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# 'Let me recommend… ': use of digital nudges or recommender systems for overweight and obesity prevention—a scoping review protocol

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## ABSTRACT

**Introduction** Recommender systems, digital tools providing recommendations, and digital nudges increasingly affect our lives. The combination of digital nudges and recommender systems is very attractive for its application in preventing overweight and obesity. However, linking recommender systems with personalised digital nudges has a potential yet to be fully exploited. Therefore, this study aims to conduct a scoping review to identify which digital nudges or recommender systems or their combinations have been used in obesity prevention and to map these systems according to the target population, health behaviour, system classification (eg, mechanisms for developing recommendations, delivery channels, personalisation, interconnection, used combination), and system implementation.

**Methods and analysis** The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews guideline was used to inform protocol development. The eligibility criteria are based on the PCC framework (Population: any human; Concept: recommender systems or digital nudges; Context: obesity prevention). MEDLINE, PsycINFO, Web of Science, CINHAL, Scopus, ACM Digital Library and IEEE Xplore were searched until September 2023. Primary studies with any design published in peer-reviewed academic journals and peer-reviewed conference papers will be included. Data will be extracted into a pre-developed extraction sheet. Results will be synthesised descriptively and narratively.

**Ethics and dissemination** No ethical approval is required for the scoping review, as data will be obtained from publicly available sources. The results of this scoping review will be published in a peer-reviewed journal, presented at conferences and used to inform the co-creation process and intervention adaptation in the context of a HealthyW8 project (www.healthyw8.eu).

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This scoping review will systematically maps digital nudges and recommender systems explicitly focusing on health behaviour (diet, physical activity, sedentary behaviour).
⇒ The work uses a rigorous methodological approach with an interdisciplinary team of experts from health, social and natural sciences, economics, engineering and computer science.
⇒ A limitation is that the database search will miss studies that do not name digital nudges or recommender systems in titles, abstracts or keywords.

## BACKGROUND

Recommender systems, digital data filtering engines that employ deep learning concepts and algorithms to make suggestions for their users, increasingly affect our lives. Whether shopping online, watching series on streaming platforms, listening to music or preparing the next meal, recommender systems suggest products, make recommendations and offer new ideas.

Based on Jesse and Jannach,[1] recommendation systems can be categorised as a form of digital nudges, as the algorithms enable various actions, such as highlighting or hiding information, simplifying information presentation, facilitating social influence, proposing alternatives, having an ordering effect or increasing the salience of incentives. These systems determine different aspects of the choice architecture for users, can serve as information filters or provide suggestions for relevant content.[1 2] They significantly impact the online user experience by influencing which information is easily accessible and affecting decision-making processes.[3] Although recommender systems and digital nudges have been investigated separately, there is a vast potential to integrate further nudging mechanisms into recommender systems to influence user decision-making. By leveraging the power of digital nudges, recommender systems

can enhance their ability to guide users' choices and preferences.

Nudges and digital nudges are similar, in that they both aim to guide people's behaviour towards desirable choices. However, the main difference lies in the context in which they are applied. Nudges refer to any form of choice architecture that triggers behaviour, while digital nudges focus on choice architecture in digital environments.[4] Digital nudges can be highly personalised and interconnected and can provide immediate feedback on choices.[5–8] They can be used in various digital contexts, such as social media, mobile apps, e-commerce or online retail. Digital nudges can help users make more conscious decisions, whether reducing online news consumption,[9] increasing physical activity (PA) levels[7] or promoting climate-friendly food choices.[10]

