 and S7 document reasons for the exclusion of each excluded record.

In total, 18 records met all the inclusion criteria, describing a total of 14 different interventions. We found five records with the same main author describing the same intervention (The eCHECKUP TO GO)⁴⁰⁻⁴⁴, so to prevent duplicate studies that might lead to biased results, we assessed the time of recruitment, the sample size, and the time of follow-up⁴⁵. The decision was to include in the narrative synthesis the work of Doumas, D. M., et al. (2021) since it had the best combination of longest time of follow-up (6 months) with the greatest sample size (n=311)⁴⁴.

Description of the studies

From among the 14 included, six were conducted in the United States of America (42.9%)^{44, 46-50}, three in European countries (21.4%)⁵¹⁻⁵³, three in Asian countries (21.4%)⁵⁴⁻⁵⁶ and two in Mexico (14.3%)^{57, 58}. Of those, 10 were implemented in an educational setting (71.4%)^{44, 46, 48, 49, 53-58}.

Concerning to study design, seven studies were randomized controlled trials (50.0%)^{44, 48, 49, 51-53, 56}, four were quasi-experimental studies (28.6%)^{54, 55, 57, 58} and three had a pre and post-test design (21.4%)^{46, 47, 50}.

Regarding the desired behaviour change, four interventions intended to promote physical activity (28.6%)^{46, 47, 54, 55}, one aimed to modify physical activity simultaneously with fruit and vegetables consumption (7.1%)⁵⁶, four were related with alcohol use (28.6%)^{44, 50, 51, 53}, four tried to prevent risky sexual behaviours (28.6%)^{49, 52, 57, 58} and one proposed to prevent tobacco use (7.1%)⁴⁸. None of the sleep hygiene interventions records was found to meet the inclusion criteria.

Recruitment and participants

Our review encompasses data from 7616 participants, with 10 included studies having relatively small size samples (≤ 150 subjects per study's condition or control)^{44, 46-50, 52, 54, 55, 58}. Sample sizes ranged from 20 subjects in the published work from Wilson, M., et al. (2017)⁴⁶ to almost 3 000 participants in the study from Norman, P., et al. (2018)⁵³.

Data included in our review were collected from participants aged 10 to 24 years old, with an average mean age of 16.7 from all studies, except two of them who did not indicate mean age of subjects^{54, 57}. A majority of studies included older adolescents (aged > 14 years old)^{44, 46, 49, 51, 53, 54, 57, 58}, only one was focused only in younger adolescents⁵⁵, two also encompassed younger adolescents (aged ≤ 14 years old) alongside older ones^{47, 48}, and three also analysed emerging adults (aged < 25 years old)^{50, 52, 56}.

Concerning ethnic background, most interventions were tested in Caucasian participants^{44, 46, 49-53}, three focused in Asian participants⁵⁴⁻⁵⁶, other three were implemented in Hispanic participants^{47, 57, 58} and one included mostly both Hispanic (43.6%) and afro-american participants (41.6%)⁴⁸.

There were more females than males in most studies^{44, 46, 50, 53, 56-58}, with two of the included studies only targeting to girls^{47, 49} yet none was targeted only to male participants. In three studies slightly more than half of the sample were men^{48, 51, 55}. No information about sex representativity was available in Brown, K. E., et al. (2018)⁵² and Pirzadeh, A., et al. (2020)⁵⁴.

In most of the studies, recruitment was achieved through educational institutions using institution-wide announcements, information sessions in lectures, classrooms, or after-school program meetings, and by sending emails and letters to participants and parents when applied^{44, 46, 48, 49, 53-58}. Social media advertisements^{50, 51}, announcements in health promotion sites, open access to the intervention's website landing page⁵¹, printed promotion materials distributed in public areas (such as schools, cafes, bars, stores, youth meetings and health-focused community events)^{47, 51}, referencing by other participants⁴⁷ and using a brief verbal introduction and printed material presented by the staff to clinical attendees⁵² were other recruitment strategies identified in included studies.

These recruitment strategies resulted in non-probabilistic samples in all these trials, so results may not be generalized to out-of-sample context.

In eight studies, financial rewards, gift cards, giveaway items and prize draws were used as incentives for retention^{44, 46, 48-51, 53, 58}.

Only three studies had 6 months of follow up^{44, 53, 54}. The others had a shorter length of study follow-up (<6 months)^{47, 49-52, 55-57} and three of them did not include follow-up measurements besides the moment immediately post-intervention^{46, 48, 58}.

Web-based interventions

A variety of web-based interventions were evaluated in the included articles, from brief online interventions based on text messaging delivered through e-mail with multimedia content links⁵³, or wearable digital tracking devices to record data and provide feedback on progress using an internet-based platform⁴⁶, to websites using narrative and animation to deliver content and challenges into real-life context combined with geographical information system to record progress⁵⁵.

Nearly half of them were at least somehow tailored^{49-52, 54, 56} and the degree of customization was also variable, ranging from interactive systems designed to generate individually tailored content matching participants' response choices^{51, 52} to intervention elements that were consistent with the participants' level of motivation/readiness to change and personalized reports on the participants' progress⁴⁵ according to their questionnaires responses.

From among our 14 included articles, 10 interventions were exclusively internet-based, and used web to deliver all intervention components including the online data collection^{42, 45, 48-50, 52-55}, most were delivered through a website and one of them was presented as a mobile application to create a gamification environment, a data collection field and shared affiliation links to other web-based resources⁴⁶. However, in the other 4 studies, the web-based component was merely one element of a multicomponent intervention, such as using a wearable digital tracking device to record progress in an internet-based platform combined with workshops, lectures, and goal setting counselling face-to-face with professionals⁴⁷, or brief tailored web-based programme with paper-based action planning cards⁵¹, or to support online educational sessions with face-to-face sessions⁵⁷ or class discussions⁵⁶.

All our identified trials were health promotion interventions and included content to promote behaviour change on a range of topics, such as diet patterns and healthy eating, physical activity, alcohol and tobacco use, and sexual behaviour.

Behaviour Change Theories and Techniques

All the included studies were theory-based interventions. Some of them were constructed based in only one theory or model, such as Transtheoretical Model/ Stages of Change⁵³, Operant Conditioning Theory⁴⁶, Information-Motivation-Behavioural Skills Model⁵⁶, Conceptual Framework of Adolescent Sexual Resilience⁵⁷, Theory of Motivational Interviewing⁵⁰, Health Action Process Approach⁵⁵, and the Self-efficacy Theory as a subset of the Social Cognitive Theory⁴⁷. In contrast, other studies relied on more than one theoretical model, combining, namely: the Social Cognitive Theory with the Transtheoretical/ Stages of Change Model⁴⁵, the Experiential Learning Theory and the Extended Elaboration Likelihood Model⁴⁸, the Theory of Planned Behaviour with the Health Action Process Approach⁵¹ or with Self-affirmation and Implementation Intentions⁵², the Social Cognitive Theory and the Health Belief Model⁵⁴, also the Social Norming Theory with Motivational Enhancement models⁴², as well as Reasoned Action Model and Fuzzy Trace Theory with multiple others psychological and health behaviour change techniques⁴⁹.

Effectiveness of the Web-based interventions

Among the 14 included studies, three used differences between pre and post-test assessment^{46, 47, 50} to document their effectiveness, while the remaining 11 based their findings in differences from intervention group to control groups, using active and non active-control groups. Namely, 6 studies used a control group as assesement-only^{44, 51-54, 56}; three studies used a non-web-based educational intervention as the control group, one regarding the study outcome⁵⁷ while the other two were about generic health themes other than the one being studied^{55, 58}; the last two were web-based interventions, where one was about an unrelated health theme⁴⁹ and the other used a website with only written content and without interactivity or entertainment features⁴⁸.

Thirteen of the 14 studied interventions revealed significant positive findings that support web-based intervention effectiveness in promoting health behaviour change. Namely, in improving motivation⁴⁶ and practice of physical activity^{47, 54, 55} as well as positive changes in weight, fitness and cardiovascular measurements⁴⁶; in decreasing self-reported problematic alcohol use^{44, 50, 51, 53} and alcohol-related

consequences⁵⁰; in improving sex norms and attitudes, self-efficacy, self-reported sexual assertiveness skills, intentions to communicate about sexual health, knowledge concerning to sexually transmitted diseases and condom use^{49, 57} and to mitigate the numbers of mishaps in pill and condom use⁵²; in reducing intention to smoke in non-smokers⁴⁸; and in increasing fruit and vegetables intake⁵⁶.

Although the study from Castillo-Arcos Ldel, C., et al. (2016) had observed a crude reduction in risky sexual behaviours in the intervention group, they were not able to show a significant reduction in those behaviours using multivariate analyses since unexpected effects in pre and post-test scores occurred in the control group. To note that the control group was subjected to the visualization of an educational video aimed to improve the general health status focusing in unhealthy food habits, mental health disorders, drug use, violence and accidents⁵⁸.

Other outcomes

The most frequent non-health related outcome measured in the included studies was acceptability^{46, 47, 50, 52, 55, 57}, but feasibility^{46, 47, 52}, engagement^{48, 50}, adherence^{46, 47} and usability⁴⁶ were also evaluated in some studies.

The main aim of some of the studies was even to test feasibility and acceptability, being the evaluation of potential efficacy a secondary objective given the pilot nature of those trials^{46, 47, 50, 52}.

In these studies, the interventions overall proved to have reasonable levels of acceptability (ranging from moderate^{47, 52} to good^{46, 50, 55, 57}) and good feasibility^{46, 47, 52, 58}. As positive features, web-based interventions were classified by participants as easy to use⁵⁰, interactive and entertaining⁴⁸. The time demanded to accomplish proposed activities⁵⁷, technical problems⁵⁰ and high drop-out-rates^{51, 56} were negative aspects of some of these interventions.

Risk of bias' assessment

The critical appraisal of individual studies performed using the Effective Public Health Practice Project – Quality Assessment Tool for Quantitative Studies (EPHPP)³⁹ for selection bias, study design, confounders, blinding, data collection methods, withdrawals and drop-outs are described in Table 2. Overall, EPHPP tool showed a low

quality of study methodology since 12 studies were classified as weak^{44, 46, 47, 49-56, 58} and two as moderate^{48, 57}.

Discussion and Conclusions

Summary of Findings

Our systematic review showed positive effects of internet-based interventions to achieve health behaviour change including increased motivation⁴⁶ and physical activity level^{46, 47, 54, 55}, decreased harmful alcohol use and its consequences^{44, 50, 51, 53}, improved attitudes, self-efficacy, assertiveness skills, intentions to communicate and knowledge concerning to sexual behaviours^{49, 52, 57}; decreased intention to smoke⁴⁸; and increased fruit and vegetables consumption⁵⁶.

However, these findings relied mostly on small sample sizes, non-probabilistic samples, and studies with lower length of follow-up, very context-specific, which limits the generalizability of the results, as already described in the literature.

In addition, although all studies analysed presented statistically significant differences between groups (control vs intervention or pre-test vs post-test), not all evaluated the intervention effect and when they do, different analytic estimators were used, compromising the quantitative summary and interpretation of the dimension of the differences. In addition to the widely used statistical significance, the use of effect size for each outcome should also be promoted, as it would allow for a more detailed reading and interpretation of results. Although our review suggest that web-based interventions are a promising approach to achieve health behaviour change, robust evidence from larger randomized controlled trials, from population's representative samples, with proved stronger size effects, is still needed.

A wide range of web-based interventions were found. It is worth noticing that the more interactive and entertaining the intervention was, the higher was the participants' retention in the study. It also increases the intervention's acceptability, and feasibility⁴⁸. Overall, web-based interventions seem to have moderate to good acceptability and feasibility^{46, 47, 50, 52, 55, 57, 58}.

In contrast to previous literature⁵⁹, we found out that researchers are largely developing interventions based on theoretical frameworks and models, which has been showed to improve intervention's effectiveness⁶⁰.

Critical points seem to be mainly related to sampling issues, representativeness of populations and absence of blinding. We identified that some important information, which is required by risk assessment tools, is sometimes nonavailable or unclear. Therefore, examining in advance all the domains evaluated in these tools may help researchers to conduct methodological studies more robust, with a higher quality of evidence.

Even though web-based interventions seem to be a promising approach to health behaviour change with a positive acceptability among adolescents, robust evidence still lacking. We keep doing the same errors as in the past since we still lack results from larger randomized controlled trials from high quality papers (lower risk of bias), with representative samples, and testing long term maintenance of these health behaviour change (time of follow-up > 6 months). These limitations are known by most of the authors, who refer to them in their papers. Nonetheless, it is crucial to identify why they keep being reported repeatedly. And moreover, try to overcome them. It was also frequent, studies being classified as pilot projects highlighting the need to study the effectiveness of the intervention in other studies, but never publishing those randomized controlled trials with the sample size needed for the effect size wanted. This may partially be explained by the lack of financial resources as well as time availability. Planning, developing, ensure the internal testing and usability testing is a very time-demanding and costly research, since the development of web-based intervention is often a back and forward process. With limit fundings and restricted time to accomplish the intervention, most researchers will fail in provided robust evidence. We suggest that more than developing new web-based intervention, researchers should unify their strengths and resources in order to largely test the existing intervention in different culturally contexts, within different population.

Limitations of This Review

The present review is intended to summarize the most relevant evidence available to assess the effectiveness of web-based interventions to promote health behaviour change in adolescents. We acknowledge that our selection of 2016 as the oldest reference comports the risk of excluding previous robust evidence. However, the

recent global increment of the importance of the web in our daily life and the emergence of other digital innovative technologies justify our focus.

It is also a fact that in the last two years, the resources and efforts of worldwide scientific community have focused on the issue of COVID-19, mitigating the investment in health-promotion interventions for children and adolescents, since the educational context where these interventions were often implemented has undergone through critical adaptations. This may partially justify the reduced number of included papers despite the growing trend observed during last years. Nevertheless, the mandatory lockdown had reinforced the need to invest in technological health promotion strategies that may be implemented at distance, large-scale and with almost the same financial and human resources.

We are aware that, due to time restrictions, we left out other databases relevant to this topic, such as EMBASE, ERIC, B-on, Emerald, among others. It has been suggested that piloting a sample of records through every review's step, like producing a "mini" review, could be used to effectively change the criteria in the data extraction table to ensure that the full review would include the most useful and relevant information, deleting the need to re-visit the papers at a later phase⁵⁸. Thus, we can consider this work as a "mini" systematic review, since an update should be performed by running the search query in other relevant databases. In addition, searching in grey literature, which was not included in this review could expand the number of eligible publications. Even though publication bias has been largely documented in the literature, it seems that this bias is increasing. It could be explained by the higher competition between researchers that tend to publish positive results rather than the negative ones⁵⁹. For this reason, searching grey literature would give us a more realistic summary of evidence.

The main limitations of the present review included combining the results of well-designed studies with less rigorously designed studies and combining heterogeneous studies regarding settings, interventions, methods, and outcomes measures. Also, the absence of analysing by subgroups of health outcomes and active components of the behaviour change intervention, may be considered a limitation. However, the low number of studies that used each health area and each behaviour change technique did not allow this analysis to be performed.

Besides these limitations, to our knowledge, this is the first systematic review summarizing the effectiveness of web-based interventions in promoting a wide range of health behaviour change, focused specifically on adolescents. Important findings were highlighted to help researchers to reach high quality evidence in the development and evaluation of web-based interventions.

Conclusion

Our findings support that web-based interventions significantly contribute to achieve health behaviour change among adolescents with reasonable levels of acceptability and feasibility. Additionally, more evidence is needed to prove their effectiveness in long term maintenance, since there are few studies with follow-up assessment larger than 6 months. As showed by the critical assessment of risk of bias, these findings are of low quality evidence, so it is urgent to test these web-based intervention in larger randomized controlled trials, within probabilistic samples, ideally in single or double blinded design and testing long term maintenance of these health behaviour change (time of follow-up > 6 months).

SO WHAT?

What is already known on this topic?

There is still a lack of robust evidence about the benefits of web-based interventions in promoting health behaviour change in general population. Its outcomes could be more relevant among adolescents because their wide use of internet, their familiarity with technology, and their preference for engaging and entertaining interventions. Although theory-based is an important predictor to behavioural interventions' effectiveness, they are often designed without relying on any theory.

What does this article add?

This study extends the prior literature showing significant positive results of behavioural web-based interventions among adolescents. However, most papers are context-specific and have non-probabilistic and small samples. Theory-based interventions are

frequent, suggesting that planners are conscious about the importance of health behavioural theories to enhance the interventions' effectiveness.

What are the implications for health promotion practice or research?

Low-quality evidence about the effectiveness of web-based interventions is still a concern. Therefore, it is important to implement rigorously designed web-based RCTs with larger time of follow-up that overcome the bias identified in the published studies included in this systematic review.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest.

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Authors' Contributions

DS were responsible for the first draft of this manuscript and for this systematic review's protocol. DS and AF performed the full-text screening against eligibility criteria, risk of bias (quality) assessment and data extraction. PP and JA contributed to this study protocol conception and design. All the authors critically revised the manuscript and gave their final approval.

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Tables and Figures

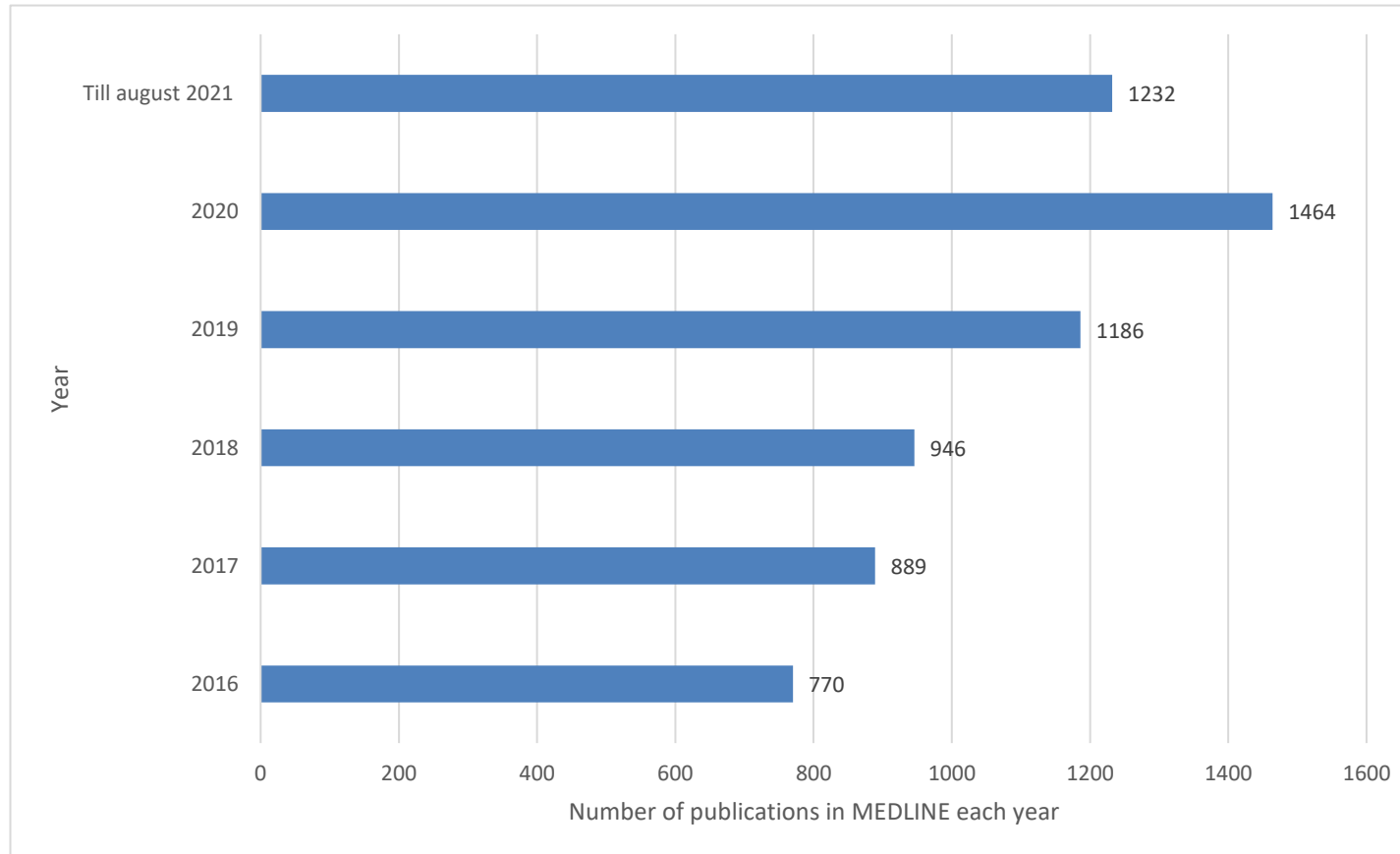


Figure 1: Trends by year of publication for search terms "health AND web-based Intervention"

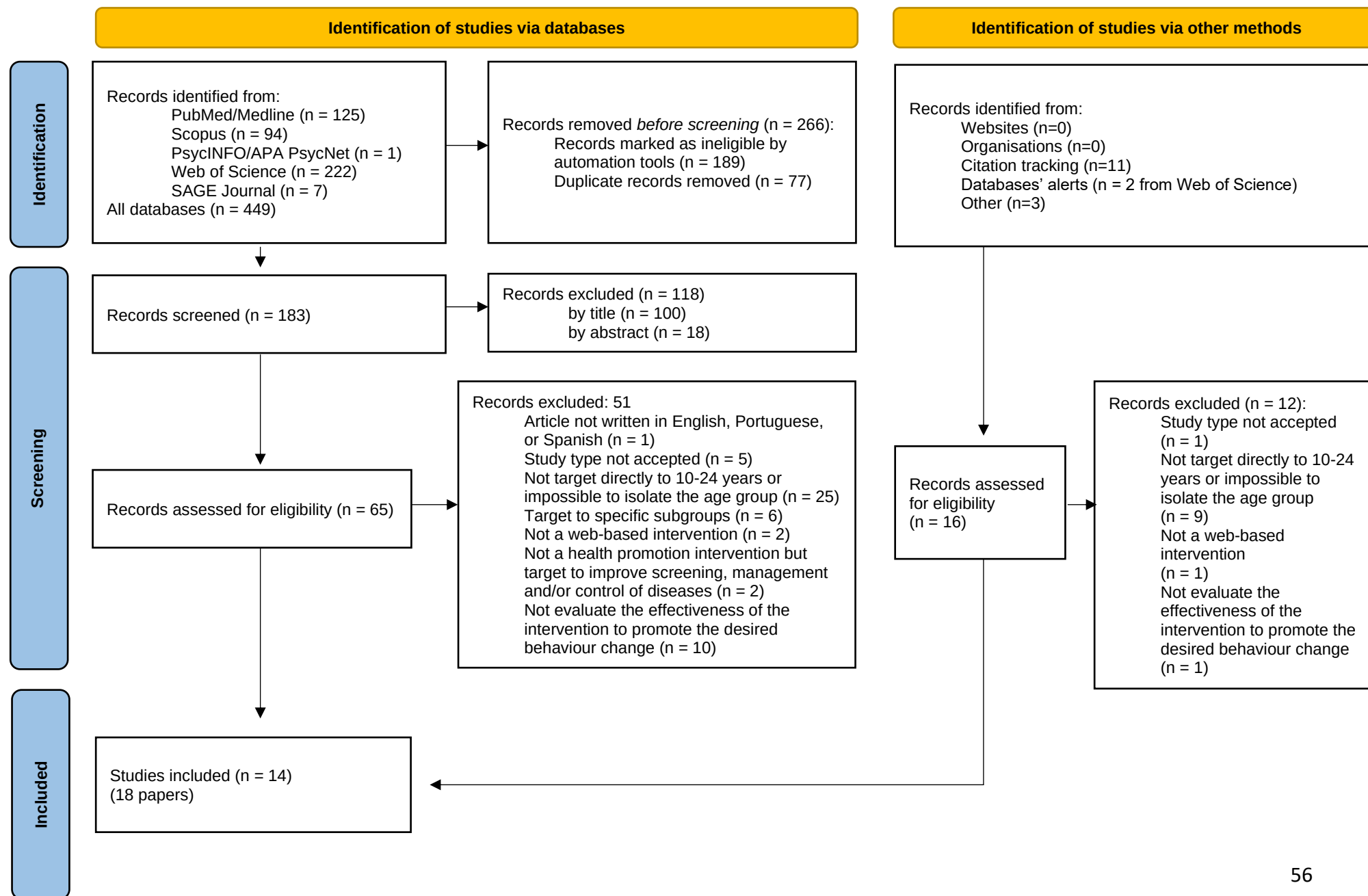


Figure 2: Study Flow Diagram adapted from: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: <http://www.prisma-statement.org/>

Table 1: Summary of narrative synthesis of included studies

HEALTH TOPIC	AUTHOR, YEAR, COUNTRY	SETTING	STUDY DESIGN	PARTICIPANTS	WEB-BASED INTERVENTION	HEALTH OUTCOMES OF INTEREST	MAIN FINDINGS
Physical Activity	Wilson, M., et al. (2017) USA, North-western United States	School	One-group pre-/post-test design (pre-experimental)	N = 20 students (convenience sample) Mean age of 16,8 years.	Multicomponent Intervention: wearable digital tracking device using an Internet-based platform + group physical activities + nutrition group education/ individual counselling session on healthy eating + weekly goal-setting sessions.	Measured at baseline and post-intervention: BMI calculation. Blood glucose level. Blood pressure and pulse measurements. Fitness and cardiovascular fitness. Cognitive and effective variables related to health behaviours. Adolescents' physical activity and healthy eating. Self-efficacy for PA and healthy eating. Self-determination. Screen time.	Participants showed improvements from pre-test to post-test in health and fitness markers (positive changes in weight, fitness, and cardiovascular measurements) and improved motivation toward PA and reduced screen time.
Physical Activity	Larsen, B., et al. (2018) USA (San Diego, CA)	Hispanic community	Pre/ post-test design (Single-arm pilot trial)	N = 21 Latina adolescents Mean age of 14,7 years.	Website mobile phone friendly (tailored Internet-delivered activity manuals, computer-expert system tailored reports, activity tip sheets, and a guide of local activity resources).	Measured at baseline and follow-up (12 weeks): PA by 7-day physical activity recall (PAR) interview and ActiGraph GT3X+ accelerometers.	Results from the 7-day PAR showed that positive changes in PA at 12 weeks were seen not just in quantity but also in type. The usage of validated self-report measures showed to be better than accelerometers among this population, since there are some activities in which the accelerometer may not be worn or that were not well measured by the accelerometer.
Physical Activity	Huang, S. J., et al. (2019) Taiwan, Taipei City	School	Quasi-experimental (Three-armed)	N _{initial} = 617 students Mean age of 11,4 years.	Two experimental groups: One using a web-based exercise program applying a self-management strategy combined with geographical information system mapping function and using a narrative animated cartoon. And the other was a knowledge-only using only the animated story.	Measured at baseline, immediately post and 3-month follow-up: PA by Chinese version of the Child/Adolescent Activity Log. Exercise-related self-efficacy using a 5-item Exercise-Related-Self-Efficacy Scale. Perceived benefit of PA using a self-developed 7-item Perceived-Benefit-of-Exercise Scale.	This intervention using self-management strategy + GIS mapping function was effective in producing small but significant increases in school children's self-efficacy and PA. The perceived benefit and the self-efficacy of regular PA might have partly affected the participants' PA levels, because the self-efficacy factor was always higher for the both experimental groups than for the control group at the post-test and follow-up; it was also higher for the self-management group than for the knowledge-only group. The intervention was more effective for male students than female students, partly because the design of the website was more appealing to male students.