Both forms of nudges are employed in interventions for overweight and obesity prevention. Given the complexity of the interplay of various behaviours required for obesity prevention (eg, PA,[11 12] dietary habits,[13 14] purchasing decisions and food choice[15–18] or active transportation[19 20]), the field is correspondingly vast and highly dynamic. For example, one systematic review showed that most nudging interventions focused on diet or nutrition, most were conducted as single experiments, and the majority achieved the intended effects. Specific nudging techniques were classified within broader categories, including accessibility, presentation, utilisation of messages and images, technology-supported information, financial incentives, sensory manipulation and cognitive loading; several studies incorporated more than one nudging technique. However, they also mentioned that the effect of nudging is unclear outside the study setting.[21] Others found that nudges resulted in an average 15.3% increase in healthier dietary or nutritional choices, as measured by a change in the frequency of healthy choices or overall caloric consumption.[22] Another systematic review of nudge strategies for weight loss in adults with obesity and overweight showed significant effects of nudging strategies on weight loss, reduction of body mass index and waist circumference. Subgroup analysis indicated that the reduction in body weight associated with nudge interventions was significant in younger and more obese individuals. However, the effect of nudge interventions on weight loss weakened over time.[23] A study of a specific type of nudging, the so-called Typology of Proximal Physical Micro-Environments (TIPPME[24]), found that the evidence to date predominantly focused on the effectiveness of information (56%) and position nudges (13%), while less evidence is available on the effectiveness of other types of TIPPME nudging interventions.[25] TIPPME is a framework for classifying and describing ways in which interventions can alter proximal physical micro-environments to change selection, purchase and consumption of food.

Technological development of apps and sensors has led to the transfer of nudges into the digital environment as more decisions are made in digital contexts.[26] Due to the possibility of personalising digital nudges based on real-time data (eg, sensor data) and using interconnectivity, digital nudges are highly interesting for health research, including obesity prevention. They are particularly valuable for tracking individual behaviour over time to detect behaviour change as they combine various data sources. First, they enable real-time data collection by multiple systems (eg, GPS, sensors, shopping data or user actions). Such data can be combined with the system recommendations based on already known data (eg, age, weight, height and eating preferences). This combination of real-time data with preferences allows for dynamic personalisation of the user's decision architecture, including feedback and monitoring. Furthermore, interconnectivity allows one user's decision to influence another user's decisions directly, such as by applying different (already established) labels, suggesting healthier swaps, default options, increasing salience or a combination of strategies.[27]

These features make the combination of digital nudges and recommender systems very attractive for obesity prevention[6] because wearable technology, chatbots and nudges involving priming, promoting, social norms or gamification can be combined to provide personalised feedback to prevent weight gain and maintain a healthy weight.[28] Linking recommender systems with personalised digital nudges represents an untapped potential that should be tested in obesity prevention. Obesity prevention is a highly important topic as currently obesity, defined by the WHO as having a body mass index greater than 30 was linked to 5.02 million deaths globally in 2019, according to the Global Burden of Disease study.[29]

Several reviews have shed light on various aspects of digital nudgings, such as categorisation,[1 30] psychological underpinning,[31–33] and the use and application of digital nudges in specific areas, such as privacy/security, E-commerce, marketing, sustainability or crowdfunding, online food choice.[1 5 6 34–36] For example, Bergram *et al*[6] described different types of digital nudges based on digital nudge patterns, outcome, context, evaluation, personalisation, interconnectivity and mode of delivery.[6] However, the context domain was labelled as health without a specific focus on the behaviour targeted by these digital nudges. Jesse and Jannach developed a taxonomy to code digital nudges, combining the work of others based on the category and the included nudging mechanism.[30 37–39] However, the health context of the system was not specified in this work either.[1]

## AIMS AND OBJECTIVES

This study aims to conduct a scoping review to identify which digital nudges or recommender systems have been used in overweight and obesity prevention and whether they have been combined (figure 1).

Obesity prevention is defined broadly as preventing overweight and obesity, including weight reduction and weight management, preventing weight gain or stabilising treatment effects. While the development and treatment

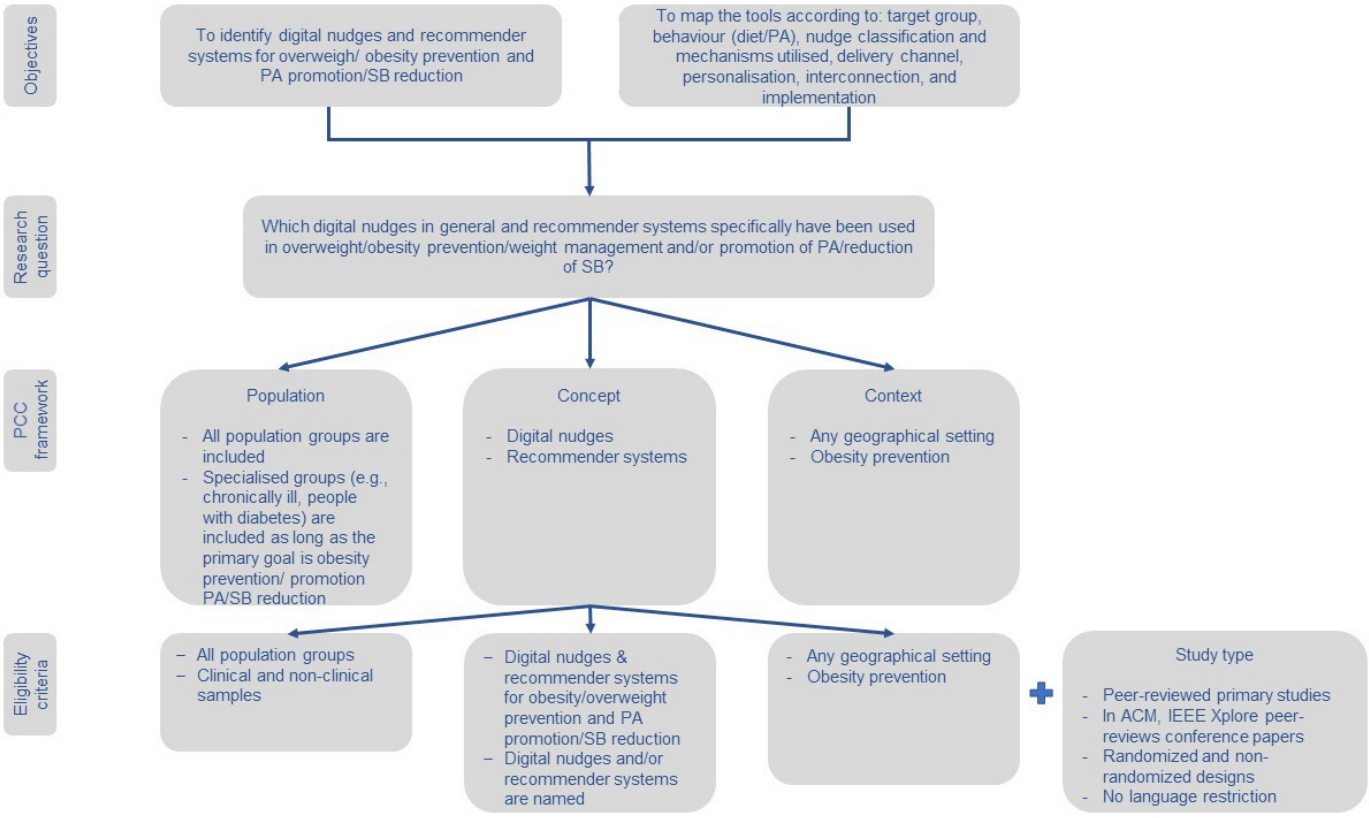


**Figure 1** Relationship between research objectives, question and eligibility criteria (adopted from Feo *et al*[54] and Pollock *et al*.[47]). PA, physical activity; PCC, Population, Concept, Context; SB, sedentary behaviour.

of overweight and obesity are multifactorial, increased energy expenditure is considered one of the most important determinants for reducing body weight.[40] PA is one of the most modifiable factors in energy expenditure; it represents approximately 25% of total energy spending and, as such, is a powerful requirement to improve the energy balance equation[41] in combination with a healthy diet. Generally, a higher level of PA is associated with a lower BMI and measured body fat, even after controlling for genetic and environmental factors, such as childhood environment.[42 43] Therefore, we include PA promotion and sedentary behaviour (SB) reduction in the overall definition of obesity prevention.

The detailed objectives of this scoping review are as follows:

1. To identify digital nudges or recommender systems for overweight and obesity prevention, PA promotion or SB reduction.
2. To map the digital nudges and recommender systems according to the target population, health behaviour (diet, PA or SB), system classification (eg, mechanisms for developing recommendations, delivery channels, personalisation, interconnection, used combination) and system implementation.

## METHODS

The scoping review method maps the literature to synthesise existing knowledge, identify key characteristics from the body of literature and identify evidence gaps.[44] Our aim to identify a broad scope of literature on digital nudges or recommender systems for obesity prevention can be addressed using a scoping review rather than a systematic review because it is more suitable for reviews targeting interventions' feasibility, appropriateness, meaningfulness or effectiveness.[44]

### Study design

The scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guideline.[45] The PRISMA-ScR checklist will be reported as part of the scoping review.