	AUTHOR, YEAR, COUNTRY	SETTING	STUDY DESIGN	PARTICIPANTS	WEB-BASED INTERVENTION	HEALTH OUTCOMES OF INTEREST	MAIN FINDINGS
Physical Activity	Pirzadeh, A., et al. (2020) Iran, Isfahan	University	Quasi-experimental	N = 278 high school students (?) Mean age.	Two web-based intervention groups. One group received education through a website with tailored education strategies based on TTM. The second group only received general education by the same website but without tailored materials.	Measured before intervention and 6-months after: Stage of exercise behaviour change questionnaire. Processes of change questionnaire. Decision-making balance questionnaire. Exercise self-efficacy scale. International PA questionnaire short form.	Education on PA based on website can be effective. The percentage of students with low, moderate, and severe levels of physical activity in the two intervention groups has increased significantly after the intervention. Participants showed significant progress during stages of change post intervention and changes were greater in the group who was trained by the TTM.
Eating Habits and Physical Activity	Duan, Y. P., et al. (2017) China, Central Region	University	Randomized controlled trial	N _{initial} = 493 undergraduate students N _{post intervention} = 337 N _{1-month follow-up} = 142 Mean age of 19,2 years.	Web-based intervention modules target social-cognitive indicators for health behaviour change for Physical Activity and Fruit and Vegetables Intake (information about risks and benefits, motivating intentions to change, identification of barriers, goal setting, development of action plans, coping plans and social support, providing tailored normative feedback).	PA by Chinese short version of the International Physical Activity Questionnaire (IPAQ-C). FVI in the past 7 days. Stages of behavioural change for PA and FVI. Social-cognitive indicators of behaviour change: positive and negative outcome expectancies for PA and FVI; self-efficacy for PA and FVI; action planning; coping planning; social support; intentions for PA and FVI; habit scale.	Students in the intervention group reported more FVI over time. Average FVI for the intervention group were all greater than the recommended amounts at the end of the 8-week intervention and at the 1-month follow-up. In terms of PA behaviour, there was no significant interaction effect. Positive results on stage progression for the PA and FVI. All 6 tests revealed significant treatment effects on motivational, volitional, and distal indicators of PA and FVI over time.
Tobacco Use	Khalil, G. E., et al. (2017) USA, Texas, Houston	School	Randomized controlled trial (2-arm single-blinded)	N = 101 adolescents Mean age of 13,4 years.	Two Web-based intervention groups: One features interactivity and entertainment to engage adolescent users (text, animations, videos, task-oriented activities, two-dimensional environment to explore health information and make a virtual character). The second group included the same health information as previous but without any features of interactivity or entertainment.	Measured at baseline and follow-up: Intention to smoke using items adapted from the susceptibility to smoke scale.	The more participants considered intervention interactive and entertaining, the more they were probably going to show a reduction in their intention to smoke. Perceived interactivity had a more grounded relationship with the reduction in intention to smoke than perceived entertainment.

	AUTHOR, YEAR, COUNTRY	SETTING	STUDY DESIGN	PARTICIPANTS	WEB-BASED INTERVENTION	HEALTH OUTCOMES OF INTEREST	MAIN FINDINGS
Sexual Behaviours	Castillo-Arcos Ldel, C., et al. (2016) Mexico, Urban Mexico	School	Quasi-experimental (single-stage cluster sampling)	N = 193 participants Mean age of 15,8 years.	Multicomponent intervention: 6 online sessions + 2 face-to-face Activities aimed at increasing levels of social competence and resilience about sexual behaviours.	Measured pre- and post-intervention: Self-reported risky sexual behaviours (defined as self-reporting unprotected sex, multiple concurrent sexual partners, and alcohol or drug use during sex). Resilience to risky sexual behaviour (defined as the ability to identify and practice strategies to avoid risky sexual behaviour).	The intervention was independently associated with improved self-reported resilience to risky sexual behaviours though not with a significant reduction in those behaviours in multivariate analyses . Participant age mediated the effect of the intervention on resilience, influencing the effectiveness of the intervention.
Sexual Behaviours	Doubova, S. V., et al. (2017) Mexico, Mexico City	School	Quasi-experimental (field trial)	N = 833 adolescents (?) Mean age.	Multicomponent intervention: Educational sessions thought a website displayed by two central characters + class discussions Main topics: dating, courtship, sexual relationship, misconceptions, and myths about gender-roles and sexual relationships, partner abuse, STIs, early pregnancy, self-esteem, safe sex, use of condoms and condom negotiation.	Measured at baseline, at the end of the four educational sessions (1st month), and at the end of the follow-up period (fourth month): Knowledge of STIs. Multidimensional Condom Attitudes Scale measuring attitudes regarding condom use. Self-efficacy toward consistent condom use.	Intervention had a positive effect on improving adolescents' knowledge of STIs, attitudes and self-efficacy toward consistent condom use. In the intervention group, the average knowledge of STIs increased 30 points compared to the control group. Increase in positive attitudes and self-efficacy toward consistent condom use was also observed more often in the intervention group.
Sexual Behaviours	Brown, K. E., et al. (2018) United Kingdom (UK), Midlands	Clinical (sexual health service)	Pilot randomized controlled trial (two-armed parallel group)	N _{initial} = 88 integrated sexual health service attendees N _{follow-up} = 67 Mean age of 20,0 years.	Multicomponent intervention: brief tailored web-based programme + paper-based action planning card. Content about contraceptive pill and/or condoms use using characters with audio to take the user through the process of identifying environmental cues to key target behaviours and planning to perform those behaviours when the environmental cue is present.	Measured at baseline and 3-month follow-up: Self-reported contraceptive pill or condom "mishaps" in the past 3 months. Contraceptive pill or condom use intention. Attitude toward contraceptive pill or condom use. Perceived behavioural control over pill or condom use. Subjective norm relating to pill or condom use. Trait self-control.	The intervention supported pill and condom users to produce quality plans since potential improvements were identified. Bivariate correlations suggest that perceived behavioural control may have a role over method use within intervention content. Also, having greater levels of trait self-control may negatively affect plan quality. The study suggests early indications that the intervention could reduce the numbers of mishaps of intervention' participants.

	AUTHOR, YEAR, COUNTRY	SETTING	STUDY DESIGN	PARTICIPANTS	WEB-BASED INTERVENTION	HEALTH OUTCOMES OF INTEREST	MAIN FINDINGS
Sexual Behaviours	Widman, L., et al. (2018) USA, South-eastern	School	Randomized Controlled Trial	N = 222 tenth-grade girls Mean age of 15.2 years.	Interactive, skills-focused web-based intervention. The intervention includes 5 modules about safer sex motivation, HIV and other STDs, sexual norms and attitudes, safer sex self-efficacy, sexual communication skills that can be completed on a computer, tablet, or smartphone device. Each module used audio and video clips, tips from other adolescents, interactive games and quizzes, infographics, and skill-building exercises with self-feedback given in real time).	Measured at pre-test, post-test and 4-month follow-up: Behavioural assessment of sexual assertiveness skills (at refusing unwanted sexual activity and negotiating condom use). Self-reported sexual assertiveness by Multidimensional Sexual Self Concept Scale. Knowledge regarding HIV and other STDs. Intentions to use condoms and to communicate about sex with items from the AIDS Risk Behaviour Assessment. Sexual Self-Efficacy from self-efficacy for HIV prevention scale.	At immediate post-test, the intervention group showed better sexual assertiveness skills measured with a behavioural task, higher self-reported assertiveness, intentions to communicate about sexual health, knowledge regarding HIV and other STDs, safer sex norms and attitudes, and condom self-efficacy compared with the control condition. At 4-month follow-up, group differences remained in knowledge regarding HIV and other STDs, condom attitudes, and condom self-efficacy.
Alcohol Use	Arnaud, N., et al. (2016) European countries (Sweden, Germany, Belgium, and Czech Republic)	Online	Randomized controlled trial (Two-armed multisite)	N _{initial} = 1449 adolescents (Convenience sample) N _{follow-up} = 211 Mean age of 16,8 years.	Interactive web-based system to generate individually tailored content. Generated information in small units using text and graphics and referred to previous participant's statements.	Measured at baseline and 3-month follow-up: Self-reported drinking index (drinking frequency, frequency of binge drinking, and typical quantity of drinks) using AUDIT-C screening tool.	Self-reported risk drinking as measured by a drinking index was significantly reduced for participants in the intervention group. Statistically significant mean differences at follow-up in favour of the intervention was found for drinking frequency and binge drinking frequency but not for quantity when missing follow-up data was not imputed. In contrast, analyses using an EM-imputed dataset revealed drinking quantity as the only significant secondary effect.

	AUTHOR, YEAR, COUNTRY	SETTING	STUDY DESIGN	PARTICIPANTS	WEB-BASED INTERVENTION	HEALTH OUTCOMES OF INTEREST	MAIN FINDINGS
Alcohol Use	Norman, P., et al. (2018) UK, large city	University	Randomized controlled trial (full-factorial design)	N _{initial} = 2,951 students before starting university N _{post-intervention} = 2,681 Mean age of 18,8 years.	Brief online intervention combining self-affirmation x TPB-based messages x implementation intentions in a factorial design.	Measured at baseline, 1 week, 1 month and 6-month follow-up: Self-reported alcohol intake (total number of units consumed and number of binge drinking sessions/week). Hazardous and harmful patterns of alcohol use from 10- item AUDIT (only at 6-month follow-up). Cognitions about binge drinking (intention, affective attitude, cognitive attitude, subjective norms, descriptive norms, and perceived control) and extent of endorsement for the beliefs (Engaging in binge drinking at university would be fun, Engaging in binge drinking at university would have a negative impact on my studies, My friends engaging in binge drinking would make my binge drinking at university more likely).	TPB-based messages had significant effects on reduce the quantity of alcohol consumed, frequency of binge drinking and harmful patterns of alcohol use over the first 6 months at university. Its effects did not diminish over time. The messages also had significant positive effects on intentions to binge drink, cognitive attitudes, subjective norms, descriptive norms, and self-efficacy, although some effects weakened over time. The effects on the quantity of alcohol and frequency of binge drinking were mediated by TPB variables with significant indirect effects through intention and self-efficacy. The effect sizes for the TPB-based messages on the quantity of alcohol consumed (d = 0.20) and the frequency of binge drinking (d = 0.17) were small. Messages were sufficiently relevant and persuasive to produce changes in behaviour without the need to form if-then plans. Non-significant effects were found for self-affirmation and forming implementation intentions.
Alcohol Use	Coughlin, L. N., et al. (2021) USA, Michigan	Online	Pre/ post-test design (Pilot study)	N = 39 participants Mean age of 20,7 years.	Mobile intervention with tailored messages and tips, inspirational images to reinforce content, web links to articles, or other web-based resources, based on users' responses to daily and weekly surveys. The intervention included gamification through a virtual aquarium environment.	Measured at baseline and 1 month follow up: Concerning to alcohol use (quantity and frequency of use, consequences of use, intention, importance confidence of change, perceived risk, reasons for use, and past month driving under influence of use).	Participants' substance use declined over time, and those reporting using the app more often reported less substance use (including fewer days drinking alcohol, binge drinking, fewer consequences of use and episodes of driving after drinking) at the 1-month follow-up than those who reported using the app less often.

	AUTHOR, YEAR, COUNTRY	SETTING	STUDY DESIGN	PARTICIPANTS	WEB-BASED INTERVENTION	HEALTH OUTCOMES OF INTEREST	MAIN FINDINGS
Alcohol Use	Doumas, D. M., et al. (2021) USA, Northwest region	School	Randomized controlled trial	N = 311 high school seniors Mean age of 17,1 years old.	Online personalized normative feedback intervention via text, graphs, and video recordings. The program intended to reduce risk factors for alcohol use and increase protective behaviours.	Measured at baseline, 30-days and 6-month follow-up: Weekly drinking quantity. Estimated peak blood alcohol concentration (eBAC). Self-reported peak alcohol volume. Classification of High-Risk vs. Low-Risk drinkers by participants' report on frequency of binge drinking in the past month.	The intervention effects were moderated by risk status, such that high-risk students in the intervention condition reported a greater reduction in alcohol use relative to students in the control condition. For weekly drinking quantity, intervention effects were limited to the baseline to 30-day follow-up period. Among high-risk students, was found a significant decrease in weekly drinking in the intervention condition. However, intervention effects from baseline to the 6-month follow-up were not significant since the control condition also reported significant decreases in weekly drinking. For eBAC, intervention effects were evident at the 30-day follow-up and were sustained at the 6-month follow-up. Specifically, among high-risk students, we found a significant decrease in eBAC relative at the 30-day and 6-month follow-up. It is unclear why it was found sustained intervention effects for eBAC but not for weekly drinking. Non-significant intervention effects for low-risk drinkers.

Table 2: Risk of Bias Assessment – EPHPP Assessment Tool for Quantitative Studies

AUTHOR, YEAR	SECTION RATING						GLOBAL RATING
	SELECTION BIAS	STUDY DESIGN	CONFOUNDERS	BLINDING	DATA COLLECTION METHODS	WITHDRAWALS AND DROP-OUTS	
Wilson, M., et al. (2017)	WEAK	MODERATE	STRONG	WEAK	STRONG	MODERATE	WEAK (two or more WEAK ratings)
Larsen, B., et al. (2018)	WEAK	MODERATE	STRONG	WEAK	STRONG	STRONG	WEAK (two or more WEAK ratings)
Huang, S. J., et al. (2019)	MODERATE	STRONG	STRONG	WEAK	MODERATE	WEAK	WEAK (two or more WEAK ratings)
Pirzadeh, A., et al. (2020)	WEAK	STRONG	WEAK	WEAK	STRONG	STRONG	WEAK (two or more WEAK ratings)
Duan, Y. P., et al. (2017)	MODERATE	STRONG	WEAK	WEAK	STRONG	WEAK	WEAK (two or more WEAK ratings)
Khalil, G. E., et al. (2017)	WEAK	STRONG	STRONG	WEAK	WEAK	NOT APPLICABLE	WEAK (two or more WEAK ratings)
Dobova, S. V., et al. (2017)	WEAK	STRONG	STRONG	MODERATE	STRONG	STRONG	MODERATE (one WEAK rating)
Brown, K. E., et al. (2018)	MODERATE	STRONG	STRONG	WEAK	STRONG	STRONG	MODERATE (one WEAK rating)
Castillo-Arcos Ldel, C., et al. (2016)	WEAK	STRONG	STRONG	WEAK	WEAK	MODERATE	WEAK (two or more WEAK ratings)
Widman, L., et al. (2018)	MODERATE	STRONG	STRONG	WEAK	WEAK	STRONG	WEAK (two or more WEAK ratings)
Arnaud, N., et al. (2016)	WEAK	STRONG	STRONG	WEAK	STRONG	WEAK	WEAK (two or more WEAK ratings)
Norman, P., et al. (2018)	WEAK	STRONG	STRONG	WEAK	STRONG	WEAK	WEAK (two or more WEAK ratings)
Coughlin, L. N., et al. (2021)	WEAK	MODERATE	STRONG	WEAK	STRONG	STRONG	WEAK (two or more WEAK ratings)
Doumas, D. M., et al. (2021)	WEAK	STRONG	STRONG	WEAK	STRONG	MODERATE	WEAK (two or more WEAK ratings)

Supplemental Material

Table S1: PRISMA 2020 checklist verification for this systematic review.

Section and Topic	Item #	Checklist item	Location where item is reported (page)
TITLE			
Title	1	Identify the report as a systematic review.	25
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	-----
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	29-31
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	31
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	32-34
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	31
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplemental material
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	34-35
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	34
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	33-34
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	33-34
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	35

Section and Topic	Item #	Checklist item	Location where item is reported (page)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	NA
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	34-36
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	NA
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	NA
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	NA
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	NA
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	56
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	36
Study characteristics	17	Cite each included study and present its characteristics.	37-41
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	41
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	From page 54

Section and Topic	Item #	Checklist item	Location where item is reported (page)
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	NA
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	41-43
	23b	Discuss any limitations of the evidence included in the review.	41-43
	23c	Discuss any limitations of the review processes used.	43-44
	23d	Discuss implications of the results for practice, policy, and future research.	43,45
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	31
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	46
Competing interests	26	Declare any competing interests of review authors.	46
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	From page 54

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Table S2: Search terms organized in three main sections.

		Search terms
Population		teenagers OR adolescents OR “young people” OR teen OR youth
AND		
Intervention		“Internet-Based Intervention” OR “Web-Based Intervention” OR “online intervention” OR “digital intervention” OR “mobile intervention”
AND		
Health outcomes	Main Outcome	“health behaviour” OR “health behaviour” OR “behaviour change” OR “behaviour change” OR “health change” OR “health promotion” OR “lifestyle”
	OR	
	● Physical activity	(exercise AND (increase OR start OR maintain*)) OR “physical activity”
	OR	
	● Eating habits and weight control	weight OR BMI OR “five a day” OR diet OR nutrition OR “healthy eating” OR “fruits and vegetables” OR sugar OR salt
	OR	
	● Smoking use	(smoking OR tobacco) AND (cessation OR stop* OR quit* OR reduc*)
	OR	
	● Alcohol use	alcohol AND (reduc* OR limit* OR decreas* OR “cutting down” OR “cut down” OR “cut back” OR less* OR curb* OR abstain)
	OR	
	● Quality of sleep	sleep OR “sleep duration” OR “sleep quality” OR insomnia OR “sleep hygiene”
	OR	
	● Sexual Behaviour	sex OR sexual* OR “safe sex” OR “responsible sex”

Table S3: Search strategy by databases.

		Search query
Database	Pubmed/MEDLINE	("Internet-Based Intervention"[Title/Abstract] OR "Web-Based Intervention"[Title/Abstract] OR "online intervention"[Title/Abstract] OR "digital intervention"[Title/Abstract] OR "mobile intervention"[Title/Abstract]) AND (teenagers[Title/Abstract] OR adolescents[Title/Abstract] OR "young people"[Title/Abstract] OR teen[Title/Abstract] OR youth[Title/Abstract])) AND (((((((("Health behaviour"[Title/Abstract] OR "health behaviour"[Title/Abstract] OR "behaviour change"[Title/Abstract] OR "behaviour change"[Title/Abstract] OR "health change"[Title/Abstract] OR "health promotion"[Title/Abstract] OR "lifestyle"[Title/Abstract]) OR ((Exercise[Title/Abstract] AND (increase[Title/Abstract] OR start[Title/Abstract] OR maintain*)) OR "physical activity"[Title/Abstract])) OR (weight[Title/Abstract] OR BMI[Title/Abstract] OR "five a day"[Title/Abstract] OR diet[Title/Abstract] OR nutrition[Title/Abstract] OR "healthy eating"[Title/Abstract] OR "fruits AND vegetables"[Title/Abstract] OR sugar[Title/Abstract] OR salt[Title/Abstract])) OR ((Smoking[Title/Abstract] OR tobacco) AND (cessation[Title/Abstract] OR stop*[Title/Abstract] OR quit*[Title/Abstract] OR reduc*))) OR (Alcohol[Title/Abstract] AND (reduc*[Title/Abstract] OR limit*[Title/Abstract] OR decreas*[Title/Abstract] OR "cutting down"[Title/Abstract] OR "cut down"[Title/Abstract] OR "cut back"[Title/Abstract] OR less*[Title/Abstract] OR curb*[Title/Abstract] OR abstain))) OR (sleep[Title/Abstract] OR "sleep duration"[Title/Abstract] OR "sleep quality"[Title/Abstract] OR insomnia[Title/Abstract] OR "sleep hygiene"[Title/Abstract])) OR (sex[Title/Abstract] OR sexual*[Title/Abstract] OR "safe sex"[Title/Abstract] OR "responsible sex"[Title/Abstract]))
Search date	May 2021	
Search within	[Title/Abstract]	
Filters applied	Results by year 2016 - 2021	
Results found	71	
		Search query
Database	SCOPUS	(TITLE-ABS-KEY ("internet-based AND intervention" OR "web-based AND intervention" OR "online AND intervention" OR "digital AND intervention" OR "mobile AND intervention")) AND (TITLE-ABS-KEY (teenagers OR adolescents OR "young AND people" OR teen OR youth)) AND ((TITLE-ABS-KEY ("health AND behaviour" OR "health AND behaviour" OR "behaviour AND change" OR "behaviour AND change" OR "health AND change" OR "health AND promotion" OR "lifestyle")) OR (TITLE-ABS-KEY ((exercise AND (increase OR start OR maintain*)) OR "physical AND activity")) OR (TITLE-ABS-KEY (weight OR bmi OR "five AND a AND day" OR diet OR nutrition OR "healthy AND eating" OR "fruits AND vegetables" OR sugar OR salt)) OR (TITLE-ABS-KEY ((smoking OR tobacco) AND (cessation OR stop* OR quit* OR reduc*))) OR (TITLE-ABS-KEY (alcohol AND (reduc* OR limit* OR decreas* OR "cutting AND down" OR "cut AND down" OR "cut AND back" OR less* OR curb* OR abstain))) OR (TITLE-ABS-KEY (sleep OR "sleep AND duration" OR "sleep AND quality" OR insomnia OR "sleep AND hygiene")) OR (TITLE-ABS-KEY (sex OR sexual* OR "safe AND sex" OR "responsible AND sex"))))
Search date	May 2021	
Search within	Article title, Abstract, keywords	
Filters applied	(LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016))	

Results found	46	
		Search query
Database	APA PsycNET	("Internet-Based Intervention" OR "Web-Based Intervention" OR "online intervention" OR "digital intervention" OR "mobile intervention") AND (teenagers OR adolescents OR "young people" OR teen OR youth) AND (("Health behaviour" OR "health behaviour" OR "behaviour change" OR "behaviour change" OR "health change" OR "health promotion" OR "lifestyle") OR ((Exercise AND (increase OR start OR maintain*)) OR "physical activity") OR (weight OR bmi OR "five a day" OR diet OR nutrition OR "healthy eating" OR "fruits and vegetables" OR sugar OR salt) OR ((Smoking OR tobacco) AND (cessation OR stop* OR quit* OR reduc*)) OR (Alcohol AND (reduc* OR limit* OR decreas* OR "cutting down" OR "cut down" OR "cut back" OR less* OR curb* OR abstain)) OR (sleep OR "sleep duration" OR "sleep quality" OR insomnia OR "sleep hygiene") OR (Sex OR sexual* OR "safe sex" OR "responsible sex"))
Search date	May 2021	
Search within	Title AND Abstract AND Keywords	
Filters applied	Year: 2016 To 2021	
Results found	1 in APA Journals	
		Search query
Database	Web of Science - Core Collection	TS= (("Internet-Based Intervention" OR "Web-Based Intervention" OR "online intervention" OR "digital intervention" OR "mobile intervention") AND (teenagers OR adolescents OR "young people" OR teen OR youth) AND (("Health behaviour" OR "health behaviour" OR "behaviour change" OR "behaviour change" OR "health change" OR "health promotion" OR "lifestyle") OR ((Exercise AND (increase OR start OR maintain*)) OR "physical activity") OR (weight OR bmi OR "five a day" OR diet OR nutrition OR "healthy eating" OR "fruits and vegetables" OR sugar OR salt) OR ((Smoking OR tobacco) AND (cessation OR stop* OR quit* OR reduc*)) OR (Alcohol AND (reduc* OR limit* OR decreas* OR "cutting down" OR "cut down" OR "cut back" OR less* OR curb* OR abstain)) OR (sleep OR "sleep duration" OR "sleep quality" OR insomnia OR "sleep hygiene") OR (Sex OR sexual* OR "safe sex" OR "responsible sex"))
Search date	June 2021	
Search within	Topic (Searches title, abstract, author keywords, and Keywords Plus)	
Filters applied	Publication Years: 2016 or 2017 or 2018 or 2019 or 2020 or 2021	
Results found	138	
		Search query
Database	SAGE Journal	("Internet-Based Intervention" OR "Web-Based Intervention" OR "online intervention" OR "digital intervention" OR "mobile intervention") AND (teenagers OR adolescents OR "young people" OR teen OR youth) AND (("Health behaviour" OR "health behaviour" OR "behaviour change" OR "behaviour change" OR "health change" OR "health promotion" OR "lifestyle") OR ((Exercise AND (increase OR start OR maintain*)) OR "physical activity") OR (weight OR bmi OR "five a day" OR diet OR nutrition OR "healthy eating" OR "fruits and vegetables" OR sugar OR salt) OR ((Smoking OR tobacco) AND (cessation OR stop* OR quit* OR reduc*)) OR (Alcohol AND (reduc* OR limit* OR decreas* OR "cutting down" OR "cut down" OR "cut back" OR less* OR curb* OR abstain)) OR (sleep OR "sleep duration" OR "sleep quality" OR insomnia OR "sleep hygiene") OR (Sex OR sexual* OR "safe sex" OR "responsible sex"))
Search date	May 2021	
Search within	Abstract (Search in Title and keywords did not return any results)	
Filters applied	Since 2016	
Results found	4	

Table S4: Detailed data extracted from included studies.

Recruitment and Participants

	AUTHOR, YEAR, COUNTRY	PARTICIPANTS	RECRUITMENT	INCENTIVES
Physical Activity	Wilson, M., et al. (2017) USA, North- western United States	N = 20 students (convenience sample) - enrolled in 10 - 12 grade - able to access a computer with Internet - able to read/ understand English - willing to attend an after-school activity $\geq$ once 1/ week - initial BMI at/ or above the 85th percentile Mean age of 16,8 years, 60% female and 85% white.	Recruited from one public high school on a first-come, first-served basis.	Modest rewards included movie tickets, 5 \$ gift cards for shopping or healthy food activities, gym passes, 50 \$ gift card at final of follow up.
	Larsen, B., et al. (2018) USA (San Diego, CA)	N = 21 Latina adolescents - aged 12-18 years - could read and write in English - underactive (<90 min/week) Mean age of 14,7 years, 100% female and 100% Hispanic.	Recruited from advertisements and presentations in health-focused community events, schools, church youth meetings and other public areas and referral from other participants.	?
	Huang, S. J., et al. (2019) Taiwan, Taipei City	N _{initial} = 617 students (only 524 completed the full experience: 88 in the intervention self-management group, 146 in the knowledge-only group, and 290 in the control group.) Mean age of 11,4 years, 51% of boys and 49% were girls.	Recruited from six elementary schools in 3 districts.	?
	Pirzadeh, A., et al. (2020) Iran, Isfahan	N = 278 high school students (94 in the tailored web-intervention group, 97 in the untailored web-intervention group and 87 in the control group) (?) Mean age and sex distribution.	Recruitment through educational institution.	?
Eating Habits and Physical Activity	Duan, Y. P., et al. (2017) China, Central Region	N _{initial} = 493 undergraduate students (270 in the intervention group and 223 in the control group) N _{post intervention} = 337 N _{1-month follow-up} = 142 aged 15-24 years Mean age in intervention group was 19,0 years and 19,4 years in control group. 40% male in the intervention group and 52,5% in the control group.	Recruited from one university in the central region of China.	?

	AUTHOR, YEAR, COUNTRY	PARTICIPANTS	RECRUITMENT	INCENTIVES
Tobacco Use	Khalil, G. E., et al. (2017) USA, Texas, Houston	N = 101 adolescents - aged 12 - 18 years - student in a middle school or high school - non-smoker Mean age of 13,4 years and 44% were female, and most participants were black/African American (42%) and Hispanic/Latino (44%).	Recruited from after-school programs.	Gift card and giveaway items to complete each survey.
Sexual Behaviours	Castillo-Arcos Ldel, C., et al. (2016) Mexico, Urban Mexico	N = 193 participants (96 in the control group and 97 in the intervention group). - aged 14–17 - not married or in common-law cohabiting relationship Mean age of 15,8 years in experimental group and 15,7 in control group. In experimental group 62% were female and 65% in the control group.	Recruited from institution-wide announcements and information sessions in an educational institution.	Portable data storage device and a gift certificate.
	Doubova, S. V., et al. (2017) Mexico, Mexico City	N = 833 adolescents (246 in the intervention group and 210 in the control group) aged 14 - 15 years of age (?) Mean age. 53% in intervention group and 58% in the control group were girls.	Recruited from two public secondary schools from the most socioeconomically disadvantaged neighbourhoods in Mexico City.	?
	Brown, K. E., et al. (2018) United Kingdom (UK), Midlands	N _{initial} = 88 integrated sexual health service attendees N _{follow-up} = 67 - aged 14 - 24 years - currently sexually active, or planning to be soon - currently accessing or planning to access either one or both contraceptive pill and condoms Mean age of 20,3 years at baseline and 19,6 at follow-up. Most of participants were white (59% at baseline and 46% at follow-up). (?) sex distribution.	Recruited from a sexual health service by clinical staff.	?
	Widman, L., et al. (2018) USA, South-eastern	N = 222 tenth-grade girls (107 in the intervention group and 115 in the control group) Mean age of 15.2 years. Participants were 38% White, 29% Hispanic and 25% Black.	Recruited from 4 rural, low-income high schools.	10\$ for returning parent consent regardless of whether consent was granted, 10\$ pretest, 30\$ for intervention and posttest and 10\$ follow-up.

	AUTHOR, YEAR, COUNTRY	PARTICIPANTS	RECRUITMENT	INCENTIVES
Alcohol Use	Arnaud, N., et al. (2016) European countries (Sweden, Germany, Belgium, and Czech Republic)	N _{initial} = 1449 adolescents (Convenience sample) N _{follow-up} = 211 - aged 16-18 years - online access - positive screening for at-risk substance use Mean age of 16,8 years and 48% were women.	Recruited using online (open access WISEteens landing page, advertisement via social media, links on health promotion sites) and offline methods (print promotion materials distributed in public areas schools, cafes, bar, stores young events).	Held a prize draw for tablet computers.
	Norman, P., et al. (2018) UK, large city	N _{initial} = 2,951 students before starting university N _{post-intervention} = 2,681 Mean age of 18,8 years. Most of the sample (54%) were women and (75%) White.	Recruited through e-mail using institutional contacts from educational institutions.	Prize draw at each time point.
	Coughlin, L. N., et al. (2021) USA, Michigan	N = 39 participants - aged 16-24 years - screened positive for past-month binge drinking or recreational cannabis use Mean age of 20,7 years and 62% female and most of sample 64% were not described as racial minorities.	Recruited from social media advertisements.	Monetary incentives through electronic gift card.
	Doumas, D. M., et al. (2021) USA, Northwest region	N = 311 high school seniors Mean age of 17,1 years old, 56% were females and 85% white.	Recruited from two urban high schools.	Incentives included 100\$ deposited to teachers school account for supplies, bagel and pizza party after follow-up if achieved 60% or greater parental consent return rate.

Web-based intervention and behaviour change theories

	AUTHOR, YEAR, COUNTRY	AIM(S)	INTERVENTION NAME	INTERVENTION DESCRIPTION	DURATION	BEHAVIOUR CHANGE THEORIES
Physical Activity	Wilson, M., et al. (2017) USA, North-western United States	To examine feasibility and receptivity of overweight adolescents joining a community-based group fitness program and to test preliminary efficacy of the intervention.	Wellness Incentive to Health (WITH)	Multicomponent Intervention: wearable digital tracking device using an Internet-based platform + group physical activities + nutrition group education/ individual counselling session on healthy eating + weekly goal-setting sessions.	12-week. Most scheduled program activities and goal-setting sessions lasted 1 to 2 hours after school and on weekends.	Theoretical concepts of self-efficacy (Bandura, 1997) as a subset of Social Cognitive Theory
	Larsen, B., et al. (2018) USA (San Diego, CA)	To report the feasibility, acceptability, and potential efficacy of a theory-based, web-delivered intervention for Latina adolescents, focused on increasing moderate to vigorous PA.	Niñas Saludables	Website mobile phone friendly (tailored Internet-delivered activity manuals, computer-expert system tailored reports, activity tip sheets, and a guide of local activity resources).	All participants received access to the Niñas Saludables study website for 12 weeks.	Social Cognitive Theory and the Transtheoretical Model and other behavioural strategies (e.g.. goal setting, self-monitoring, and increasing social support).
	Huang, S. J., et al. (2019) Taiwan, Taipei City	To investigate the effectiveness of a theory-based, technology-integrated website in promoting the PA of schoolchildren.	Exercise Journey to the West	Two experimental groups: One using a web-based exercise program applying a self-management strategy combined with geographical information system mapping function and using a narrative animated cartoon. And the other was a knowledge-only using only the animated story.	8-week intervention, during computer education lessons at the participating schools (40 min on each occasion).	Social cognitive theory, as well as Health Belief Model
	Pirzadeh, A., et al. (2020) Iran, Isfahan	To examine the effects of a web-based intervention on the promotion of physical activity among adolescents using the TTM.	Salamat	Two web-based intervention groups. One group received education through a website with tailored education strategies based on TTM. The second group only received general education by the same website but without tailored materials.	?	Transtheoretical model (TTM)

	AUTHOR, YEAR, COUNTRY	AIM(S)	INTERVENTION NAME	INTERVENTION DESCRIPTION	DURATION	BEHAVIOUR CHANGE THEORIES
Eating Habits and Physical Activity	Duan, Y. P., et al. (2017) China, Central Region	To test the efficacy of a Web-based intervention compared with a control group condition to improve PA and FVI in Chinese university students. To examine the effects on behaviours, stages of change movement for PA and FVI, social-cognitive indicators for PA and FVI, and perceived mental health outcomes.	?	Web-based intervention modules target social-cognitive indicators for health behaviour change for Physical Activity and Fruit and Vegetables Intake (information about risks and benefits, motivating intentions to change, identification of barriers, goal setting, development of action plans, coping plans and social support, providing tailored normative feedback).	8 weeks, 1 session per week, which lasted about 20 minutes.	Health Action Process Approach (HAPA) model
Tobacco Use	Khalil, G. E., et al. (2017) USA, Texas, Houston	To evaluate the impact of a Web-based intervention on adolescents' intention to smoke, while considering the experience of interactivity and entertainment as predictors of reduced intention to smoke. To test associations that link participation in a Web-based program to changes in a health outcome.	ASPIRE	Two Web-based intervention groups: One features interactivity and entertainment to engage adolescent users (text, animations, videos, task-oriented activities, two-dimensional environment to explore health information and make a virtual character). The second group included the same health information as previous but without any features of interactivity or entertainment.	4 sessions, 40 minutes each, spread over a period of 1 month	Interactivity and entertainment to change health outcomes as supported by the experiential learning theory (ELT) and the extended elaboration likelihood model (E-ELM)
Sexual Behaviours	Castillo-Arcos Ldel, C., et al. (2016) Mexico, Urban Mexico	To evaluate the effect of an Internet-based intervention to reduce sexual risk behaviours and increase resilience to sexual risk behaviours among Mexican adolescents.	"Connect"	Multicomponent intervention: 6 online sessions + 2 face-to-face Activities aimed at increasing levels of social competence and resilience about sexual behaviours.	8 sessions of 1h (6h online)	Conceptual framework of Adolescent Sexual Resilience
	Dobova, S. V., et al. (2017) Mexico, Mexico City	To evaluate the effect of an internet-based educational intervention to increase knowledge of STIs, attitudes and self-efficacy toward consistent condom use in Mexican adolescents.	?	Multicomponent intervention: Educational sessions through a website displayed by two central characters + class discussions Main topics: dating, courtship, sexual relationship, misconceptions, and myths about gender-roles and sexual relationships, partner abuse, STIs, early pregnancy, self-esteem, safe sex, use of condoms and condom negotiation.	Four weekly 1-h internet-based educational sessions. Internet sessions were followed by a 3-month follow-up period including six 30-min class discussions	The information-motivation-behavioural skills (IMB) model.

	AUTHOR, YEAR, COUNTRY	AIM(S)	INTERVENTION NAME	INTERVENTION DESCRIPTION	DURATION	BEHAVIOUR CHANGE THEORIES
Sexual Behaviours	Brown, K. E., et al. (2018) United Kingdom (UK), Midlands	To response to the following research questions: Do participants find the trial acceptable and is it feasible? Does the web-based intervention support the production of good quality action plans? Is there a relationship between trait self-control and quality of action plans? Are there any changes in self- report contraceptive pill and condom use mishaps at three-month follow-up in each intervention arm.	?	Multicomponent intervention: brief tailored web-based programme + paper-based action planning card. Content about contraceptive pill and/or condoms use using characters with audio to take the user through the process of identifying environmental cues to key target behaviours and planning to perform those behaviours when the environmental cue is present.	Around 10-15 minutes	Theory of Planned Behaviour and Health Action Process Approach
	Widman, L., et al. (2018) USA, South- eastern	To evaluate the efficacy of an interactive, Web-based sexual health program for developing sexual assertiveness skills and enhancing sexual decision- making in adolescent girls.	HEART	Interactive, skills-focused web-based intervention. The intervention includes 5 modules about safer sex motivation, HIV and other STDs, sexual norms and attitudes, safer sex self-efficacy, sexual communication skills that can be completed on a computer, tablet, or smartphone device. Each module used audio and video clips, tips from other adolescents, interactive games and quizzes, infographics, and skill- building exercises with self-feedback given in real time).	Aprox. 45 MIN	Psychological and health behaviour change theories, including the Reasoned Action Model and Fuzzy Trace Theory
Alcohol Use	Arnaud, N., et al. (2016) European countries (Sweden, Germany, Belgium, and Czech Republic)	To evaluate the effectiveness of a targeted and fully automated Web-based brief motivational intervention with no face-to-face components on substance use among adolescents screened for at-risk substance	WISEteens	Interactive web-based system to generate individually tailored content. Generated information in small units using text and graphics and referred to previous participant's statements.	Range 5-30 min [mean 15.5 min (7.1)]	Theory of motivational interviewing (decisional balance, confidence and importance ruler, and provision of behavioural and regulatory strategies to resist peer pressure) and individual feedback techniques

	AUTHOR, YEAR, COUNTRY	AIM(S)	INTERVENTION NAME	INTERVENTION DESCRIPTION	DURATION	BEHAVIOUR CHANGE THEORIES
Alcohol Use	Norman, P., et al. (2018) UK, large city	To test if combining (1) messages that target key beliefs from the TPB that underlie binge drinking, (2) a self-affirmation manipulation to reduce defensive processing, and (3) implementation intentions (if-then plans to avoid binge drinking) reduces alcohol consumption in the first 6 months at university.	?	Brief online intervention combining self-affirmation x TPB-based messages x implementation intentions in a factorial design.	?	Theory of planned behaviour combined with self-affirmation and implementation intentions
	Coughlin, L. N., et al. (2021) USA, Michigan	To describe the iterative development and initial feasibility and acceptability testing of an mHealth smartphone app designed to reduce escalation in substance use.	MISARA	Mobile intervention with tailored messages and tips, inspirational images to reinforce content, web links to articles, or other web-based resources, based on users' responses to daily and weekly surveys. The intervention included gamification through a virtual aquarium environment.	30 days period	Operant conditioning theory (Motivational intervention framework, mindfulness, behavioural activation techniques)
	Doumas, D. M., et al. (2021) USA, Northwest region	To investigate the efficacy of the eCHECKUP TO GO on reducing alcohol use among high school seniors across the academic year.	eCHECKUP TO GO	Online personalized normative feedback intervention via text, graphs, and video recordings. The program intended to reduce risk factors for alcohol use and increase protective behaviours.	30-minute	Social norming theory and motivational enhancement models

Health behaviours change outcomes and secondary outcomes

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Physical Activity	Wilson, M., et al. (2017) USA, North-western United States	Measured at baseline and post-intervention: BMI calculation. Blood glucose level. Blood pressure and pulse measurements. Fitness and cardiovascular fitness. Cognitive and effective variables related to health behaviours. Adolescents' physical activity and healthy eating. Self-efficacy for PA and healthy eating. Self-determination. Screen time.	Weight was significantly reduced, with an average 1.6 kg lost. Nine participants lost weight with a range of 181.4g to 6.0kg. Other fitness improvements were noted on balance, total number of push-ups completed (from 17.9 ± 9.4 to 28.7 ± 15.0, $p \leq .001$), number of sit-ups completed in a minute (from 22.3 ± 11.7 to 27.9 ± 11.8, $p \leq .05$), long jump distance (from 152.9 ± 29.9 to 161.8 ± 27.2, $p \leq .05$), systolic blood pressure (from 122.4 ± 6.8 to 112.4 ± 9.3, $p \leq .05$), and left hamstring strength (from 26.64 ± 6.9 to 29.09 ± 6.60, $p \leq .05$). Cognitive and Affective Variables Related to Health Behaviours mean values were significantly improved, with large effect sizes for the self-determination physical activity scale (from 3.5 ± 0.64 to 4.8 ± 0.67, $p \leq .001$) and screen time hours scale (from 3.3 ± 0.71 to 2.8 ± 0.78, $p \leq .001$).	Computer Usability and Satisfaction Questionnaires at the final posttest. Participation in each one of the 33 activities was also evaluated.	On average, participants attended 11.0 activities (SD = 7.2). Eighteen participant evaluations (90%) were received at the program's end. The mean value of the seven combined evaluation items was 2.3 (SD = 0.7), with 1 being the most favourable possible score. Participants' records on the activity tracking Web site showed that they wore their digital device on average 31 days (SD = 21.8), amounting to 37% of a possible 84 total program days. Average days of use decreased over time. Calories consumed were recorded by only five participants.
	Larsen, B., et al. (2018) USA (San Diego, CA)	Measured at baseline and follow-up (12 weeks): PA by 7-day physical activity recall (PAR) interview and ActiGraph GT3X+ accelerometers.	MVPA measured by the 7-day PAR, increased weekly with a mean increase of 58.8 (SD 46.3) min/person ($P < .001$; range: 4-155) from a mean 24.7 (SD 26.1) at baseline (range: 0-85) to 79.4 (SD 46.8) at follow-up (range: 14-177). Likelihood-based estimates showed significant increases baseline to 12 weeks ($P < .001$). All participants who completed follow-up visits reported doing some PA, ranging from 14 to 177 min/week. Activity types reported were more varied than at baseline and included running, walking, soccer, Zumba, swimming, and cycling. MVPA measured by accelerometer decreased from 24.8 min/week at baseline to 10.4 (SD 30.2) at 12 weeks. Some girls who reported high activity at follow-up participated in activities in which the accelerometer could not be worn (eg, swimming or contact sports) or that were not well measured by the accelerometer (eg, cycling).	Acceptability was measured by satisfaction surveys. Feasibility was determined by considering recruitment, retention, and adherence to the intervention. The intervention was considered acceptable if at least 75% of participants indicated they were satisfied/very satisfied with the program and was considered feasible if at least 80% of participants were retained, defined as attending the 12-week assessment.	Acceptability - Overall satisfaction was moderate, with 72% of participants saying they were satisfied/very satisfied with the program. Feasibility - 90% returned for the 12-week assessment. Adherence was moderate. Approximately two-thirds (63%) of monthly questionnaires were completed. Only 42% reported reading most/all of the individually tailored reports, and 42% reported reading at least half of the additional emailed tip sheets.

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Physical Activity	Huang, S. J., et al. (2019) Taiwan, Taipei City	Measured at baseline, immediately post and 3-month follow-up: PA by Chinese version of the Child/Adolescent Activity Log. Exercise-related self-efficacy using a 5-item Exercise-Related-Self-Efficacy Scale. Perceived benefit of PA using a self-developed 7-item Perceived-Benefit-of-Exercise Scale.	Effect on PA - students in both experimental groups were significantly more active than those in the control group, in addition, the self-management group scored higher than the knowledge-only group. The total amount of physical activity at posttest reached a significant level. The self-management group was significantly more active than the knowledge-only and control groups. Psychological determinants - a significantly higher level of perceived benefit ($F(2,502) = 3.84, p = .02$) and PA self-efficacy ($F(2,479) = 36.91, p = .00$) was discovered for the self-management group than for the knowledge-only and control groups, with the effect sizes being 0.015 and 0.135, respectively. However, no significant effect of perceived benefit was present 3 months later. Further analysis revealed significant differences between all groups. Male students in the self-management group achieved a significantly higher amount of PA than those in the control group. However, no difference was discovered among the groups' female students. This demonstrated that the website intervention increased the amount of PA only in male students, with this increase sustained at 3 months later, but was not effective for the female students.	An evaluation of the website was conducted immediately after the 8-week intervention.	86% in the self - management AND (82%) knowledge-only groups replied were satisfied with the website. No significant differences were identified between the two groups ($F = 2.80, p = .095$). More than 85% were attracted to the website, thought the layout was clear, surfing was easy and descriptions were understandable. There were significant differences between the self-management and knowledge-only groups regarding the following issues: "The content of this website helped me learn more about exercise" ($F = 18.22, p = .000$); and "I now better understand my own habits regarding physical activity" ($F = 30.22, p = .000$). On both points, the self-management group reported higher agreement than the knowledge-only group.
	Pirzadeh, A., et al. (2020) Iran, Isfahan	Measured before intervention and 6-months after: Stage of exercise behaviour change questionnaire. Processes of change questionnaire. Decision-making balance questionnaire. Exercise self-efficacy scale. International PA questionnaire short form.	After intervention, most participants were in groups of action or maintenance for self-reported stage of change. Mean differences for decisional balance, and self-efficacy in intervention were higher in people who moved in a progressive pattern from precontemplation, contemplation, or preparation at baseline to action or maintenance after intervention than for people who remained in precontemplation, contemplation or preparation before and after the intervention. These differences were significant for decisional balance in both intervention groups. The mean differences related to processes of change, self-efficacy, and decisional balance in intervention groups 1 and 2 were significantly higher than those in controls. Comparisons of means for decisional balance changes and self-efficacy changes revealed significant differences in mean between both intervention groups and the control group, but not between each intervention group.	Nonapplicable	Nonapplicable

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Eating Habits and Physical Activity	Duan, Y. P., et al. (2017) China, Central Region	PA by Chinese short version of the International Physical Activity Questionnaire (IPAQ-C). FVI in the past 7 days. Stages of behavioural change for PA and FVI. Social-cognitive indicators of behaviour change: positive and negative outcome expectancies for PA and FVI; self-efficacy for PA and FVI; action planning; coping planning; social support; intentions for PA and FVI; habit scale.	Out of 8 effects, 7 were statistically significant, with an effect size of η^2 2 ranging from .08 to .20. Only PA behaviour was not statistically significant. However, the mean values of PA at different intensities (see Figure 3) indicated that there were descriptive differences between the 2 groups, which were clearly in favor of the intervention group. This was matched by the effects on FVI, however, with significant effects (η^2 2 =.13, $P < .001$).	Nonapplicable	Nonapplicable
Tobacco Use	Khalil, G. E., et al. (2017) USA, Texas, Houston	Measured at baseline and follow-up: Intention to smoke using items adapted from the susceptibility to smoke scale.	The intervention group had a significant decrease in intention to smoke (slope=-0.28, $P = .008$), while the control group had no significant change from baseline to follow-up (slope<0.001, $P = .99$). Participants in intervention group were significantly more likely to show a decrease in their intention to smoke over time compared with the control group (group $\times$ time interaction effect; beta=-0.18, $P = .008$).	At follow-up, was measured perceived interactivity, perceived entertainment, and perceived credibility of message.	No significant difference between the conditions regarding to perceived credibility of message content, $F_{1,56} = 3.67$, $P = .06$. Perceived credibility scores for both groups were found to be significantly greater than 3 on a 5-point Likert scale (ASPIRE: $t_{40} = 4.38$, $P < .001$; control: $t_{42} = 8.48$, $P < .001$), proving that both interventions were perceived to be credible sources of information related to smoking. A mixed-effects models showed that perceived interactivity and perceived entertainment independently worked as significant predictors of a decrease in intention to smoke (model 1: beta interactivity=-0.27, $P = .004$ and model 2: beta entertainment=-0.20, $P = .04$).

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Sexual Behaviours	Castillo-Arcos Ldel, C., et al. (2016) Mexico, Urban Mexico	Measured pre- and post-intervention: Self-reported risky sexual behaviours (defined as self-reporting unprotected sex, multiple concurrent sexual partners, and alcohol or drug use during sex). Resilience to risky sexual behaviour (defined as the ability to identify and practice strategies to avoid risky sexual behaviour).	Pre-to-post changes in the experimental group showed a increase in Jalowiec coping ¹ a decrease in self-esteem. The control group also showed changes in pre-to-post test scores which was even greater than the pre-post test score changes observed in the experimental group for sexual uncertainty. Age was associated with pre-to-post test changes in sexual resilience ($\beta = -6.10$, $p = .019$), which partially mediated the beneficial effect of the intervention on sexual resilience ($\beta = 5.70$, $p = .034$). Age was similarly associated with pre-to-post test changes in risky sexual behaviour ($\beta = 1.33$, $p = .045$). Only decreased social support was significantly associated with increased risky sexual behaviour ($\beta = -0.17$, $p = .039$) while HIV/AIDS susceptibility, self-efficacy, and age were marginally associated ($p < .1$). Again, intervention group was not associated with changes in risky sexual behaviour. Pre-to-post changes in the experimental group showed a increase in Jalowiec coping and a decrease in self-esteem.	Nonapplicable	Nonapplicable
	Doubova, S. V., et al. (2017) Mexico, Mexico City	Measured at baseline, at the end of the four educational sessions (1st month), and at the end of the follow-up period (fourth month): Knowledge of STIs. Multidimensional Condom Attitudes Scale measuring attitudes regarding condom use. Self-efficacy toward consistent condom use.	Analysis of Diff-in-Diff treatment effect between T- and C-groups for knowledge of STIs revealed 9.12 ($P < 0.0001$) and 30.34 points ($P < 0.0001$) improvement during the first and fourth months, respectively. Regarding attitudes concerning condom use, Diff-in-Diff treatment effect between T- and C-groups was statistically significant for improvements in positive attitudes regarding condom use at 4-month for reliability and effectiveness of condoms (0.65 points, $P < 0.0001$), pleasure associated with condom use (0.66 points, $P < 0.0001$), stigma attached to condom use (0.47 points, $P < 0.0001$), embarrassment related to negotiation and use of a condom (0.75 points, $P < 0.0001$), and embarrassment related to condom purchase (0.59 points, $P < 0.0001$). The fourth month evaluation showed a statistically significant improvement in self-efficacy use for all except one domain. There was no statistically significant Diff-in-Diff treatment effect between T- and C-groups at the fourth month about the certainty to postpone sex when not having a condom. Improvement in other domains varied from 0.64 ($P < 0.0001$) for certainty about condom use whenever having vaginal sex to 1.70 ($P < 0.0001$) for certainty to always using a condom for vaginal sex when the partner had been drinking or using drugs.	Nonapplicable	Nonapplicable

¹ The Jalowiec Coping Scale is a questionnaire, measuring the use and efficacy of coping strategies.

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Sexual Behaviours	Brown, K. E., et al. (2018) United Kingdom (UK), Midlands	Measured at baseline and 3-month follow-up: Self-reported contraceptive pill or condom “mishaps” in the past 3 months. Contraceptive pill or condom use intention. Attitude toward contraceptive pill or condom use. Perceived behavioural control over pill or condom use. Subjective norm relating to pill or condom use. Trait self-control.	Consultation of the mean scores by time and condition suggests that the number of self-reported mishaps with participants’ main method of contraception is reduced by time 2 in the intervention condition compared to controls. Mean scores for other variables from the Theory of Planned Behaviour do not appear to differ by time or condition.	Acceptability was measured by the % of participants who were willing to consent relative to the total eligible. Also, the number of participants willing to provide contact details and numbers who responded to provide follow-up measures vs. those lost to follow-up. Drop-out analyses assessed whether participants lost to follow-up differed on key socio-demographic measures from those who remained. Feasibility was assessed based on the acceptability measures above and assessment of the recruitment rate relative to the potential for recruitment based on total number of clinic attendees during data collection periods.	Participation in the study appears to have been acceptable to clinic attendees. Of the 102 who reached the research room, 86.3 per cent agreed to take part and provide contact details for follow-up. Of those who completed baseline measures, provided contact details for follow-up, and were randomised to receive either the intervention or usual care, 76.1 per cent provided follow-up measures, representing relatively low attrition. Chi-square analyses showed that dropping out vs. providing follow-up data was not significantly associated with sexual orientation (straight vs. not straight) of participants ($\chi^2 = 1.158$; $df = 1$; $p = .282$); nor with ethnicity (white British vs. not white British) of participants ($\chi^2 = 2.46$; $df = 1$; $p = .62$); nor with frequency of sexual activity (at least weekly vs. less than weekly sex) of participants ($\chi^2 = .384$; $df = 1$; $p = .54$).
	Widman, L., et al. (2018) USA, South-eastern	Measured at pre-test, post-test and 4-month follow-up: Behavioural assessment of sexual assertiveness skills (at refusing unwanted sexual activity and negotiating condom use). Self-reported sexual assertiveness by Multidimensional Sexual Self Concept Scale. Knowledge regarding HIV and other STDs. Intentions to use condoms and to communicate about sex with items from the AIDS Risk Behaviour Assessment. Sexual Self-Efficacy from self-efficacy for HIV prevention scale.	Intervention subjects showed better sexual assertiveness skills (Cohen’s $d = 0.28$). At posttest, treatment participants also reported higher self-reported sexual assertiveness, sexual communication intentions, knowledge regarding HIV and other STDs, condom norms, condom attitudes, and condom self-efficacy compared with control participants (all Ps < .05). The effect sizes of these outcomes were small to moderate (Cohen’s ds = 0.33–0.78); however, the effect on sexual knowledge was particularly strong (Cohen’s $d = 4.78$). At 4-month follow up, intervention group had statistically significantly greater knowledge regarding HIV and STDs, more positive condom attitudes, and greater condom self-efficacy compared with control group (Cohen’s ds = 0.56, 0.45, and 0.30, respectively). The group differences that we initially observed in communication intentions, self-reported assertiveness, and condom norms had diminished by 4 months. The study was not powered to detect statistically significant changes in condom use. Results of the logistic regression were in the direction of better condom use for those in the intervention compared, though this effect was not significant (odds ratio = 1.85 [95% confidence interval = 0.45, 7.56]; $dCox = 0.37$).	Nonapplicable	Nonapplicable

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Alcohol Use	Arnaud, N., et al. (2016)	Measured at baseline and 3-month follow-up: Self-reported drinking index (drinking frequency, frequency of binge drinking, and typical quantity of drinks) using AUDIT-C screening tool.	Past month drinking index - 3 months after the intervention, participants in the intervention group have reduced their drinking as indicated by reduced AUDIT-C based scores relative to baseline with an adjusted mean change of -0.85 (95% CI -1.49 to -0.26) while those in the control group slightly increased their drinking as indicated by a mean increase in drinking of 0.16 (95% CI -0.50 to 0.82). Adjusted mean differences between both groups were 1.02 (95% CI 0.25-1.79) and statistically significant (F1,134=6.8, P=.010, d=.26).	Overall satisfaction	The WISEteens intervention was pilot-tested in two steps, and considering this pilot test, most adolescents were satisfied or totally satisfied with the system, design, comprehensibility, and intervention dialogue. The intervention completion rate indicates acceptable user engagement in the “real world” and a good balance between the required amount of program exposure and adherence requirements of a single session. However, the dropout rate was high and the authors consider it might be partly caused by invalid email addresses used by the participants and the fact that the system sent only one email reminder per participant.
	European countries (Sweden, Germany, Belgium, and Czech Republic)		Drinking frequency - A significant between-group difference in drinking frequency of 0.25 (95% CI 0.02-0.50) in favour of the WISEteens group (F1,134=4.4, P=.037, d=.15), which was not maintained in the analysis based on EM-imputation (F1,1329=3.2, P=.073, d=.11) due to significant reductions relative to baseline in both groups (Ps<.001). Binge drinking frequency - A significant adjusted mean difference between groups of 0.31 (95% CI 0.01-0.61; F1,121=4.2, P=.044, d=.16) in the non-imputed data analysis, which was not maintained in the imputed analysis (F1,1329=2.3, P=.130, d=.01). Drinking quantity - Significant reductions relative to baseline for the intervention group in the non-imputed analysis of -0.39 (95% CI -0.72 to -0.06, P=.024), but these reductions were non-significantly different from the control group (between-group differences: 0.31, 95% CI -0.17 to 0.62; F1,155=1.3, P=.257, d=.13).	Drop-outs	

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Alcohol Use	Norman, P., et al. (2018) UK, large city	Measured at baseline, 1 week, 1 month and 6-month follow-up: Self-reported alcohol intake (total number of units consumed and number of binge drinking sessions/week). Hazardous and harmful patterns of alcohol use from 10- item AUDIT (only at 6-month follow-up). Cognitions about binge drinking (intention, affective attitude, cognitive attitude, subjective norms, descriptive norms, and perceived control) and extent of endorsement for the beliefs (Engaging in binge drinking at university would be fun, Engaging in binge drinking at university would have a negative impact on my studies, My friends engaging in binge drinking would make my binge drinking at university more likely).	Alcohol consumption - Time had a significant effect on the number of units of alcohol consumed and frequency of binge drinking, both declined from the first week till 1 month and then remained stable till 6 months. Message about binge drinking condition had a significant main effect on the number of units of alcohol consumed, $F(1, 616) = 6.32$, $p = .01$, $d = 0.20$, and on the frequency of binge drinking, $F(1, 616) = 4.25$, $p = .04$, $d = 0.17$, which was lower among participants who viewed the messages. Message condition had a significant main effect on AUDIT scores at 6-month follow-up, $F(1, 875) = 4.43$, $p = .04$, $d = 0.14$, which were lower among those who viewed the messages (MMESS = 7.77, SD = 6.21) than those who did not (MNoMESS = 8.71, SD = 6.50). Fewer participants exceeded the cut-off score for possible harmful patterns of alcohol use in the message condition (48.1%) than in the no message condition (55.5%) at 6-month follow-up, $\chi^2(1, N = 882) = 4.92$, $p = .03$. Cognitions about binge drinking - Time had a significant effect on all cognitions and all increased over time, indicating more favourable cognitions about binge drinking. Differences between all the time points were significant, except for the difference between immediate and 1-month follow-up scores for intention and between the 1- and 6-month follow-up scores for subjective norms and perceived control. The belief that binge drinking at university would be fun also increased over time, $F(2, 1318) = 16.83$, $p < .001$, whereas the belief that binge drinking would have a negative impact on their studies decreased over time, $F(2, 1312) = 9.75$, $p < .001$. Differences between the immediate and 1-month follow-up scores for both beliefs were non-significant, but all other differences were significant. Message condition had a significant main effect on all of the cognitions about binge drinking, with the exception of perceived control. Participants who viewed the messages reported weaker intentions to binge drink at university, $F(1, 665) = 12.43$, $p < .001$, $d = 0.27$, less positive affective attitudes, $F(1, 663) = 9.84$, $p = .002$, $d = 0.24$, less positive cognitive attitudes, $F(1, 664) = 12.69$, $p < .001$, $d = 0.28$, lower subjective norms, $F(1, 664) = 8.22$, $p = .004$, $d = 0.22$, lower descriptive norms, $F(1, 665) = 53.29$, $p < .001$, $d = 0.56$, and lower self-efficacy, $F(1, 664) = 5.38$, $p = .02$, $d = 0.18$, than participants who did not view the messages. Participants who viewed the messages were also less likely to believe that binge drinking at university would be fun, $F(1, 659) = 8.17$, $p = .04$, $d = 0.22$, and more likely to believe that it would have a negative impact on their studies, $F(1, 656) = 26.19$, $p < .001$, $d = 0.40$, than participants who did not view the messages. The significant effects of message condition on intention, $F(2, 1330) = 3.09$, $p = .046$, affective attitude, $F(2, 1326) = 5.45$, $p = .004$, cognitive attitude, $F(2, 1328) = 7.41$, $p = .001$, subjective norms, $F(2, 1328) = 3.39$, $p = .03$, descriptive norms, $F(2, 1330) = 11.72$, $p < .001$, and the belief that binge drinking would impact on studies, $F(2, 1312) = 13.61$, $p < .001$, were qualified by significant interactions with time. Effects of the messages weakened over time, although the effects on intention, affective attitude, and descriptive norms remained significant at 6-month follow-up.	Nonapplicable	Nonapplicable

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS	MEASURES	RESULTS
Alcohol Use	Coughlin, L. N., et al. (2021) USA, Michigan	Measured at baseline and 1 month follow up: Concerning to alcohol use (quantity and frequency of use, consequences of use, intention, importance confidence of change, perceived risk, reasons for use, and past month driving under influence of use).	Ratings of intention (change between follow-up and baseline ($\Delta_{(fu-bl)}=0.4$) and importance ($\Delta_{(fu-bl)}=0.3$) to reduce alcohol use increased slightly from baseline to 1-month follow-up, but confidence in the ability to reduce use did not increase ($\Delta_{(fu-bl)}=-0.1$). Regarding behaviours, all variables decreased from baseline to 1-month follow-up, including weekly alcohol ($\Delta_{(fu-bl)}=-0.8$) use ($\Delta_{(fu-bl)}=-0.2$), monthly binge-drinking days ($\Delta_{(fu-bl)}=-0.4$), number of past-month substance use consequences ($\Delta_{(fu-bl)}=-0.8$), frequency of past-month drinking and driving ($\Delta_{(fu-bl)}=-0.8$). Finally, more self-reported app engagement was associated with decreases from baseline to follow-up in past-month behaviours, including total number of drinks ($r=0.4$), total binge-drinking days ($r=-0.5$), substance use consequences ($r=-0.1$) and episodes of drinking and driving ($r=-0.2$).	Acceptability questions at follow-up. Participants were also asked about self-reported points earned in the app, which is a proxy measure for app engagement feasibility.	Acceptability - Most participants (79%) at least somewhat liked MiSARA, with almost all reporting that the design was appealing (92%). Most most participants also felt it was not interactive enough (69%). Ratings for fun to use, interesting, and the aquarium was fun were modest. 75% of participants indicating the aquarium itself did not influence the time spent using the app. The content was viewed as age-appropriate (92%) and data collection via the app was acceptable (92% participants agreeing that they were comfortable with self-reporting, and 72% were comfortable with the app collecting passive data). Although the app was easy to use (87%) with clear instructions (90%), 23% participants sometimes or regularly had technical problems. Finally, most participants (74%) rated the app 3 or more stars. Engagement Feasibility - Participants reported an average earning of 986.2 points (SD 688.0; range 0-2110; first quartile 324, third quartile 1591, median 1163; n=34; 5 missing). Alcohol use was the only baseline characteristic meaningfully associated with app engagement (estimate -10.5, SE 4.4; 95% CI -19.2 to -1.8), such that more alcohol use was associated with less app engagement.

AUTHOR, YEAR, COUNTRY		HEALTH BEHAVIOUR CHANGE OUTCOMES		SECONDARY OUTCOMES	
		MEASURES	RESULTS		MEASURES
Alcohol Use		Measured at baseline, 30-days and 6-month follow-up: Weekly drinking quantity. Estimated peak blood alcohol concentration (eBAC). Self-reported peak alcohol volume. Classification of High-Risk vs. Low Risk drinkers by participants' report on frequency of binge drinking in the past month.	Weekly drinking quantity - The Time x Condition interaction effect ($p = .28$) and the Time x Condition x Risk Status interaction effect ($p = .13$) were not significant. Specific comparisons, however, revealed a significant Time x Condition x Risk Status interaction from baseline to the 30-day follow-up ($p = .05$) but not from baseline to the 6-month follow-up ($p = .13$). Only for high-risk drinkers, the Time x Condition interaction was significant from baseline to the 30-day follow-up ($p = .03$), demonstrating significantly greater reductions in weekly drinking in the intervention relative to the control, the same wasn't found from baseline to the 6-month follow-up ($p = .14$). Further comparisons examining pairs of means revealed that high-risk drinkers in the intervention condition reported significant reductions in weekly drinking from baseline to the 30-day follow-up ($\text{padj} < .001$) and from baseline to the 6-month follow-up ($\text{padj} < .001$), suggesting initial changes were sustained for students in the intervention condition. However, students in control group also demonstrated a decrease in weekly drinking from baseline to the 6-month follow-up ($\text{padj} = .05$), leading to non-significant interactions. For low-risk drinkers, the Time x Condition interaction was not significant from baseline to either the 30-day follow-up ($p = .70$) or the 6-month follow-up ($p = .59$), demonstrating no differences between low-risk drinkers in the intervention and control conditions over time. eBAC - For the overall model, the Time x Condition interaction effect ($p = .02$) and the Time x Condition x Risk Status interaction effect ($p = .01$) were significant. Specific comparisons revealed a statistically significant interaction effect for Time x Condition x Risk Status interaction from baseline to the 30-day follow-up ($p = .007$) and from baseline to the 6-month follow-up ($p = .02$). For high-risk drinkers, the Time x Condition interaction was significant from baseline to the 30-day follow-up ($p = .001$) and from baseline to the 6-month follow-up ($p = .009$), demonstrating greater reductions in eBAC in the intervention condition relative to the control condition at both time points. Further comparisons examining pairs of means revealed that among high-risk drinkers, participants in the intervention condition had significant reductions in eBAC at the 30-day follow-up ($\text{padj} < .001$) and at the 6-month follow-up ($\text{padj} = .002$), indicating a sustained decrease in eBAC. There were no significant reductions in eBAC for the control condition from baseline to either the 30-day or 6-month follow-ups. For low-risk drinkers, the Time x Condition interaction was not significant from baseline to either the 30-day follow-up ($p = .97$) or the 6-month follow-up ($p = .83$), demonstrating no differences between low-risk drinkers in the intervention and control conditions over time.	Nonapplicable	Nonapplicable
	Doumas, D. M., et al. (2021) USA, Northwest region				

Table S5: Detailed Risk of Bias Assessment – EPHPP Assessment Tool for Quantitative Studies

AUTHOR, YEAR		Wilson, M., et al. (2017)	Larsen, B., et al. (2018)	Huang, S. J., et al. (2019)	Pirzadeh, A., et al. (2020)	Duan, Y. P., et al. (2017)	Khalil, G. E., et al. (2017)	Dobova, S. V., et al. (2017)
A) SELECTION BIAS	Q1. Are the individuals selected to participate in the study likely to be representative of the target population?	3-Not likely	3-Not likely	2-Somewhat likely	4-Can't tell	2-Somewhat likely	3-Not likely	2-Somewhat likely
	Q2. What percentage of selected individuals agreed to participate?	5- Can't tell	1- 80 to 100% agreement	1- 80 to 100% agreement	2- 60 to 79% agreement	1- 80 to 100% agreement	5- Can't tell	3- less than 60% agreement
	Section Rate	3 - WEAK	3 - WEAK	2 - MODERATE	3 - WEAK	2 - MODERATE	3 - WEAK	3 - WEAK
B) STUDY DESIGN	Indicate the study type	5 - Cohort (one group pre + post (before and after))	5 - Cohort (one group pre + post (before and after))	2 - Controlled clinical trial	2 - Controlled clinical trial	2 - Controlled clinical trial	2 - Controlled clinical trial	1 - Randomized controlled trial
	Was the study described as randomized? If NO, go to Component C.	No	No	Yes	Yes	Yes	Yes	Yes
	If Yes, was the method of randomization described? (See dictionary)			No	No	No	No	Yes
	If Yes, was the method appropriate? (See dictionary)			No	No	No	No	Yes
	Section Rate	2 - MODERATE	2 - MODERATE	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG
C) CONFOUNDERS	Q1. Were there important differences between groups prior to the intervention?	2 - No	2 - No	2 - No	3 - Can't tell	1 - Yes	2 - No	1 - Yes
	Q2. If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?					4- Can't Tell		1- 80 to 100% (most)
	Section Rate	1 - STRONG	1 - STRONG	1 - STRONG	3 - WEAK	3 - WEAK	1 - STRONG	1 - STRONG
D) BLINDING	Q1. Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?	1 - Yes	1 - Yes	3 - Can't tell	3 - Can't tell	3 - Can't tell	1 - Yes	1 - Yes
	Q2. Were the study participants aware of the research question?	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	2 - No
	Section Rate	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	2 - MODERATE
E) DATA COLLECTION METHODS	Q1. Were data collection tools shown to be valid?	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	3 - Can't tell	1 - Yes
	Q2. Were data collection tools shown to be reliable?	1 - Yes	1 - Yes	2 - No	1 - Yes	1 - Yes	1 - Yes	1 - Yes
	Section Rate	1 - STRONG	1 - STRONG	2 - MODERATE	1 - STRONG	1 - STRONG	3 - WEAK	1 - STRONG

AUTHOR, YEAR		Wilson, M., et al. (2017)	Larsen, B., et al. (2018)	Huang, S. J., et al. (2019)	Pirzadeh, A., et al. (2020)	Duan, Y. P., et al. (2017)	Khalil, G. E., et al. (2017)	Doubova, S. V., et al. (2017)
F) WITHDRAWALS AND DROP-OUTS	Q1. Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?	2 - No	1 - Yes	2 - No	1 - Yes	3 - Can't tell	4 - Not Applicable	1 - Yes
	Q2. Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest)	2 - 60 to 79%	1 - 80 to 100%	1 - 80 to 100%	1 - 80 to 100%	3 - less than 60%	5 - Not Applicable	1 - 80 to 100%
	Section Rate	2 - MODERATE	1 - STRONG	3 - WEAK	1 - STRONG	3 - WEAK	NOT APPLICABLE	1 - STRONG
G) INTERVENTION INTEGRITY	Q1. What percentage of participants received the allocated intervention or exposure of interest?	1 - 80 to 100%	1 - 80 to 100%	1 - 80 to 100%	1 - 80 to 100%	3 - less than 60%	1 - 80 to 100%	1 - 80 to 100%
	Q2. Was the consistency of the intervention measured?	1 - Yes	3 - Can't tell	1 - Yes	3 - Can't tell	3 - Can't tell	3 - Can't tell	1 - Yes
	Q3. Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?	5 - No	5 - No	4 - Yes	6 - Can't tell	4 - Yes	6 - Can't tell	5 - No
H) ANALYSES	Q1. Indicate the unit of allocation (choose one)	organization/ institution	individual	practice/office	individual	individual	individual	individual
	Q2. Indicate the unit of analysis (choose one)	individual	individual	individual	individual	individual	individual	individual
	Q3. Are the statistical methods appropriate for the study design?	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes
	Q4. Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?	1 - Yes	1 - Yes	3 - Can't tell	2 - No	1 - Yes	2 - No	2 - No
Is there a discrepancy between the two reviewers with respect to the component (A-F) ratings?		No	No	No	No	Yes	No	No
If yes, indicate the reason for the discrepancy						2 - Differences in interpretation of criteria		
GLOBAL RATING (decision of both reviewers)		3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	2 - MODERATE

AUTHOR, YEAR		Brown, K. E., et al. (2018)	Castillo-Arcos Ldel, C., et al. (2016)	Widman, L., et al. (2018)	Arnaud, N., et al. (2016)	Norman, P., et al. (2018)	Coughlin, L. N., et al. (2021)	Doumas, D. M., et al. (2021)
A) SELECTION BIAS	Q1. Are the individuals selected to participate in the study likely to be representative of the target population?	2-Somewhat likely	3-Not likely	2-Somewhat likely	3-Not likely	2-Somewhat likely	3-Not likely	2-Somewhat likely
	Q2. What percentage of selected individuals agreed to participate?	5- Can't tell	1- 80 to 100% agreement	2- 60 to 79% agreement	2- 60 to 79% agreement	3- less than 60% agreement	3- less than 60% agreement	3- less than 60% agreement
	Section Rate	2 - MODERATE	3 - WEAK	2 - MODERATE	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK
B) STUDY DESIGN	Indicate the study type	2 - Controlled clinical trial	1 - Randomized controlled trial	1 - Randomized controlled trial	1 - Randomized controlled trial	1 - Randomized controlled trial	5 - Cohort (one group pre + post (before and after))	1 - Randomized controlled trial
	Was the study described as randomized? If NO, go to Component C.	No	Yes	Yes	Yes	Yes	No	Yes
	If Yes, was the method of randomization described? (See dictionary)	No	Yes	Yes	Yes	No		Yes
	If Yes, was the method appropriate? (See dictionary)	No	Yes	Yes	Yes			Yes
	Section Rate	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG	2 - MODERATE	1 - STRONG
C) CONFOUNDERS	Q1. Were there important differences between groups prior to the intervention?	1 - Yes	2 - No	1 - Yes	1 - Yes	2 - No	2 - No	1 - Yes
	Q2. If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?	1- 80 to 100% (most)		1- 80 to 100% (most)	1- 80 to 100% (most)			1- 80 to 100% (most)
	Section Rate	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG
D) BLINDING	Q1. Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?	3 - Can't tell	1 - Yes	3 - Can't tell	3 - Can't tell	3 - Can't tell	1 - Yes	3 - Can't tell
	Q2. Were the study participants aware of the research question?	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes
	Section Rate	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK
E) DATA COLLECTION METHODS	Q1. Were data collection tools shown to be valid?	1 - Yes	2 - No	2 - No	1 - Yes	1 - Yes	1 - Yes	1 - Yes
	Q2. Were data collection tools shown to be reliable?	1 - Yes	2 - No	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes
	Section Rate	1 - STRONG	3 - WEAK	3 - WEAK	1 - STRONG	1 - STRONG	1 - STRONG	1 - STRONG

AUTHOR, YEAR		Brown, K. E., et al. (2018)	Castillo-Arcos Ldel, C., et al. (2016)	Widman, L., et al. (2018)	Arnaud, N., et al. (2016)	Norman, P., et al. (2018)	Coughlin, L. N., et al. (2021)	Doumas, D. M., et al. (2021)
F) WITHDRAWALS AND DROP-OUTS	Q1. Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?	1 - Yes	1 - Yes	1 - Yes	1 - Yes	2 - No	1 - Yes	1 - Yes
	Q2. Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest)	1 - 80 to100%	2 - 60 to 79%	1 - 80 to100%	3 - less than 60%	3 - less than 60%	1 - 80 to100%	2 - 60 to 79%
	Section Rate	1 - STRONG	2 - MODERATE	1 - STRONG	3 - WEAK	3 - WEAK	1 - STRONG	2 - MODERATE
G) INTERVENTION INTEGRITY	Q1. What percentage of participants received the allocated intervention or exposure of interest?	1 - 80 to 100%	2 - 60 to 79%	1 - 80 to 100%	3 - less than 60%	1 - 80 to 100%	1 - 80 to 100%	1 - 80 to 100%
	Q2. Was the consistency of the intervention measured?	1 - Yes	1 - Yes	3 - Can't tell	1 - Yes	3 - Can't tell	3 - Can't tell	3 - Can't tell
	Q3. Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?	6 - Can't tell	4 - Yes	4 - Yes	6 - Can't tell	5 - No	5 - No	4 - Yes
H) ANALYSES	Q1. Indicate the unit of allocation (choose one)	organization/ institution	individual	individual	individual	individual	individual	practice/office
	Q2. Indicate the unit of analysis (choose one)	individual	individual	individual	individual	individual	individual	individual
	Q3. Are the statistical methods appropriate for the study design?	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes	1 - Yes
	Q4. Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?	1 - Yes	2 - No	2 - No	1 - Yes	1 - Yes	2 - No	1 - Yes
Is there a discrepancy between the two reviewers with respect to the component (A-F) ratings?		Yes	No	Yes	No	No	No	No
If yes, indicate the reason for the discrepancy		3 - Differences in interpretation of study		3 - Differences in interpretation of study				
GLOBAL RATING (decision of both reviewers)		2 - MODERATE	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK	3 - WEAK

Table S6: Reasons for exclusion of each record before full-text assessment for eligibility

	Author	Year	Excluded by	Reason
1.	Larsen, M. E., et al.	2017	Title	Does not include our study behaviours
2.	Ip, P., et al.	2016	Title	Study design is not accepted
3.	D. J. Kerrigan, M. R. Rukstalis, J. K. Ehrman, S. J. Keteyian, R. She and G. L. Alexander	2019	Title	Not on topic
4.	Moreno, G. and T. van Mierlo	2021	Title	Does not include our study behaviours
5.	C. J. Moores, A. Maeder, J. Miller, I. Prichard, L. K. Lewis, L. K. Bell, et al.	2019	Title	Study design is not accepted
6.	E. F. Rothman, M. Bair-Merritt and S. Broder-Fingert	2021	Title	Not on topic
7.	Ferré-Grau, C., et al.	2021	Title	Does not include our study behaviours
8.	J. A. Bauermeister, J. M. Golinkoff, K. J. Horvath, L. B. Hightow-Weidman, P. S. Sullivan and R. Stephenson	2018	Title	Study design is not accepted
9.	G. Sabben, V. Akelo, V. Mudhune, K. Ondeng'e, R. Ndivo, R. Stephenson, et al.	2019	Title	Study design is not accepted
10.	Chambers, S. K., et al.	2017	Title	Study design is not accepted
11.	Marzo, R. R., et al.	2021	Title	Not on topic
12.	T. H. Elgan, N. Kartengren, A. K. Strandberg, M. Ingemarson, H. Hansson, U. Zetterlind, et al.	2016	Title	Study design is not accepted
13.	N. S. Cox, B. Eldridge, S. Rawlings, J. Dreger, J. Corda, J. Hauser, et al.	2019	Title	Study design is not accepted
14.	Hillhouse, J., et al.	2017	Title	Does not include our study behaviours
15.	Baldwin, P. A., et al.	2020	Title	Does not include our study behaviours
16.	Hides, L., et al.	2020	Title	Does not include our study behaviours
17.	J. M. Salsman, L. E. McLouth, M. Cohn, J. A. Tooze, M. Sorkin and J. T. Moskowitz	2020	Title	Study design is not accepted

	Author	Year	Excluded by	Reason
18.	Schaub, M. P., et al.	2018	Title	Study design is not accepted
19.	Herrero, R., et al.	2019	Title	Not on topic
20.	P. Ip, K. L. Chan, C. B. Chow, T. H. Lam, S. Y. Ho, W. H. S. Wong, et al.	2016	Title	Study design is not accepted
21.	P. Sousa, E. Duarte, R. Ferreira, A. Esperanca, R. Frontini, R. Santos-Rocha, et al.	2019	Title	Study design is not accepted
22.	P. Magalhaes, C. Silva, B. Pereira, G. Figueiredo, A. Guimaraes, A. Pereira, et al.	2020	Title	Study design is not accepted
23.	M. A. Russell and J. M. Gajos	2020	Title	Not on topic
24.	A. M. Gregory and A. Sadeh	2016	Title	Study design is not accepted
25.	S. Ramalho, P. F. Saint-Maurice, D. Silva, H. F. Mansilha, C. Silva, S. Goncalves, et al.	2020	Title	Study design is not accepted
26.	A. Riobueno-Naylor, H. Williamson, K. Canenguez, A. Kogosov, A. Drexler, F. Sadeq, et al.	2021	Title	Not on topic
27.	de la Vega, R., et al.	2020	Title	Not on topic
28.	Wu, Y., et al.	2020	Title	Not on topic
29.	K. J. Nadeau, S. A. Stotz, K. Moore, Y. Garcia-Reyes, S. M. Sereika, H. Stein, et al.	2020	Title	Not on topic
30.	Wong, G., et al.	2018	Title	Study design is not accepted
31.	Long, L., et al.	2016	Title	Study design is not accepted
32.	F. Sieverink, S. M. Kelders and J. van Gemert-Pijnen	2017	Title	Study design is not accepted
33.	K. E. Champion, N. C. Newton, L. Stapinski and M. Teesson	2018	Title	Does not include our study behaviours
34.	B. L. Curtis, R. D. Ashford, K. I. Magnuson and S. R. Ryan-Pettes	2019	Title	Study design is not accepted

	Author	Year	Excluded by	Reason
35.	C. Nolan, L. Packel, R. Hope, J. Levine, L. Baringer, E. Gatare, et al.	2020	Title	Study design is not accepted
36.	T. M. Schwinn, J. E. Hopkins and S. P. Schinke	2016	Title	Not on topic
37.	C. C. McDonald, B. M. Brawner, J. Fargo, J. Swope and M. S. Sommers	2018	Title	Not on topic
38.	A. Brigden, E. Anderson, C. Linney, R. Morris, R. Parslow, T. Serafimova, et al.	2020	Title	Study design is not accepted
39.	L. Li, D. Novillo-Ortiz, N. Azzopardi-Muscat and P. Kostkova	2021	Title	Study design is not accepted
40.	A. Werner-Seidler, L. Johnston and H. Christensen	2018	Title	Study design is not accepted
41.	J. R. D. McIntosh, S. Jay, N. Hadden and P. J. Whittaker	2017	Title	Study design is not accepted
42.	J. Philipp, C. Franta, M. Zeiler, S. Truttmann, T. Wittek, H. Imgart, et al.	2021	Title	Not target to participant aged 10-24
43.	M. S. H. Hsu, A. Rouf and M. Allman-Farinelli	2018	Title	Study design is not accepted
44.	Diestelkamp, S., et al.	2019	Title	Study design is not accepted
45.	C. Wright, P. M. Dietze, E. Kuntsche, M. Livingston, P. A. Agius, R. Room, et al.	2020	Title	Study design is not accepted
46.	M. Mudannayake, T. A. Weerasinghe and leee	2018	Title	Not on topic
47.	K. Wunsch, T. Eckert, J. Fiedler, L. Cleven, C. Niermann, H. Reiterer, et al.	2020	Title	Study design is not accepted
48.	Boucher, E. M., et al.	2021	Title	Study design is not accepted
49.	D. File, B. Bothe, M. Kapitany-Foveny and Z. Demetrovics	2020	Title	Study design is not accepted
50.	G. Stassen, C. Grieben, I. Frobose and A. Schaller	2020	Title	Not on topic

	Author	Year	Excluded by	Reason
51.	S. Strommer, M. Barrett, K. Woods-Townsend, J. Baird, D. Farrell, J. Lord, et al.	2020	Title	Study design is not accepted
52.	Karyotaki, E., et al.	2019	Title	Study design is not accepted
53.	Martin, P., et al.	2020	Title	Not on topic
54.	M. Wiklander, J. Strandquist, C. M. Obol, L. E. Eriksson, J. Winterling, K. A. Rodriguez-Wallberg, et al.	2017	Title	Does not include our study behaviours
55.	H. Blake, H. Quirk, P. Leighton, T. Randell, J. Greening, B. L. Guo, et al.	2016	Title	Study design is not accepted
56.	R. W. S. Coulter, S. Mitchell, K. Prangley, S. Smallwood, L. Bonanno, E. N. Foster, et al.	2021	Title	Study design is not accepted
57.	K. Sinadinovic, M. Johansson, A. S. Johansson, T. Lundqvist, P. Lindner and U. Hermansson	2020	Title	Does not include our study behaviours
58.	Park, E. and M. Kwon	2018	Title	Study design is not accepted
59.	J. Hagstrom, M. Ander, M. Cernvall, B. Ljotsson, H. W. Wiman, L. von Essen, et al.	2020	Title	Not on topic
60.	L. Wozney, A. Huguet, K. Bennett, A. D. Radomski, L. Hartling, M. Dyson, et al.	2017	Title	Study design is not accepted
61.	Baldwin, P. A., et al.	2021	Title	Study design is not accepted
62.	Bountress, K. E., et al.	2020	Title	Not on topic
63.	N. Redmond, L. Harker, Y. Bamps, S. S. Flemming, J. P. Perryman, N. J. Thompson, et al.	2017	Title	Not on topic
64.	McDonald, C. C., et al.	2021	Title	Not on topic
65.	G. M. J. Taylor, M. N. Dalili, M. Semwal, M. Civljak, A. Sheikh and J. Car	2017	Title	Study design is not accepted
66.	N. C. Newton, C. Chapman, T. Slade, C. Conroy, L. Thornton, K. E. Champion, et al.	2018	Title	Study design is not accepted

	Author	Year	Excluded by	Reason
67.	Das, J. K., et al.	2016	Title	Study design is not accepted
68.	T. P. Palfai, K. D. Tahaney and M. R. Winter	2016	Title	Not on topic
69.	S. J. Drabble, A. O'Cathain, A. J. Scott, M. A. Arden, S. Keating, M. Hutchings, et al.	2020	Title	Not on topic
70.	Gava, G., et al.	2021	Title	Not on topic
71.	Coulter, R. W. S., et al.	2019	Title	Study design is not accepted
72.	Logie, C. H., et al.	2016	Title	Study design is not accepted
73.	T. M. Palermo, R. de la Vega, J. Dudeney, C. Murray and E. Law	2018	Title	Not on topic
74.	Fedele, D. A., et al.	2017	Title	Study design is not accepted
75.	A. Pennou, T. Lecomte, S. Potvin and Y. Khazaal	2019	Title	Study design is not accepted
76.	Doyle, A. M., et al.	2021	Title	Study design is not accepted
77.	Murray, C. B., et al.	2020	Title	Not on topic
78.	Wadham, E., et al.	2019	Title	Study design is not accepted
79.	A. Knowlden and M. Sharma	2016	Title	Not target to participant aged 10-24
80.	T. Tomazic and O. S. Jerkovic	2020	Title	Does not include our study behaviours
81.	A. Hurley-Wallace, D. E. Schoth, S. Lilley, G. Williams and C. Liossi		Title	Not on topic
82.	Witzel, T. C., et al.	2019	Title	Study design is not accepted
83.	B. T. Bell, N. Toth, L. Little and M. A. Smith	2016	Title	Not on topic

	Author	Year	Excluded by	Reason
84.	Carli, V.	2016	Title	Not on topic
85.	Z. Y. Wang, J. P. Wang and A. Maercker	2016	Title	Not on topic
86.	Abuwalla, Z., et al.	2019	Title	Does not include our study behaviours
87.	Prescott, T. L., et al.	2016	Title	Not on topic
88.	Lonsdale, C., et al.	2016	Title	Study design is not accepted
89.	Eschenbeck, H., et al.	2019	Title	Does not include our study behaviours
90.	Cross, A., et al.	2020	Title	Study design is not accepted
91.	E. E. Bonar, D. M. Schneeberger, C. Bourque, J. A. Bauermeister, S. D. Young, F. C. Blow, et al.	2020	Title	Study design is not accepted
92.	J. Stinson, L. Wolfson and N. Poole	2020	Title	Does not include our study behaviours
93.	N. Varas-Diaz, E. Betancourt-Diaz, A. J. Lozano, L. Huang, L. DiNapoli, A. Hanlon, et al.	2019	Title	Not target to participant aged 10-24
94.	Couturier, J., et al.	2021	Title	Not on topic
95.	N. Canale, A. Vieno, M. D. Griffiths, C. Marino, F. Chieco, F. Disperati, et al.	2016	Title	Not on topic
96.	D. Carnicer-Pont, E. Loureiro-Varela, J. M. Manresa, M. Martinez, A. Avecilla, L. Montero-Pons, et al.	2019	Title	Study design is not accepted
97.	R. E. Metcalfe, J. M. Matulis, Y. J. Cheng and E. A. Stormshak	2021	Title	Not on topic
98.	Nielsen, A., et al.	2018	Title	Study design is not accepted
99.	J. A. Maertens, A. M. Jimenez-Zambrano, K. Albright and A. F. Dempsey	2017	Title	Not on topic

	Author	Year	Excluded by	Reason
100.	Feroz, A., et al.	2019	Title	Study design is not accepted
101.	Craig, S. L., et al.	2021	Abstract	Does not include our study behaviours
102.	Modi, A. C., et al.	2017	Abstract	Does not include our study behaviours
103.	G. Corno, G. Molinari, M. Espinoza, R. Herrero, E. Etchemendy, A. C. Vega, et al.	2016	Abstract	Study design is not accepted
104.	Goodman, J. A. and T. Israel	2020	Abstract	Not target to participant aged 10-24
105.	A. C. Modi, M. Schmidt, A. W. Smith, L. Turnier, N. Glaser and S. L. Wade	2017	Abstract	Does not include our study behaviours
106.	Machado, N. M., et al. (2019).	2019	Abstract	Not on topic
107.	G. MacArthur, D. M. Caldwell, J. Redmore, S. H. Watkins, R. Kipping, J. White, et al.	2018	Abstract	Study design is not accepted
108.	DeFrank, G., et al.	2019	Abstract	Not on topic
109.	Steinke, J., et al.	2017	Abstract	Not on topic
110.	S. McNamara, M. Bittner and S. Healy		Abstract	Not on topic
111.	P. C. Diedrichs, M. J. Atkinson, K. M. Garbett, H. Williamson, E. Halliwell, N. Rumsey, et al.	2016	Abstract	Not target to participant aged 10-24
112.	M. A. M. Noh, N. A. M. Zin, N. S. Ashaari and leee	2019	Abstract	Not on topic
113.	L. J. Meltzer and C. E. Pugliese	2017	Abstract	Study design is not accepted
114.	Pollak, K. I., et al.	2016	Abstract	Not on topic
115.	Pollak, K. I., et al.	2016	Abstract	Not on topic
116.	Aicken, C. R. H., et al.	2016	Abstract	Not on topic
117.	D. Thompson, C. Callender, C. Gonynor, K. W. Cullen, M. J. Redondo, A. Butler, et al.	2019	Abstract	Not target to participant aged 10-24
118.	W. A. Hall and E. Nethery	2019	Abstract	Study design is not accepted

Table S7: Reasons for exclusion during full-text assessment for eligibility

Author	Year	Decision	Reason to exclude
Ignacio, M., et al.	2019	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
M. C. Barry, M. Threats, N. A. Blackburn, S. LeGrand, W. Dong, D. V. Pulley, et al.	2018	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
L. M. Rojas, M. Bahamon, C. Lebron, P. Montero-Zamora, M. Pardo, M. Wakefield, et al.	2021	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
M. Nitsch, C. N. Dimopoulos, E. Flaschberger, K. Saffran, J. F. Kruger, L. Garlock, et al.	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
M. L. A. Lustria, J. Cortese, M. A. Gerend, K. Schmitt, Y. M. Kung and C. McLaughlin	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
S. Goodman, B. Morrongiello and K. Meckling	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
M. Orr, J. Isaacs, R. Godbout, M. Witmans and P. Corkum	2019	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Champion, K. E., et al.	2020	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
J. D. Hanson, T. L. Weber, U. Shrestha, V. J. Bares, M. Seiber and K. Ingersoll	2020	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
Davies, E. L., et al.	2017	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Bravo-González, J., et al.	2017	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Sundar, T. K. B., et al.	2019	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
A. Rohde, A. Duensing, C. Dawczynski, J. Godemann, S. Lorkowski and C. Brombach	2019	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
M. Deady, K. L. Mills, M. Teesson and F. Kay-Lambkin	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
S. Wen, H. Larsen, M. Boffo, R. Grasman, T. Pronk, J. B. G. van Wijngaarden, et al.	2020	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Sundar et al.	2018	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change

Author	Year	Decision	Reason to exclude
Zhang, Z., et al.	2019	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
J. Winterling, M. Wiklander, C. M. Obol, C. Lampic, L. E. Eriksson, B. Pelters, et al.	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
B. Cliffe, A. Croker, M. Denne, J. Smith, and P. Stallard	2020	To exclude	Target to specific subgroups
Lei, S., et al.	2021	To exclude	Study type not accepted
Bidargaddi, N., et al.	2017	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Estrada, Y., et al.	2019	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
L. Widman, C. E. Golin, K. Kamke, J. Massey and M. J. Prinstein	2017	To exclude	Not evaluate the effectiveness of the web-based interventions
B. G. Kurowski, S. L. Wade, J. W. Dexheimer, J. Dyas, N. H. Zhang and L. Babcock	2016	To exclude	Target to specific subgroups
van Luenen, S., et al.	2018	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
G. Stassen, C. Grieben, O. Sauzet, I. Frobose and A. Schaller	2020	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Jones Bell, M., et al.	2019	To exclude	Study type not accepted
Hobbs, L. J., et al.	2019	To exclude	Study type not accepted
G. Marchand and S. Healy	2019	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Nik Farid, N. D., et al.	2018	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
R. Webster, S. M. Cpsychol, C. Estcourt, M. Gerressu, J. V. Bailey and S. S. T. G. Men	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
C. Grieben, G. Stassen and I. Frobose	2017	To exclude	Article not written in English/Portuguese/Spanish
E. S. Zhou and C. J. Recklitis	2021	To exclude	Target to specific subgroups
J. J. Crouse, K. C. Morley, N. Buckley, A. Dawson, D. Seth, L. A. Monds, et al.	2021	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
C. J. C. Wright, P. M. Dietze, B. Crockett and M. S. C. Lim	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group

Author	Year	Decision	Reason to exclude
K. E. Brown, K. Newby, M. Caley, A. Danahay and I. Kehal	2016	To exclude	Not a health promotion intervention but target to improve screening, management and/or control of diseases
M. Barker, J. Baird, W. Lawrence, C. Vogel, S. Stommer, T. Rose, et al.	2016	To exclude	Study type not accepted
E. R. Walsh-Buhi, H. Helmy, K. Harsch, N. Rella, C. Godcharles, A. Ogunrunde, et al.	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
T. Bickmore, Z. Zhang, M. Reichert, C. Julce and B. Jack	2020	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Tinner, L. E., et al.	2020	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
C. R. Howell, K. R. Krull, R. E. Partin, N. S. Kadan-Lottick, L. L. Robison, M. M. Hudson, et al.	2018	To exclude	Target to specific subgroups
Prado, G., et al.	2019	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Gonsalves, L., et al.	2019	To exclude	Not a web-based intervention
Saliars, E., et al.	2017	To exclude	Study type not accepted
E. Knox, C. Glazebrook, T. Randell, P. Leighton, B. L. Guo, J. Greening, et al.	2019	To exclude	Target to specific subgroups
Karekla, M. and S. N. Savvides	2021	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
M. F. Gwynette, D. Morriss, N. Warren, J. Truelove, J. Warthen, C. P. Ross, et al.	2017	To exclude	Target to specific subgroups
Barry, M. C., et al.	2018	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
S. Pedersen, A. Gronhoj and J. Thogersen	2016	To exclude	Not a web-based intervention
Estcourt, C. S., et al.	2017	To exclude	Not a health promotion intervention but target to improve screening, management and/or control of diseases
J. V. Bailey, R. Webster, R. Hunter, M. Griffin, N. Freemantle, G. Rait, et al.	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group

Records identified via other methods			
Author	Year	Decision	Reason to exclude
Müller, A. M., & Khoo, S.	2016	To exclude	Study type not accepted
Hargreaves EA, Mutrie N, Fleming JD.	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Ho Han 1, Kelley Pettee Gabriel 2, Harold Willis Kohl 3rd 1 2	2017	To exclude	Not a web-based intervention
Friederichs SA, Bolman C, Oenema A, Verboon P, Lechner L.	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Fulton EA, Newby K, Kwah K, Schumacher L, Gokal K, Jackson LJ, Naughton F, Coleman T, Owen A & Brown KE.	2021	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Bailey, J.V., Webster, R., Griffin, M., Freemantle, N., Hunter, R., Rait, G., et al.	2016	To exclude	Not evaluate the effectiveness of the intervention to promote the desired behaviour change
Michelle C Carter 1; Victoria J Burley 1; Janet E Cade 1	2017	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Job G Godino 1, Gina Merchant 1, Gregory J Norman 1, Michael C Donohue 2, Simon J Marshall 1, James H Fowler 3, Karen J Calfas 1, Jeannie S Huang 4, Cheryl L Rock 5, William G Griswold 6, Anjali Gupta 7, Fredric Raab 6, B J Fogg 8, Thomas N Robinson 9, Kevin Patrick 10	2016	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Sangwon Bae et al.	2017	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Gajecki M et al.	2017	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Christy K. Scott et al.	2020	To exclude	Not target directly to 10-24 years or impossible to isolate the age group
Scarpa, M. P., et al.	2021	To exclude	Not target directly to 10-24 years or impossible to isolate the age group

Manuscripts 2 - Failures in Game-Based Learning Experiences Sometimes Win

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Abstract:

Introduction: Although it is conventional wisdom that we learn most from failures, it is uncommon to explore in scientific publications the adversities of the complex process of games' design and implementation. Therefore, mistakes in the process of game development are likely to be repeated, and the complexity of the design and implementation process is underestimated.

Aim: To address the various challenges and adversities when designing and implementing PLATE, which is a Minecraft-based learning project that aimed to foster nutrition literacy in adolescents.

Methods: Successive iterations of a qualitative approach including observation, focus groups and interviews were applied to every step. The focus was on what went wrong in each part. Each problem was classified and analysed. We started by designing a gamified strategy to be used in the PLATE project, including (1) analysis of the advantages and disadvantages of various options for games/platforms and digital media; (2) discussion of the content to be included, taking into account the students' curricula; (3) storyboard creation; (4) prototyping and designing process; (5) focus groups with teachers to present the strategy and playtesting with students; (6) game adjustments to meet criticism received. The final version was implemented at three hosting schools with different socio-demographic contexts. The researchers followed the project implementation in close partnership with the responsible teachers, identifying and solving the adversities reported. At the end of the project's implementation, interviews were carried out with the teachers and students, and the impressions of each participant were collected.

Results: We identified main challenges concerning the game design and development, players experiences, school-receptivity, implementation, effectiveness, and project management. We highlighted unavoidable factors, related to school-receptivity and project implementation that demand customization of the experience according to the socio-educational context of the host.

Conclusion: This paper identified and expanded on the existing literature problems that may limit the success of a game-based learning experience, in order to contribute to a successful outcome.

Keywords: Minecraft, nutrition, education, literacy, game-based learning, gamification

Introduction

The digital society demands much from the learning spaces. The students have changed, and it's necessary to motivate them in new ways. Digital game-based learning (GBL) seems to be a great weapon (Prensky, 2005; Tsekleves, Cosmas and Aggoun, 2014). However, its usage isn't simple. Spreading games and game-based interventions into learning sites is costly, meaning the monetary investments needed and the necessity to break the institutions' resistances (Gee, 2005; Hébert, Jenson and Terzopoulos, 2021). The researchers and game developers know that having scientific evidence of the games' positive outcomes is a powerful argument to prospect and convince hosting schools.

Not surprisingly, there is a great focus on publishing and investigating the experiences' results. Not only, results. But positive results.

The literature supports this assumption. After analysing 143 papers, Boyle and her colleagues (2016) provided high-quality evidence of the benefits of using games with diverse literacy purposes. Van Gaalen and her team (2020) revealed that the negative results of using gamification in health professionals' education weren't reported in the papers analysed. They argue that for being an incipient method (compared to traditional ones), it's possible that the positive results are overreported, and the negative ones remain under- or undeclared, causing publication bias (van Gaalen et al., 2020).

Undeniably, the positive impact of GBL is greatly reported. The games' immersive and playful environment increases the students' engagement and motivation in the learning process (Gee, 2005; Prensky, 2005; Boyle et al., 2016).

Focusing on the papers related to Minecraft, the game used in the PLATE project presented here, the benefits of applying it to learning experiences are also well-documented. This sandbox game has been widely used in educational spaces since 2009, when it was released. The launch of Minecraft: Education Edition and its more than 2 million users are evidence of the interest the game evokes among educators (Baek, Min and Yun, 2020). Minecraft-based learning experiences published outcomes include the development of problem-solving and conflict-resolution skills (Jagannath, Salen and Slovák, 2020; Jung et al., 2017; Scholten, 2017), and the increasing confidence and communication skills (Hobbs et al., 2019; Marcon and Faulkner, 2016; Scholten, 2017). Finding and evaluating information, creating, and innovating, collaborating were also skills developed

(Bebbington and Vellino, 2015; Cilauro, 2015; Dezuanni, 2018; Jarvoll, 2018; Jung et al., 2017; Scholten, 2017).

In fact, the positive results are abundant, and although we don't exclude the bias hypothesis presented by van Gaalen and her colleagues (2020), this isn't our point.

If we focused only on the PLATE's outcomes, we could truly present positive results. Nevertheless, these winning outcomes were only possible after failing, and learning, and improving all over the project life. We argue, then, that it's necessary to explore the adversities of the complex process of games' design and implementation in scientific publications. This is what is presented, step-by-step, in the following sections. Through presenting this process, we aim to address the challenges and adversities when designing and implementing PLATE, which is a Minecraft: Education-based learning project that aimed to foster nutrition literacy in adolescents.

Methods

Overview of the game-based learning intervention, PLATE

The intervention took place in three schools. In two of them, Natural Sciences classes were used. At the third, the project was implemented in the STEAM (Science, Technology, Engineering, the Arts and Mathematics) classes.

The intervention occurred, between October and December 2020, under the guidance of the respective teacher. It included six teachers, nine classes and 202 students. However, one of the schools dropped out of the project before the intervention's end. So, the final sample encompassed four teachers, six classes and 142 students. The game's multiplayer template was delivered for free in the hosting schools. Each user had his own avatar to interact in his group's template (each group had four or five students).

In Minecraft, the players faced a dystopian world where its inhabitants adopted a sedentary lifestyle and an inadequate diet. In that wrecked world, all knowledge about food and its importance for health was forgotten. Players were invited to explore the world and restore 15 lost books on nutrition and food to the city library. The template we made available consists of a tutorial and three more game areas: besides the library, there were also the market and the hospital.

The challenges proposed in Minecraft were complemented by other learning activities on Microsoft Teams, like preparing and video recording a healthy recipe, creating a nutrition and cancer prevention flyer, doing an audio interview about eating disorders, among others. When delivering

these tasks and according to the student's performance, the teacher could hand 0 to 5 emeralds in Minecraft.

PLATE ends when players restore all the lost books into the city library and complete every requested Microsoft Teams' tasks.

In figure 1, we present some of the elements cited previously: (A) a lost book, (B) an in-game challenge example, (C) an in-game invitation to a Microsoft Teams' assignment, (D) our main character - Dra. Martina - congratulating the students for recovering a book).



Figure 1: Examples of PLATE's elements in Minecraft: Education Edition

Intervention development: detailed description of tasks and constraints

Qualitative approaches are more appropriate to provide the insight necessary to understand the participants' role in the intervention. Therefore, we opted for a design-based research methodology. Given the interpretive position adopted in this research, the essential processes included observing, investigating, and documenting, in detail, the unique educational experiences of individuals, in the complexity of real classrooms.

PLATE intervention followed a 6 steps strategy: (1) comparative analysis of the advantages and disadvantages of available games/platforms and digital media; (2) discussion of the content to

be included, considering the students' curricula; (3) storyboard creation; (4) prototyping and designing process; (5) focus groups with teachers to strategy evaluation and playtesting with students; (6) game adjustments to meet criticism received.

In STEP 1, we started by investigating the feasibility of developing a GBL. After evaluating the limited resources available (budget, experts, time), our team opted to use a commercial game. The literature review of the most successful games available for educational purposes led us to Minecraft. The main reasons for this choice were: the outcomes of the Minecraft-based learning interventions; adapting the game to our needs was free; the age of our target audience; their familiarity and engagement with this game; the hostings' digital characteristics.

The two first institutions recruited are Microsoft Showcase Schools, which means teachers and students were familiarized with the Microsoft Education programs. The third school interested in hosting PLATE had the Microsoft Education package required. Another benefit of the choice is that the Microsoft platforms don't use the students' personal emails and are under the schools' data protected environment.

Despite having carefully evaluated all the pros and cons of the available options, we still faced unexpected difficulties like the Minecraft: Education full version wasn't included in the Microsoft package available in one of the schools. The trial wasn't enough to encompass the whole intervention period. To solve this, we contacted Microsoft Portugal and the company kindly provided provisory licenses.

Providing compatible devices for each student was another important concern. As, till this moment, Minecraft: Education Edition is only supported on operating systems for PC, iPad, Mac, and Chromebook, it was important to provide this equipment to the students. The two first schools had enough devices for each student. But, in the third school, the compatible equipment was available only in the informatics laboratory. Due to the COVID-19, these devices were loaned to students in prophylactic isolation, which caused a break to our intervention. This factor contributed to this school's decision of leaving the project. Clearly, the technological requirements influence the schools' recruitment and the intervention's effectiveness.

An additional constraint of using Minecraft is that the level of aptitude to play could be very heterogeneous among students, so the time needed to complete the intervention would vary accordingly. To minimize this and engage all users, we designed a multiplayer strategy, complemented with Microsoft Teams' activities, being desirable to include students with different digital skills in each team.

The gamified tasks in Microsoft Teams had pros and cons. This was a good strategy to present the nutrition and food learning content and was useful to engage the students who aren't game attracted. Conversely, leaving Minecraft to complete the Microsoft Teams' tasks disrupted the player experience. Using the game's characters to present the activities and convert the students' grades into Minecraft emeralds wasn't enough to overcome this constraint.

In STEP 2, we considered the students' curricula of Natural Sciences to define the learning objectives, specify expected knowledge and behaviour outcomes, and analyse how to match the content with the learning objectives to produce the desired behaviour change.

To encourage teachers to use the proposed GBL, it was indispensable addressing the learning objectives already included in students' curricula, but this also offered some challenges. Due to the inflexibility of the Natural Sciences curriculum, these topics are usually taught at the beginning of the academic year. Due to Covid-19, some changes in the planning of the school year occurred, and adjustments were needed to match the intervention duration to the schools' schedules. As PLATE is a one-year project, our team had only six months to fully develop the GBL and implement it in the first school.

Although we conducted focus groups with three teachers, who were very cooperative and used their spare time to participate, having a Natural Sciences teacher in our development team would have been more beneficial.

The Natural Sciences curriculum has linear and progressive themes to be taught, which is hard to fit into Minecraft's open-ended nature. The content and the game challenges needed to be adjusted to Minecraft: Education's tools, rules, and environment, balancing the learning objectives and the playfulness of the game.

Since PLATE is an in-classroom project, our results revealed it's impossible to isolate the intervention's outcomes, especially because the intervention depends on teachers' support. As the pandemic overloaded the teachers, it also limited the adherence of schools.

In STEP 3, we created strategies addressing the gamification design. Due to the conditions explained previously in this paper, the storyboard, game rules, mechanisms, and inclusion of the nutrition contents had to be fitted to the Minecraft features and constraints, which demanded several team meetings and users' tests.

One of PLATE's game objectives was collecting Minecraft's emeralds by correctly responding to the game's questions. Since we also needed to gamify the Microsoft Teams' tasks, we asked the teachers to evaluate the students' performance and handed them emeralds. This demanded extra

work from teachers, which could be solved if there was an automatic and integrated score in Microsoft Teams. To prevent students from giving themselves emeralds, one of the rules was gaming in the survival mode and deactivating cheats. At the end of the project, we realized that more experienced gamers used creative mode and cheated advantages to solve some of the challenges found, which revealed unavoidable limitations of using Minecraft.

Since there are no mods available in the Education Edition, the objects and inventory are restricted. It wasn't easy to illustrate healthy eating options, which precluded some of the challenges initially imagined by our team. Also, in Minecraft, the “lives” increase the more you eat, without considering the healthiness of the food you select, so we decided not to use a life bar.

Another challenge was defining the penalties. This happened because Minecraft principally uses the “death” of the player to penalize them, which implies losing all their inventory. It wouldn't be a good option in our narrative and the time we had available. Our solution was highlighting the errors using red lights and the hits with green lights. We scored the right answers without penalizing the wrong ones. At the end of the project, we would find out that this wasn't the best decision since players realized there was no score difference among the teams who solved the tasks on the first try from those who tried multiple times. Penalizing the player revealed to be crucial to engage students and hold them accountable for their choices.

It was also challenging to fit the curriculum's content into the writing characters limitation imposed by Minecraft. Nonetheless, we used all the options available to present game challenges and introduce conflict.

Making the aesthetics fit into our dystopian world narrative was also challenging, due to the pixelated gaming environment.

In STEP 4, we developed all draft materials needed for future implementation. This step included a written manual to familiarize the teachers with the gamification process and the proposed contents; a full video with all the game challenges solved; and short illustrative videos. We also kept in constant remote contact with teachers to collect their feedback and suggestions. These materials intended to overcome the mandatory social distance adopted during the COVID-19 lockdown, which limited the researchers' presence in schools and the availability of teachers to participate in training sessions.

Although the same materials were distributed to all teachers, there were noticeable differences in teachers' knowledge about the content of them.

We used usability testing to evaluate our first prototype during students' holiday season, before intervention. The sessions were conducted online with three volunteers fitted to the target. During the test, we observed what they were doing during the playing experience and annotated our observations and their feedback. We identified several opportunities to improve such as the game navigation and the necessity of including non-players characters to guidance; increase the difficulty of the questions; add more action and adventure to challenges; add complexity to the game mechanisms making them more stimulating; broaden the spectrum of the included content; improve the game's aesthetics to better fit to the dystopian world narrative; create more game areas to enhance the evolution in the game.

Due to the little time available, after those improvements new usability tests were conducted with two participants from our team's acquaintance.

In the second tests, the users showed more engagement, responding better to the game aesthetics, the immersive narrative, and the stimulating challenges. While the first group revealed "the tasks were easy and somehow childish" but the game "have the potential to involve them", these second interviewees reported being engaged saying that "the questions aren't exceedingly difficult" even asked to continue playing since "it's fun to play, so it's a good way to learn nutrition". However, the open-ended nature of Minecraft remained a problem to solve, the reason why we included - besides the guiding non-players characters - an in-game tutorial.

In STEP 5, we scheduled several meetings with the responsible teachers in each hosting school to adjust the implementation to their needs. PLATE ended up being implemented in six Natural Sciences classes and in two STEAM classes. We needed to drop out of our intention to design a comparative study because the recruited schools showed much reluctance in participating as a control group. Besides, the 2020's lockdown period affected the school's schedules, which caused different start dates in each hosting. Although these flexibilities were essential to improve adherence, we knew it would have unpreventable impacts on our planned evaluation.

One unexpected constraint was the occurrence of unforeseen interruption periods, which happened at different times: when it occurred in a later phase, the teachers and students were already captivated by PLATE so, despite the negative impact on the games' flow, the opinions gathered at the final interviews revealed they had a positive experience, overall.

When it happened only after the first week, the students weren't already engaged in PLATE. Additionally, the school curriculum was behindhand, ensuring compatible devices was difficult, and the two teachers involved were uncomfortable in guiding students in an unfamiliar tool. Not

following the students' paths within the game also concerned these teachers. This led to one school quitting, so our final sample missed two Natural Sciences' classes. We emphasize that this dropped-out school also reported that PLATE caused a noisy environment which was considered disturbing. In other schools, this ambience was reported as denoting the student's motivation and bringing the students together. In one of them, however, the intervention was moved to a laboratory, where the students could be far from the other classes, which demanded a silent ambience.

There were issues completely unexpected by our team but that influenced the outcomes and caused unavoidable differences among teams. At both schools that completed the intervention, another problem was the occurrence of unpredictable bugs. We offered remote support to the teachers and solved the problem before the following class. However, experienced gamers used the available Minecraft cheats to deal with them on their own. Teachers and students highlighted it as evidence of the students' problem-solving and team-working skills, as reported during the interviews conducted in STEP 6.

In this step, we collected the criticism of three teachers and eight students to improve this pilot version. The interviewees were from both schools who concluded the program and declared they were also reporting their colleagues' opinions. We identified that students neglected some of the texts presented during the game, firstly trying to complete tasks by chance. Even though we tried to present the tasks in a sequential format, more experienced gamers interviewed showed they neglected this information. This may have happened because we tried to modify the Minecraft exploratory nature, already familiar to some students. Less experienced gamers were more attentive to the game's guidance provided.

The absence of mandatory sequential learning progress in the game was also one of the most important concerns reported by all teachers to use this pedagogical strategy to evaluate the students' learning, especially because this was a multiplayer strategy so measuring the learning of each player was hard.

We concluded this all impacted the knowledge transference and compromised the effectiveness of the intervention. Nonetheless, all the interviewees reported an increase in awareness or behaviour change, namely in more water ingestion, in becoming more label-conscious consumers, and in better grades achievement.

During the interviews, the teachers also revealed that the project turned out to be very time-demanding since the themes presented by PLATE are taught in fewer lessons. Knowing that a GBL

takes longer than a traditional pedagogical strategy, we recommend conducting this intervention in more flexible curricula, such as STEAM or Citizenship.

The two Natural Science's teachers evaluated that scoring the Microsoft Teams' tasks at the same scale wasn't appropriate, as the effort needed to complete the assignments varied much among them.

Assuming this GBL deserves improvements to balance students' expectations and teachers' necessities, we focused on the failures found to minimize them in the future and contribute to a more successful outcome.

Results and Discussion

Based on project failures, we highlighted the main challenges under six GBL domains: game design and development, players experiences, school-receptivity, implementation, effectiveness, and project management. After organizing them under these dimensions, we developed a checklist, as presented in table 1.

Table 1: Checklist to a GBL intervention

Domains	Checklist
Project Management	1. Is the cost fitted to the budget? 2. Does the team have all the technical skills the project needs? 3. Are the participatory design sessions conducted with a representative sample of the target audience? 4. Is the project duration compatible with the school schedule? 5. Are the hosting schools' technical conditions supportive of the intervention? 6. Can the team provide the support the hosting schools need, encompassing teacher training, online or <i>in-loco</i> support, extra materials, and technical needs (manuals, licenses, etc)?
Game design and development	1. Is developing a serious game worthy of the costs, and suitable to the projects' budget and time? 2. Is there any commercial game adequate for the project and the teachers' educational purposes? 3. Are the advantages and disadvantages of the chosen game well-documented in the literature? 4. Are the desired learning outcomes fitted into the game elements (narrative, aesthetics, rewards)? 5. Are the students' expectations known? 6. Are the teachers' needs addressed?

Domains	Checklist
Players experiences	1. Are the students' game-skills differences and the possible impacts in the outcomes well-known (especially when using a commercial off-the-shelf game)? 2. Are the external educational assignments integrated within the GBL, without interrupting the game's immersive experience? 3. Do the game challenges duration match into each class length and, at the same time, keep the students engaged with the whole GBL? 4. Have the school's technical conditions and pedagogy principles been considered when deciding the better gaming option (single-player or multiplayer)?
School-receptivity	1. Does the team plan strategies to encourage teachers using GBL? 2. Does the team plan strategies to engage the scholar community making it supportive of the GBL intervention? 3. Are the project's purposes fitted in the best subject (considering each curriculum's restrictions and flexibilities)? 4. Does the team plan how the material and human support will be delivered during (or previously to) the intervention period?
Implementation	1. Is it necessary to customize the intervention to each school, considering their particular hosting conditions, pedagogy, expectations, and schedules?
Effectiveness	1. Does the team plan how to attract control schools to the intervention? 2. Does the team plan how to verify the curricular outcomes? 3. Does the team plan how to measure the project's outcomes? 4. Does the team plan how to isolate (or minimize) the multiple interferences (technical bugs and constraints, teacher's impacts on the learning process, etc) in the outcomes?

By doing so, our study makes a major contribution to the point highlighted by Tseklevs, Cosmas and Aggoun (2014) and Hébert, Jenson, and Terzopoulos (2021). These authors remarked on the importance of considering the actual - and not an ideal one - classroom before developing a GBL. Since the ideal classroom is hard to find, taking the proposed dimensions into account is crucial to customize the intervention to each school's needs.

Our checklist joins the challenges we faced, and the ones presented by the authors previously cited. To do so, we organized their findings under the dimensions we coded, as presented in figure 2.

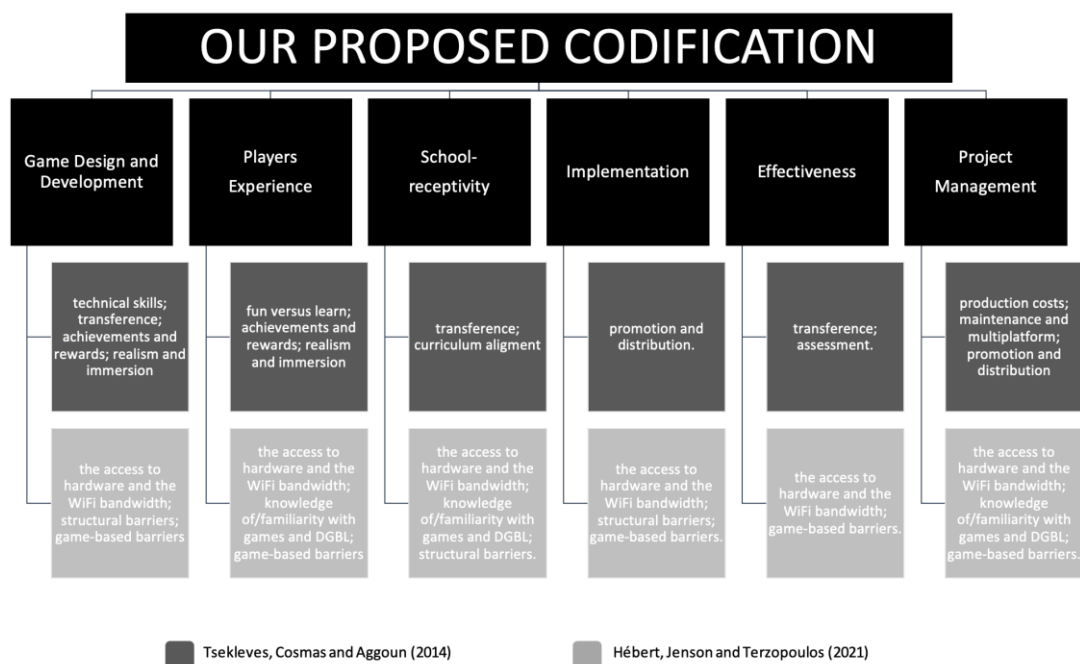


Figure 2: Framework for coding "failures" on the different steps of operationalization procedures and comparison with previous approaches

We considered this approach relevant because, although the obstacles are commonly described in the literature, they are found in an unstructured way, being necessary to look across several papers to compile meaningful ones. These were the only authors we detected who tabulated them.

Tseklevs, Cosmas, and Aggoun (2014) collected the benefits and challenges presented in 34 studies published between 2002-2012 and coded them. Their aim was to help stakeholders in developing actions and policies toward the inclusion of serious games in formal educational spaces.

Hébert, Jenson, and Terzopoulos (2021) focused on the teachers' voice to present the barriers to digital GBL in classrooms, and named the main challenges mentioned by the group.

We highlight that Tseklevs, Cosmas, and Aggoun (2014) tag as benefits issues that designers can interpret as challenges, like the "achievements and rewards". It increases the students' engagement with the scholar curriculum, but the development of the scoring mechanisms demands great effort. For our paper purposes, it can be included among the "game design and development" challenges and the "players' experiences" issues. Similarly, the authors codify "realism and immersion" under the benefits list, which is positive under the learning purposes lenses but very challenging to developers. On the other hand, the barriers they list were also faced by our team. Among the technical and financial ones, they include "technical skills", "maintenance and

multiplatform”, and “production costs”. “Promotion and distribution”, which means promoting the game through diverse media channels is also under the technical and financial umbrella. The other group of barriers is educational, containing “transference” (guaranteeing that the learning topics presented through the game are really transferred as knowledge in the real world); “assessment” (mechanisms able to measure the players’ learning performance); “fun versus learn” (distinguishing the games that are branded as educational from the ones that truly are serious games), and “curriculum alignment” (mandatory linkage between the school curriculum and the game’s learning aims). These items were distributed under several of our domains.

Hébert, Jenson, and Terzopoulos (2021) code “the access to hardware and the WiFi bandwidth” (access to up-to-date and undamaged devices; proper internet speed, licenses and network; logging time considering the classes length); “Knowledge of/familiarity with games and DGBL (digital game-based learning)” (connections between the games available and their curriculum; lack of confidence in using GBL); “Structural barriers” (lacks of support from the school community; compromise of attending the curriculum expectations agreed in the school's assembly); “Game-based barriers” (supportive tools to teachers; inclusion of all activities materials into the game, to keep the immersive experience). All these obstacles impact more than one of our domains.

Conclusion

This paper identified and expanded on the existing literature problems that may limit the success of a GBL, to contribute to a successful outcome. The checklist developed through the errors we committed, added to the ones found in previous studies, aims to contribute to a successful outcome of GBL interventions. Although we are conscious that the challenges and concerns differ much worldwide, as there are multiple social and educational cultures and inequalities, we genuinely believe this checklist can be a useful tool in many sceneries and realities and helps to define realistic outcomes to GBL.

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III. Conclusions and Final Remarks

The results from this thesis show that web-based interventions significantly contribute to promote health behaviour change among adolescents, maintaining reasonable levels of acceptability and feasibility. Specifically, the effectiveness of the interventions was reflected in increased physical activity, decreased harmful alcohol use, improved attitudes, self-efficacy, assertiveness skills, intentions to communicate and knowledge concerning to sexual behaviours, decreased intention to smoke, and increased fruit and vegetables consumption. However, the majority of studies are of low quality of evidence. Critical points seem to be mainly related to sampling issues, representativeness of populations, absence of blinding and lack of assessment of long-term maintenance of behaviours.

In addition, the case study of the PLATE project, identified problems that may mitigate the success of a game-based-learning and developed a checklist suggesting that planning an intervention conscious of the potential barriers, will help to ensure a successful web-based intervention.

Writing this dissertation has been an enriching experience both personally and professionally. Being able to perform different roles, namely as a researcher in a real project (manuscript 2) and as an academic reviewer of others projects (manuscript 1) allowed me to see and experience the difficulties, uncertainties, and the decisions we need to make to obtain scientific knowledge.

Therefore, the findings from both manuscripts complement each other, the present dissertation tried to encompass a closer dialogue between health promotion research in practice and the point of view of reviewers. This was achieved by participating in both activities: conducting a systematic review as well as developing and testing a pilot web-based program. We suggest that, on one hand, the low-quality evidence found in manuscript 1 could be explained by the enormous challenges that planners often face during the development and implementation of their intervention. On the other hand, the lack of robust evidence to support web-based interventions' effectiveness will limit funding, which means fewer resources to conduct their research and consequently even more challenges. This act like a snowball, making both results indissociable.

As a reviewer, we found studies that often fail to recruit representative samples of the target population. But as a researcher, I experienced the difficulties of researching in social settings that may have players (schools boards, teachers, parents, students) interacting with variable levels of engagement and receptivity.

Another example of the learnings of a dual role was related to intervention time. We also must consider the time and resources that researchers have available since some funding's are very

restricted and limited time wise, for example, the PLATE project only had one year to be fully developed, improved, and implemented. These barriers underlined our findings from systematic review, as many papers had a pilot nature and no representative samples. While for researchers the convenience samples are a needed limitation to be able to conduct the study, for reviewers it may not be a reliable source to draw conclusions about the population.

The study design is another concern for researchers. It is well-known that randomized controlled trials are the best source of evidence to test the effectiveness of an intervention. However, in practice issues may arise that hinder the research team in conducting the intended study methodology. In PLATE, the reluctance and disinterest of school boards in being a control group made it difficult to conduct an experimental study. In our sample of included articles, we realized that half also failed in conducting a randomized controlled trial.

In our systematic review, we largely found non-blind designs. The content of health promotion interventions is usually intention-revealing by default, being difficult to blind participants regarding the study objectives. Despite that, web-based intervention may be implemented without any face-to-face contact between experimenters and subjects. Double or even triple blinding studies are not a common practice in these interventions. However, we suggest this should be a good practice for future researchers, since ensuring experimenters and/or analysts being unaware of participants allocation is easier in web-based interventions with online data collection than it is in face-to-face interventions or assessments.

Other important lessons from this work suggest that being aware of all the main domains assessed in risk of bias tools used in our research field will help experimenters to plan and conduct more quality evidence studies, overcoming the problem of unclear data.

As showed in our review, health promotion interventions targeting this young age group are often implemented in school settings, this is also true for web-based interventions. This is a preferred setting for health promotion planners because educational institutions have everyday contact with almost every adolescent during a large part of their day. Even though educational content is an invaluable component of health behaviour change, it is not enough as also demonstrated in the PLATE project. So, to effectively achieve and promote maintenance of health behaviour change, educational interventions should strongly rely on health behaviour change theories. Educational contents should aim to improve awareness and skills of the targeted subject, using tailored content to better respond to users' needs and expectations.

Although we reinforce the potential benefits of web-based interventions to promote health behaviour changes among adolescents, we also underline that implementation challenges and barriers are compromising the evidence found to support its effectiveness. So, we suggest that grant funders should increase financial and time resources available to researchers. Consequently, this will help with theory-based review, the development of the intervention, the pilot user testing, the improvement of the intervention in line with the previous feedback and also the overall testing of the intervention. Likewise, researchers should invest their valuable resources and strengths to evaluate prior promising web-based interventions in larger randomized controlled trials, with samples with representativeness, application of a blinded design and testing long-term maintenance of these health behaviour changes (time of follow-up > 6 months).

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Annex and Appendix

Annex 1 - BCT Taxonomy retrieved from Michie, S., et al. (2013).

Grouping and BCTs	Grouping and BCTs	Grouping and BCTs
1. Goals and planning	6. Comparison of behaviour	12. Antecedents
1.1. Goal setting (behaviour)	6.1. Demonstration of the behaviour	12.1. Restructuring the physical environment
1.2. Problem solving	6.2. Social comparison	12.2. Restructuring the social environment
1.3. Goal setting (outcome)	6.3. Information about others' approval	12.3. Avoidance/reducing exposure to cues for the behaviour
1.4. Action planning	7. Associations	12.4. Distraction
1.5. Review behaviour goal(s)	7.1. Prompts/cues	12.5. Adding objects to the environment
1.6. Discrepancy between current behaviour and goal	7.2. Cue signalling reward	12.6. Body changes
1.7. Review outcome goal(s)	7.3. Reduce prompts/cues	13. Identity
1.8. Behavioural contract	7.4. Remove access to the reward	13.1. Identification of self as role model
1.9. Commitment	7.5. Remove aversive stimulus	13.2. Framing/reframing
2. Feedback and monitoring	7.6. Satiation	13.3. Incompatible beliefs
2.1. Monitoring of behaviour by others without feedback	7.7. Exposure	13.4. Valued self-identify
2.2. Feedback on behaviour	7.8. Associative learning	13.5. Identity associated with changed behaviour
2.3. Self-monitoring of behaviour	8. Repetition and substitution	14. Scheduled consequences
2.4. Self-monitoring of outcome(s) of behaviour	8.1. Behavioural practice/rehearsal	14.1. Behaviour cost
2.5. Monitoring of outcome(s) of behaviour without feedback	8.2. Behaviour substitution	14.2. Punishment
2.6. Biofeedback	8.3. Habit formation	14.3. Remove reward
2.7. Feedback on outcome(s) of behaviour	8.4. Habit reversal	14.4. Reward approximation
3. Social support	8.5. Overcorrection	14.5. Rewarding completion
3.1. Social support (unspecified)	8.6. Generalisation of target behaviour	14.6. Situation-specific reward
3.2. Social support (practical)	8.7. Graded tasks	14.7. Reward incompatible behaviour
3.3. Social support (emotional)	9. Comparison of outcomes	14.8. Reward alternative behaviour
4. Shaping knowledge	9.1. Credible source	14.9. Reduce reward frequency
4.1. Instruction on how to perform the behaviour	9.2. Pros and cons	14.10. Remove punishment
4.2. Information about Antecedents	9.3. Comparative imagining of future outcomes	15. Self-belief
4.3. Re-attribution	10. Reward and threat	15.1. Verbal persuasion about capability
4.4. Behavioural experiments	10.1. Material incentive (behaviour)	15.2. Mental rehearsal of successful performance
5. Natural consequences	10.2. Material reward (behaviour)	15.3. Focus on past success
5.1. Information about health consequences	10.3. Non-specific reward	15.4. Self-talk
5.2. Salience of consequences	10.4. Social reward	16. Covert learning
5.3. Information about social and environmental consequences	10.5. Social incentive	16.1. Imaginary punishment
5.4. Monitoring of emotional consequences	10.6. Non-specific incentive	16.2. Imaginary reward
5.5. Anticipated regret	10.7. Self-incentive	16.3. Vicarious consequences
5.6. Information about emotional consequences	10.8. Incentive (outcome)	
	10.9. Self-reward	
	10.10. Reward (outcome)	
	10.11. Future punishment	
	11. Regulation	
	11.1. Pharmacological support	
	11.2. Reduce negative emotions	
	11.3. Conserving mental resources	
	11.4. Paradoxical instructions	

Annex 2 – BCT’s definitions retrieved from Michie, S., et al. (2013).

Note for Users

The definitions of Behaviour Change Techniques (BCTs):

- i. contain verbs (e.g., provide, advise, arrange, prompt) that refer to the action(s) taken by the person/s delivering the technique. BCTs can be delivered by an ‘interventionist’ or self-delivered
- ii. contain the term “behaviour” referring to a single action or sequence of actions that includes the performance of wanted behaviour(s) and/or inhibition (non-performance) of unwanted behaviour(s)
- iii. note alternative or additional coding where relevant
- iv. note the technical terms associated with particular theoretical frameworks where relevant (e.g. ‘including implementation intentions)

No.	Label	Definition	Examples
1. Goals and planning			
1.1	Goal setting (behaviour)	Set or agree on a goal defined in terms of the behaviour to be achieved <i>Note: only code goal-setting if there is sufficient evidence that goal set as part of intervention; if goal unspecified or a behavioural outcome, code 1.3, Goal setting (outcome); if the goal defines a specific context, frequency, duration or intensity for the behaviour, <u>also</u> code 1.4, Action planning</i>	Agree on a daily walking goal (e.g. 3 miles) with the person and reach agreement about the goal Set the goal of eating 5 pieces of fruit per day as specified in public health guidelines
1.2	Problem solving	Analyse , or prompt the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitators (includes ‘ Relapse Prevention ’ and ‘ Coping Planning ’) <i>Note: barrier identification without solutions is not sufficient. If the BCT does not include analysing the behavioural problem, consider 12.3, Avoidance/changing exposure to cues for the behaviour, 12.1, Restructuring the physical environment, 12.2, Restructuring the social environment, or 11.2, Reduce negative emotions</i>	Identify specific triggers (e.g. being in a pub, feeling anxious) that generate the urge/want/need to drink and develop strategies for avoiding environmental triggers or for managing negative emotions, such as anxiety, that motivate drinking Prompt the patient to identify barriers preventing them from starting a new exercise regime e.g., lack of motivation, and discuss ways in which they could help overcome them e.g., going to the gym with a buddy

1.3	Goal setting (outcome)	Set or agree on a goal defined in terms of a positive outcome of wanted behaviour <i>Note: only code guidelines if set as a goal in an intervention context; if goal is a behaviour, code 1.1, Goal setting (behaviour); if goal unspecified code 1.3, Goal setting (outcome)</i>	Set a weight loss goal (e.g. 0.5 kilogram over one week) as an outcome of changed eating patterns
1.4	Action planning	Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive) (includes ' Implementation Intentions ') <i>Note: evidence of action planning does not necessarily imply goal setting, only code latter if sufficient evidence</i>	Encourage a plan to carry condoms when going out socially at weekends Prompt planning the performance of a particular physical activity (e.g. running) at a particular time (e.g. before work) on certain days of the week
1.5	Review behaviour goal(s)	Review behaviour goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of (or in addition to) the first, or no change <i>Note: if goal specified in terms of behaviour, code 1.5, Review behaviour goal(s), if goal unspecified, code 1.7, Review outcome goal(s); if discrepancy created consider also 1.6, Discrepancy between current behaviour and goal</i>	Examine how well a person's performance corresponds to agreed goals e.g. whether they consumed less than one unit of alcohol per day, and consider modifying future behavioural goals accordingly e.g. by increasing or decreasing alcohol target or changing type of alcohol consumed
1.6	Discrepancy between current behaviour and goal	Draw attention to discrepancies between a person's current behaviour (in terms of the <i>form, frequency, duration, or intensity</i> of that behaviour) and the person's previously set outcome goals, behavioural goals or action plans (goes beyond self-monitoring of behaviour) <i>Note: if discomfort is created only code 13.3, Incompatible beliefs and not 1.6, Discrepancy between current behaviour and goal; if goals are modified, also code 1.5, Review behaviour goal(s) and/or 1.7, Review outcome goal(s); if feedback is provided, also code 2.2, Feedback on behaviour</i>	Point out that the recorded exercise fell short of the goal set
1.7	Review outcome goal(s)	Review outcome goal(s) jointly with the person and consider modifying goal(s) in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of, or in addition to the first <i>Note: if goal specified in terms of behaviour, code 1.5, Review behaviour goal(s), if goal unspecified, code 1.7,</i>	Examine how much weight has been lost and consider modifying outcome goal(s) accordingly e.g., by increasing or decreasing

		Review outcome goal(s); if discrepancy created consider also 1.6, Discrepancy between current behaviour and goal	subsequent weight loss targets
1.8	Behavioural contract	Create a written specification of the behaviour to be performed, agreed on by the person, and witnessed by another <i>Note: also code 1.1, Goal setting (behaviour)</i>	Sign a contract with the person e.g. specifying that they will not drink alcohol for one week
1.9	Commitment	Ask the person to affirm or reaffirm statements indicating commitment to change the behaviour <i>Note: if defined in terms of the behaviour to be achieved also code 1.1, Goal setting (behaviour)</i>	Ask the person to use an "I will" statement to affirm or reaffirm a strong commitment (i.e. using the words "strongly", "committed" or "high priority") to start, continue or restart the attempt to take medication as prescribed
2. Feedback and monitoring			
2.1	Monitoring of behaviour by others without feedback	Observe or record behaviour with the person's knowledge as part of a behaviour change strategy <i>Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only 2.2, Feedback on behaviour, and not 2.1, Monitoring of behaviour by others without feedback; if monitoring outcome(s) code 2.5, Monitoring outcome(s) of behaviour by others without feedback; if self-monitoring behaviour, code 2.3, Self-monitoring of behaviour</i>	Watch hand washing behaviours among health care staff and make notes on context, frequency and technique used
2.2	Feedback on behaviour	Monitor and provide informative or evaluative feedback on performance of the behaviour (e.g. form, frequency, duration, intensity) <i>Note: if Biofeedback, code only 2.6, Biofeedback and not 2.2, Feedback on behaviour; if feedback is on outcome(s) of behaviour, code 2.7, Feedback on outcome(s) of behaviour; if there is no clear evidence that feedback was given, code 2.1, Monitoring of behaviour by others without feedback; if feedback on behaviour is evaluative e.g. praise, also code 10.4, Social reward</i>	Inform the person of how many steps they walked each day (as recorded on a pedometer) or how many calories they ate each day (based on a food consumption questionnaire).
2.3	Self-monitoring of behaviour	Establish a method for the person to monitor and record their behaviour(s) as part of a behaviour change strategy <i>Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if monitoring of outcome of behaviour, code 2.4, Self-monitoring of outcome(s) of behaviour; if monitoring is by someone else (without feedback), code 2.1, Monitoring of behaviour by others without feedback</i>	Ask the person to record daily, in a diary, whether they have brushed their teeth for at least two minutes before going to bed Give patient a pedometer and a form for recording

			daily total number of steps
2.4	Self-monitoring of outcome(s) of behaviour	Establish a method for the person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy <i>Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code ; if monitoring behaviour, code 2.3, Self-monitoring of behaviour; if monitoring is by someone else (without feedback), code 2.5, Monitoring outcome(s) of behaviour by others without feedback</i>	Ask the person to weigh themselves at the end of each day, over a two week period, and record their daily weight on a graph to increase exercise behaviours
2.5	Monitoring outcome(s) of behaviour by others without feedback	Observe or record outcomes of behaviour with the person's knowledge as part of a behaviour change strategy <i>Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only 2.7, Feedback on outcome(s) of behaviour; if monitoring behaviour code 2.1, Monitoring of behaviour by others without feedback; if self-monitoring outcome(s), code 2.4, Self-monitoring of outcome(s) of behaviour</i>	Record blood pressure, blood glucose, weight loss, or physical fitness
2.6	Biofeedback	Provide feedback about the body (e.g. physiological or biochemical state) using an external monitoring device as part of a behaviour change strategy <i>Note: if Biofeedback, code only 2.6, Biofeedback and <u>not</u> 2.2, Feedback on behaviour or 2.7, Feedback on outcome(s) of behaviour</i>	Inform the person of their blood pressure reading to improve adoption of health behaviours
2.7	Feedback on outcome(s) of behaviour	Monitor and provide feedback on the outcome of performance of the behaviour <i>Note: if Biofeedback, code only 2.6, Biofeedback and <u>not</u> 2.7, Feedback on outcome(s) of behaviour; if feedback is on behaviour code 2.2, Feedback on behaviour; if there is no clear evidence that feedback was given code 2.5, Monitoring outcome(s) of behaviour by others without feedback; if feedback on behaviour is evaluative e.g. praise, also code 10.4, Social reward</i>	Inform the person of how much weight they have lost following the implementation of a new exercise regime
3. Social support			
3.1	Social support (unspecified)	Advise on, arrange or provide social support (e.g. from friends, relatives, colleagues, 'buddies' or staff) or non-contingent praise or reward for performance of the behaviour. It includes encouragement and counselling, but only when it is directed at the behaviour <i>Note: attending a group class and/or mention of 'follow-up' does not necessarily apply this BCT, support must be explicitly mentioned; if practical, code 3.2, Social support (practical); if emotional, code 3.3, Social support</i>	Advise the person to call a 'buddy' when they experience an urge to smoke Arrange for a housemate to encourage continuation with the

		(emotional) (includes ' Motivational interviewing ' and ' Cognitive Behavioural Therapy ') 	behaviour change programme Give information about a self-help group that offers support for the behaviour
3.2	Social support (practical)	Advise on, arrange, or provide practical help (<i>e.g. from friends, relatives, colleagues, 'buddies' or staff</i>) for performance of the behaviour <i>Note: if emotional, code 3.3, Social support (emotional); if general or unspecified, code 3.1, Social support (unspecified) If only restructuring the physical environment or adding objects to the environment, code 12.1, Restructuring the physical environment or 12.5, Adding objects to the environment; attending a group or class and/or mention of 'follow-up' does not necessarily apply this BCT, support must be explicitly mentioned.</i>	Ask the partner of the patient to put their tablet on the breakfast tray so that the patient remembers to take it
3.3	Social support (emotional)	Advise on, arrange, or provide emotional social support (<i>e.g. from friends, relatives, colleagues, 'buddies' or staff</i>) for performance of the behaviour <i>Note: if practical, code 3.2, Social support (practical); if unspecified, code 3.1, Social support (unspecified)</i>	Ask the patient to take a partner or friend with them to their colonoscopy appointment
4. Shaping knowledge			
4.1	Instruction on how to perform a behaviour	Advise or agree on how to perform the behaviour (includes ' Skills training ') <i>Note: when the person attends classes such as exercise or cookery, code 4.1, Instruction on how to perform the behaviour, 8.1, Behavioural practice/rehearsal and 6.1, Demonstration of the behaviour</i>	Advise the person how to put a condom on a model of a penis correctly
4.2	Information about antecedents	Provide information about antecedents (<i>e.g. social and environmental situations and events, emotions, cognitions</i>) that reliably predict performance of the behaviour	Advise to keep a record of snacking and of situations or events occurring prior to snacking
4.3	Re-attribution	Elicit perceived causes of behaviour and suggest alternative explanations (<i>e.g. external or internal and stable or unstable</i>)	If the person attributes their over-eating to the frequent presence of delicious food, suggest that the 'real' cause may be the person's inattention to bodily signals of hunger and satiety
4.4	Behavioural experiments	Advise on how to identify and test hypotheses about the behaviour, its causes and consequences, by collecting and interpreting data	Ask a family physician to give evidence-based advice rather than prescribe antibiotics and to

			note whether the patients are grateful or annoyed
5. Natural consequences			
5.1	Information about health consequences	Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour <i>Note: consequences can be for any target, not just the recipient(s) of the intervention; emphasising importance of consequences is not sufficient; if information about emotional consequences, code 5.6, Information about emotional consequences; if about social, environmental or unspecified consequences code 5.3, Information about social and environmental consequences</i>	Explain that not finishing a course of antibiotics can increase susceptibility to future infection Present the likelihood of contracting a sexually transmitted infection following unprotected sexual behaviour
5.2	Salience of consequences	Use methods specifically designed to emphasise the consequences of performing the behaviour with the aim of making them more memorable (goes beyond informing about consequences) <i>Note: if information about consequences, also code 5.1, Information about health consequences, 5.6, Information about emotional consequences or 5.3, Information about social and environmental consequences</i>	Produce cigarette packets showing pictures of health consequences e.g. diseased lungs, to highlight the dangers of continuing to smoke
5.3	Information about social and environmental consequences	Provide information (e.g. written, verbal, visual) about social and environmental consequences of performing the behaviour <i>Note: consequences can be for any target, not just the recipient(s) of the intervention; if information about health or consequences, code 5.1, Information about health consequences; if about emotional consequences, code 5.6, Information about emotional consequences; if unspecified, code 5.3, Information about social and environmental consequences</i>	Tell family physician about financial remuneration for conducting health screening Inform a smoker that the majority of people disapprove of smoking in public places
5.4	Monitoring of emotional consequences	Prompt assessment of feelings after attempts at performing the behaviour	Agree that the person will record how they feel after taking their daily walk
5.5	Anticipated regret	Induce or raise awareness of expectations of future regret about performance of the unwanted behaviour <i>Note: <u>not</u> including 5.6, Information about emotional consequences; if suggests adoption of a perspective or new perspective in order to change cognitions <u>also</u> code 13.2, Framing/reframing</i>	Ask the person to assess the degree of regret they will feel if they do not quit smoking
5.6	Information about emotional consequences	Provide information (e.g. written, verbal, visual) about emotional consequences of performing the behaviour <i>Note: consequences can be related to emotional health disorders (e.g. depression, anxiety) and/or states of mind (e.g. low mood, stress); <u>not</u> including 5.5, Anticipated regret; consequences can be for any target, not just the</i>	Explain that quitting smoking increases happiness and life satisfaction

		recipient(s) of the intervention; if information about health consequences code 5.1, Information about health consequences ; if about social, environmental or unspecified code 5.3, Information about social and environmental consequences	
6. Comparison of behaviour			
6.1	Demonstration of the behaviour	Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g. via film, pictures, for the person to aspire to or imitate (includes ' Modelling '). <i>Note: if advised to practice, also code, 8.1, Behavioural practice and rehearsal; If provided with instructions on how to perform, also code 4.1, Instruction on how to perform the behaviour</i>	Demonstrate to nurses how to raise the issue of excessive drinking with patients via a role-play exercise
6.2	Social comparison	Draw attention to others' performance to allow comparison with the person's own performance <i>Note: being in a group setting does not necessarily mean that social comparison is actually taking place</i>	Show the doctor the proportion of patients who were prescribed antibiotics for a common cold by other doctors and compare with their own data
6.3	Information about others' approval	Provide information about what other people think about the behaviour. The information clarifies whether others will like, approve or disapprove of what the person is doing or will do	Tell the staff at the hospital ward that staff at all other wards approve of washing their hands according to the guidelines
7. Associations			
7.1	Prompts/cues	Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance <i>Note: when a stimulus is linked to a specific action in an if-then plan including one or more of frequency, duration or intensity also code 1.4, Action planning.</i>	Put a sticker on the bathroom mirror to remind people to brush their teeth
7.2	Cue signalling reward	Identify an environmental stimulus that reliably predicts that reward will follow the behaviour (includes ' Discriminative cue ')	Advise that a fee will be paid to dentists for a particular dental treatment of 6-8 year old, but not older, children to encourage delivery of that treatment (the 6-8

			year old children are the environmental stimulus)
7.3	Reduce prompts/cues	Withdraw gradually prompts to perform the behaviour (includes <u>Fading</u>)	Reduce gradually the number of reminders used to take medication
7.4	Remove access to the reward	Advise or arrange for the person to be separated from situations in which unwanted behaviour can be rewarded in order to reduce the behaviour (includes <u>Time out</u>)	Arrange for cupboard containing high calorie snacks to be locked for a specified period to reduce the consumption of sugary foods in between meals
7.5	Remove aversive stimulus	Advise or arrange for the removal of an aversive stimulus to facilitate behaviour change (includes <u>Escape learning</u>)	Arrange for a gym-buddy to stop nagging the person to do more exercise in order to increase the desired exercise behaviour
7.6	Satiation	Advise or arrange repeated exposure to a stimulus that reduces or extinguishes a drive for the unwanted behaviour	Arrange for the person to eat large quantities of chocolate, in order to reduce the person's appetite for sweet foods
7.7	Exposure	Provide systematic confrontation with a feared stimulus to reduce the response to a later encounter	Agree a schedule by which the person who is frightened of surgery will visit the hospital where they are scheduled to have surgery
7.8	Associative learning	Present a neutral stimulus jointly with a stimulus that already elicits the behaviour repeatedly until the neutral stimulus elicits that behaviour (includes <u>'Classical/Pavlovian Conditioning'</u>) <i>Note: when a BCT involves reward or punishment, code one or more of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Present repeatedly fatty foods with a disliked sauce to discourage the consumption of fatty foods
8. Repetition and substitution			
8.1	Behavioural practice/rehearsal	Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill	Prompt asthma patients to practice measuring their peak flow in the nurse's consulting room

		<i>Note: if aiming to associate performance with the context, <u>also</u> code 8.3, Habit formation</i>	
8.2	<i>Behaviour substitution</i>	Prompt substitution of the unwanted behaviour with a wanted or neutral behaviour <i>Note: if this occurs regularly, <u>also</u> code 8.4, Habit reversal</i>	Suggest that the person goes for a walk rather than watches television
8.3	<i>Habit formation</i>	Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour <i>Note: <u>also</u> code 8.1, Behavioural practice/rehearsal</i>	Prompt patients to take their statin tablet before brushing their teeth every evening
8.4	<i>Habit reversal</i>	Prompt rehearsal and repetition of an alternative behaviour to replace an unwanted habitual behaviour <i>Note: <u>also</u> code 8.2, Behaviour substitution</i>	Ask the person to walk up stairs at work where they previously always took the lift
8.5	<i>Overcorrection</i>	Ask to repeat the wanted behaviour in an exaggerated way following an unwanted behaviour	Ask to eat <u>only</u> fruit and vegetables the day after a poor diet
8.6	<i>Generalisation of a target behaviour</i>	Advise to perform the wanted behaviour, which is already performed in a particular situation, in another situation	Advise to repeat toning exercises learned in the gym when at home
8.7	<i>Graded tasks</i>	Set easy-to-perform tasks, making them increasingly difficult, but achievable, until behaviour is performed	Ask the person to walk for 100 yards a day for the first week, then half a mile a day after they have successfully achieved 100 yards, then two miles a day after they have successfully achieved one mile
9. Comparison of outcomes			
9.1	<i>Credible source</i>	Present verbal or visual communication from a credible source in favour of or against the behaviour <i>Note: code this BCT if source generally agreed on as credible e.g., health professionals, celebrities or words used to indicate expertise or leader in field and if the communication has the aim of persuading; if information about health consequences, <u>also</u> code 5.1, Information about health consequences, if about emotional consequences, <u>also</u> code 5.6, Information about emotional consequences; if about social, environmental or unspecified consequences <u>also</u> code 5.3, Information about social and environmental consequences</i>	Present a speech given by a high status professional to emphasise the importance of not exposing patients to unnecessary radiation by ordering x-rays for back pain
9.2	<i>Pros and cons</i>	Advise the person to identify and compare reasons for wanting (pros) and not wanting to (cons) change the behaviour (includes ' Decisional balance ') <i>Note: if providing information about health consequences, <u>also</u> code 5.1, Information about health consequences; if providing information about emotional consequences,</i>	Advise the person to list and compare the advantages and disadvantages of prescribing antibiotics for upper

		<i>also code 5.6, Information about emotional consequences; if providing information about social, environmental or unspecified consequences also code 5.3, Information about social and environmental consequences</i>	respiratory tract infections
9.3	Comparative imagining of future outcomes	Prompt or advise the imagining and comparing of future outcomes of changed versus unchanged behaviour	Prompt the person to imagine and compare likely or possible outcomes following attending versus not attending a screening appointment
10. Reward and threat			
10.1	Material incentive (behaviour)	Inform that money, vouchers or other valued objects will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes ' Positive reinforcement ') <i>Note: if incentive is social, code 10.5, Social incentive if unspecified code 10.6, Non-specific incentive, and not 10.1, Material incentive (behaviour); if incentive is for outcome, code 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Inform that a financial payment will be made each month in pregnancy that the woman has not smoked
10.2	Material reward (behaviour)	Arrange for the delivery of money, vouchers or other valued objects if and only if there has been effort and/or progress in performing the behaviour (includes ' Positive reinforcement ') <i>Note: If reward is social, code 10.4, Social reward, if unspecified code 10.3, Non-specific reward, and not 10.1, Material reward (behaviour); if reward is for outcome, code 10.10, Reward (outcome). If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome)</i>	Arrange for the person to receive money that would have been spent on cigarettes if and only if the smoker has not smoked for one month
10.3	Non-specific reward	Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour (includes ' Positive reinforcement ') <i>Note: if reward is material, code 10.2, Material reward (behaviour), if social, code 10.4, Social reward, and not 10.3, Non-specific reward; if reward is for outcome code</i>	Identify something (e.g. an activity such as a visit to the cinema) that the person values and arrange for this to be

		10.10, Reward (outcome). If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome)	delivered if and only if they attend for health screening
10.4	Social reward	Arrange verbal or non-verbal reward if and only if there has been effort and/or progress in performing the behaviour (includes ' Positive reinforcement ') <i>Note: if reward is material, code 10.2, Material reward (behaviour), if unspecified code 10.3, Non-specific reward, and not 10.4, Social reward; if reward is for outcome code 10.10, Reward (outcome). If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome)</i>	Congratulate the person for each day they eat a reduced fat diet
10.5	Social incentive	Inform that a verbal or non-verbal reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes ' Positive reinforcement ') <i>Note: if incentive is material, code 10.1, Material incentive (behaviour), if unspecified code 10.6, Non-specific incentive, and not 10.5, Social incentive; if incentive is for outcome code 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Inform that they will be congratulated for each day they eat a reduced fat diet
10.6	Non-specific incentive	Inform that a reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes ' Positive reinforcement ') <i>Note: if incentive is material, code 10.1, Material incentive (behaviour), if social, code 10.5, Social incentive and not 10.6, Non-specific incentive; if incentive is for outcome code 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Identify an activity that the person values and inform them that this will happen if and only if they attend for health screening
10.7	Self-incentive	Plan to reward self in future if and only if there has been effort and/or progress in performing the behaviour <i>Note: if self-reward is material, also code 10.1, Material incentive (behaviour), if social, also code 10.5, Social incentive, if unspecified, also code 10.6, Non-specific incentive; if incentive is for outcome code 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Encourage to provide self with material (e.g., new clothes) or other valued objects if and only if they have adhered to a healthy diet
10.8	Incentive (outcome)	Inform that a reward will be delivered if and only if there has been effort and/or progress in achieving the behavioural outcome (includes ' Positive reinforcement ')	Inform the person that they will receive money if and only if a

		<i>Note: this includes social, material, self- and non-specific incentives for outcome; if incentive is for the behaviour code 10.5, Social incentive, 10.1, Material incentive (behaviour), 10.6, Non-specific incentive or 10.7, Self-incentive and <u>not</u> 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	certain amount of weight is lost
10.9	Self-reward	Prompt self-praise or self-reward if and only if there has been effort and/or progress in performing the behaviour <i>Note: if self-reward is material, <u>also</u> code 10.2, Material reward (behaviour), if social, <u>also</u> code 10.4, Social reward, if unspecified, <u>also</u> code 10.3, Non-specific reward; if reward is for outcome code 10.10, Reward (outcome). If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome)</i>	Encourage to reward self with material (e.g., new clothes) or other valued objects if and only if they have adhered to a healthy diet
10.10	Reward (outcome)	Arrange for the delivery of a reward if and only if there has been effort and/or progress in achieving the behavioural outcome (includes ' Positive reinforcement ') <i>Note: this includes social, material, self- and non-specific rewards for outcome; if reward is for the behaviour code 10.4, Social reward, 10.2, Material reward (behaviour), 10.3, Non-specific reward or 10.9, Self-reward and <u>not</u> 10.10, Reward (outcome). If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome)</i>	Arrange for the person to receive money if and only if a certain amount of weight is lost
10.11	Future punishment	Inform that future punishment or removal of reward will be a consequence of performance of an unwanted behaviour (may include fear arousal) (includes ' Threat ')	Inform that continuing to consume 30 units of alcohol per day is likely to result in loss of employment if the person continues
11. Regulation			
11.1	Pharmacological support	Provide, or encourage the use of or adherence to, drugs to facilitate behaviour change <i>Note: if pharmacological support to reduce negative emotions (i.e. anxiety) then <u>also</u> code 11.2, Reduce negative emotions</i>	Suggest the patient asks the family physician for nicotine replacement therapy to facilitate smoking cessation
11.2	Reduce negative emotions^b	Advise on ways of reducing negative emotions to facilitate performance of the behaviour (includes ' Stress Management ') <i>Note: if includes analysing the behavioural problem, <u>also</u> code 1.2, Problem solving</i>	Advise on the use of stress management skills, e.g. to reduce anxiety about joining Alcoholics Anonymous

11.3	Conserving mental resources	Advise on ways of minimising demands on mental resources to facilitate behaviour change	Advise to carry food calorie content information to reduce the burden on memory in making food choices
11.4	Paradoxical instructions	Advise to engage in some form of the unwanted behaviour with the aim of reducing motivation to engage in that behaviour	Advise a smoker to smoke twice as many cigarettes a day as they usually do Tell the person to stay awake as long as possible in order to reduce insomnia
12. Antecedents			
12.1	Restructuring the physical environment	Change, or advise to change the physical environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments) <i>Note: this may also involve 12.3, Avoidance/reducing exposure to cues for the behaviour; if restructuring of the social environment code 12.2, Restructuring the social environment; if only adding objects to the environment, code 12.5, Adding objects to the environment</i>	Advise to keep biscuits and snacks in a cupboard that is inconvenient to get to Arrange to move vending machine out of the school
12.2	Restructuring the social environment	Change, or advise to change the social environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments) <i>Note: this may also involve 12.3, Avoidance/reducing exposure to cues for the behaviour; if also restructuring of the physical environment also code 12.1, Restructuring the physical environment</i>	Advise to minimise time spent with friends who drink heavily to reduce alcohol consumption
12.3	Avoidance/reducing exposure to cues for the behaviour	Advise on how to avoid exposure to specific social and contextual/physical cues for the behaviour, including changing daily or weekly routines <i>Note: this may also involve 12.1, Restructuring the physical environment and/or 12.2, Restructuring the social environment; if the BCT includes analysing the behavioural problem, only code 1.2, Problem solving</i>	Suggest to a person who wants to quit smoking that their social life focus on activities other than pubs and bars which have been associated with smoking
12.4	Distraction	Advise or arrange to use an alternative focus for attention to avoid triggers for unwanted behaviour	Suggest to a person who is trying to avoid between-meal snacking to focus on a topic they enjoy (e.g. holiday plans) instead of focusing on food

12.5	Adding objects to the environment	Add objects to the environment in order to facilitate performance of the behaviour <i>Note: Provision of information (e.g. written, verbal, visual) in a booklet or leaflet is insufficient. If this is accompanied by social support, also code 3.2, Social support (practical); if the environment is changed beyond the addition of objects, also code 12.1, Restructuring the physical environment</i>	Provide free condoms to facilitate safe sex Provide attractive toothbrush to improve tooth brushing technique
12.6	Body changes	Alter body structure, functioning or support directly to facilitate behaviour change	Prompt strength training, relaxation training or provide assistive aids (e.g. a hearing aid)
13. Identity			
13.1	Identification of self as role model	Inform that one's own behaviour may be an example to others	Inform the person that if they eat healthily, that may be a good example for their children
13.2	Framing/reframing	Suggest the deliberate adoption of a perspective or new perspective on behaviour (e.g. its purpose) in order to change cognitions or emotions about performing the behaviour (includes ' Cognitive structuring '); <i>If information about consequences then code 5.1, Information about health consequences, 5.6, Information about emotional consequences or 5.3, Information about social and environmental consequences instead of 13.2, Framing/reframing</i>	Suggest that the person might think of the tasks as reducing sedentary behaviour (rather than increasing activity)
13.3	Incompatible beliefs	Draw attention to discrepancies between current or past behaviour and self-image, in order to create discomfort (includes ' Cognitive dissonance ')	Draw attention to a doctor's liberal use of blood transfusion and their self-identification as a proponent of evidence-based medical practice
13.4	Valued self-identity	Advise the person to write or complete rating scales about a cherished value or personal strength as a means of affirming the person's identity as part of a behaviour change strategy (includes ' Self-affirmation ')	Advise the person to write about their personal strengths before they receive a message advocating the behaviour change
13.5	Identity associated with changed behaviour	Advise the person to construct a new self-identity as someone who 'used to engage with the unwanted behaviour'	Ask the person to articulate their new identity as an 'ex-smoker'

14. Scheduled consequences			
14.1	Behaviour cost	Arrange for withdrawal of something valued if and only if an unwanted behaviour is performed (includes ' Response cost '). Note if withdrawal of contingent reward code, 14.3, Remove reward	Subtract money from a prepaid refundable deposit when a cigarette is smoked
14.2	Punishment	Arrange for aversive consequence contingent on the performance of the unwanted behaviour	Arrange for the person to wear unattractive clothes following consumption of fatty foods
14.3	Remove reward	Arrange for discontinuation of contingent reward following performance of the unwanted behaviour (includes ' Extinction ')	Arrange for the other people in the household to ignore the person every time they eat chocolate (rather than attending to them by criticising or persuading)
14.4	Reward approximation	Arrange for reward following any approximation to the target behaviour, gradually rewarding only performance closer to the wanted behaviour (includes ' Shaping ') <i>Note: also code one of 59-63</i>	Arrange reward for any reduction in daily calories, gradually requiring the daily calorie count to become closer to the planned calorie intake
14.5	Rewarding completion	Build up behaviour by arranging reward following final component of the behaviour; gradually add the components of the behaviour that occur earlier in the behavioural sequence (includes ' Backward chaining ') <i>Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Reward eating a supplied low calorie meal; then make reward contingent on cooking and eating the meal; then make reward contingent on purchasing, cooking and eating the meal
14.6	Situation-specific reward	Arrange for reward following the behaviour in one situation but not in another (includes ' Discrimination training ') <i>Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Arrange reward for eating at mealtimes but not between meals
14.7	Reward incompatible behaviour	Arrange reward for responding in a manner that is incompatible with a previous response to that situation (includes ' Counter-conditioning ') <i>Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Arrange reward for ordering a soft drink at the bar rather than an alcoholic beverage

14.8	Reward alternative behaviour	Arrange reward for performance of an alternative to the unwanted behaviour (includes <u>'Differential reinforcement'</u>) <i>Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome); consider also coding 1.2, Problem solving</i>	Reward for consumption of low fat foods but not consumption of high fat foods
14.9	Reduce reward frequency	Arrange for rewards to be made contingent on increasing duration or frequency of the behaviour (includes <u>'Thinning'</u>) <i>Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</i>	Arrange reward for each day without smoking, then each week, then each month, then every 2 months and so on
14.10	Remove punishment	Arrange for removal of an unpleasant consequence contingent on performance of the wanted behaviour (includes <u>'Negative reinforcement'</u>)	Arrange for someone else to do housecleaning only if the person has adhered to the medication regimen for a week
15. Self-belief			
15.1	Verbal persuasion about capability	Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed	Tell the person that they can successfully increase their physical activity, despite their recent heart attack.
15.2	Mental rehearsal of successful performance	Advise to practise imagining performing the behaviour successfully in relevant contexts	Advise to imagine eating and enjoying a salad in a work canteen
15.3	Focus on past success	Advise to think about or list previous successes in performing the behaviour (or parts of it)	Advise to describe or list the occasions on which the person had ordered a non-alcoholic drink in a bar
15.4	Self-talk	Prompt positive self-talk (aloud or silently) before and during the behaviour	Prompt the person to tell themselves that a walk will be energising
16. Covert learning			
16.1	Imaginary punishment	Advise to imagine performing the unwanted behaviour in a real-life situation followed by imagining an unpleasant consequence (includes <u>'Covert sensitisation'</u>)	Advise to imagine overeating and then vomiting
16.2	Imaginary reward	Advise to imagine performing the wanted behaviour in a real-life situation followed by imagining a pleasant consequence (includes <u>'Covert conditioning'</u>)	Advise the health professional to imagine giving

			dietary advice followed by the patient losing weight and no longer being diabetic
16.3	<i>Vicarious consequences</i>	Prompt observation of the consequences (including rewards and punishments) for others when they perform the behaviour <i>Note: if observation of health consequences, also code 5.1, Information about health consequences; if of emotional consequences, <u>also</u> code 5.6, Information about emotional consequences, if of social, environmental or unspecified consequences, <u>also</u> code 5.3, Information about social and environmental consequences</i>	Draw attention to the positive comments other staff get when they disinfect their hands regularly

Annex 3 – Key questions to consider in phases of the development process for online health interventions extracted from Horvath, K. J., et al. (2015).

Phase Questions

Plan & Analyze: Intervention conception; team member involvement in the initial planning; hiring the vendor; adaptation of an existing website or curriculum, learning about the target audience, and formative research

Does the study coordinator have experience with online health intervention development and with communicating with vendor?

Does the study team include someone with experience in contract negotiations?

Does the study team include someone with experience in software programming?

Does the research team understand the target population, including their uptake of technologies, their computer literacy, and how they will react to various aspects of the intervention?

Did the research team allow enough time to conceptualize goals of the project and develop some of the content prior to meeting with the vendor?

Design: Defining the individual components of the websites; discussions about authoring and uploading content; and work processes with the vendor

Has the research team conducted an inventory of their values and objectives for designing the online health intervention?

Is there sufficient time to address communication problems that may arise during the development process?

Is a detailed contract between the intervention team and the vendor in place prior to beginning development?

Does the contract provide specific language about the scope of work?

Are there sufficient funds remaining to pay the vendor to maintain the website after launch?

Is there a system in place to document all decisions made between the research and vendor teams?

Will the intervention have a content management system and is there sufficient time to upload content for the intervention?

Test & Refine: Internal testing; usability testing; and de-bugging

Is sufficient time set aside during internal testing and de-bugging?

What are the processes for reporting bugs to the vendor and ensuring that bugs are fixed?

Appendix 1 - Declaration of authorization from hosting schools from PLATE

Apêndice I - Declaração de Autorização de Realização da Investigação

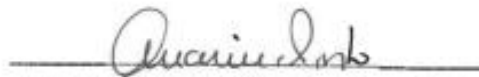
Declaração

Para os devidos efeitos declaro que autorizo a realização do trabalho de investigação **"PLATE – Programa de Literacia Alimentar de base Tecnológica em Escolas: a prevenção da obesidade na adolescência"**, promovido pelo Instituto de Saúde Pública da Universidade do Porto e realizado no âmbito da dissertação de mestrado em Educação para a Saúde da estudante Daniela Marques de Sousa, sob orientação da Prof.^a Doutora Patrícia Padrão e coordenação do Prof. Doutor José Azevedo, na instituição de ensino que represento.

Mais declaro que o trabalho proposto acima é de todo o interesse do **Colégio Novo da Maia**, contribuindo para o desenvolvimento contínuo de novas estratégias pedagógicas para promoção da Educação em Saúde dos nossos alunos e corpo docente.

Maia, 14 de Set. de 2020

A representante da Direção do Colégio Novo da Maia



Exmo. Diretora Dr.^a Marina Torres Pinto,

Declaração

Para os devidos efeitos declaro que autorizo a realização do trabalho de investigação **“PLATE – Programa de Literacia Alimentar de base Tecnológica em Escolas: a prevenção da obesidade na adolescência”**, promovido pelo Instituto de Saúde Pública da Universidade do Porto e realizado no âmbito da dissertação de mestrado em Educação para a Saúde da estudante Daniela Marques de Sousa, sob orientação da Prof^a Doutora Patrícia Padrão e coordenação do Prof. Doutor José Azevedo, na instituição de ensino que represento.

Mais declaro que o trabalho proposto acima é de todo o interesse do Colégio das Terras de Santa Maria, contribuindo para o desenvolvimento contínuo de novas estratégias pedagógicas para promoção da Educação em Saúde dos nossos alunos e corpo docente.

Argoncilhe, 14 de setembro de 2020

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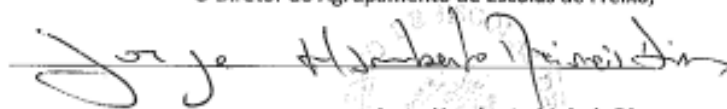
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Para os devidos efeitos declaro que autorizo a realização do trabalho de investigação "PLATE – Programa de Literacia Alimentar de base Tecnológica em Escolas: a prevenção da obesidade na adolescência", promovido pelo Instituto de Saúde Pública da Universidade do Porto e realizado no âmbito da dissertação de mestrado em Educação para a Saúde da estudante Daniela Marques de Sousa, sob orientação da Profª Doutora Patrícia Padrão e coordenação do Prof. Doutor José Azevedo, na instituição de ensino que represento.

Mais declaro que o trabalho proposto acima é de todo o interesse do Agrupamento de Escolas de Freixo, contribuindo para o desenvolvimento contínuo de novas estratégias pedagógicas para promoção da Educação em Saúde dos nossos alunos e corpo docente.

Freixo, 08 de setembro de 2020

O Diretor do Agrupamento de Escolas de Freixo,



Jorge Humberto Meireis Dias

SEDE ADMINISTRATIVA FACULDADE DE **MEDICINA**

FACULDADE DE **PSICOLOGIA** E DE CIÊNCIAS DA EDUCAÇÃO