### Protocol and registration

The work on this study began in July 2023, and the database searches were conducted in September 2023. This protocol was written in August–September 2023 (ie, before the screening process started), submitted for peer review and registered at the Open Science Framework[46] in October 2023. Screening and study selection are scheduled for October 2023 until March 2024, data extraction for April–June 2024 and data synthesis for July 2024.

### Eligibility criteria

The eligibility criteria were based on the PCC (Population, Concept, Context) framework[47] (figure 1, table 1).

Table 1 Eligibility for the scoping review

| PCC | Inclusion criteria | Exclusion criteria |
|---|---|---|
| Population | Any human population groups (children or adults; healthy, at risk for chronic diseases or clinical samples) | No human population |
| Concept | Digital nudges or recommender systems (stated in the title, abstract or full-text of a study) | Digital nudges or recommender systems not used or studies that use digital nudges or rely on recommender systems but do not name them in the title, abstract or full-text |
| Context | Any geographical setting<br>Overweight and obesity prevention (eg, nutrition, food recipes, grocery stores, meal preparation, PA promotion, SB prevention) | Digital nudges or recommender systems that are used in for example, blockchain, finances, security, privacy, agriculture, service and e-commerce and not used for overweight and obesity prevention |

PA, physical activity; SB, sedentary behaviour.

We aim to identify and include primary studies with any design (randomised or non-randomised studies with quantitative or qualitative data). All languages will be included in the initial search. During the full-text screening, we will exclude studies not published in English or German unless the language expertise is available in the review team. We will also include peer-reviewed conference papers from ACM Digital Library and IEEE Xplore due to the different publication traditions in computer science and engineering. Books, reports, dissertations, pre-prints, project reports, unpublished work and grey literature (non-peer-reviewed work) will be excluded.

### Search strategy

The electronic search strategy was developed and calibrated within the team in collaboration with an experienced librarian (LC). MEDLINE and PsycINFO via Ovid, Web of Science, CINHAL via Ebsco, Scopus, ACM Digital Library and IEEE Xplore were searched (by LC) until September 2023. The search strategy for MEDLINE is reported in online supplemental file 1.

An iterative technique adapted from JBI's three-step approach was used to develop the search strategy.[48 49] First, a preliminary search was done in MEDLINE based on an initial set of key terms. The retrieved papers were reviewed regarding their eligibility. Keywords, synonyms and index terms were identified from the retrieved papers and used to revise the search strategy. The revised search strategy was discussed with the team to ensure that the terminology from different disciplines (eg, health, economics, engineering and computer science) was considered. Second, the main search was undertaken across all seven databases using all identified keywords and index terms. Third, the search results will be screened following deduplication (done by LC).

The search syntax development was based on the Peer Review of Electronic Search Strategies guideline.[50] Our research librarian (LC) implemented the following aspects of the search syntax development: (1) quality of translation of the research question into search terms done by inspecting the number of hits per syntax line, (2) appropriate use of adjacency proximity operators done by comparing the number of hits following different adjacency limits, (3) choice of subject headings done by inspecting the number of hits per syntax line, (4) text word searching done by inspecting the truncation and inclusion of British and American spelling and (5) spelling and any syntax errors done by reading the syntax strategy line by line and inspecting the use of Boolean operators and brackets.

Subject terms used for the search strategy included digital nudges or recommender systems combined with aspects of obesity prevention (eg, weight management, PA, SB, diet, food, nutrition and their synonyms; table 2).

### Engagement with experts

A 'crowd-sourced' element will expand the search for suitable articles by posting the search on the X/Twitter and LinkedIn accounts of the involved institutions (eg, BIPS, EE) and on the HealthyW8 website (www.healthyw8.eu). This strategy aims to raise awareness of the project and obtain suggestions for additional studies relevant to the scoping review.

## Study selection process

The resources located in the search will be imported into EndNote 20 for deduplication. The deduplicated library will be imported into the software RAYYAN. The

Table 2 Subject terms used

| MeSH | PsycInfo subject headings | CINAHL subject headings |
|---|---|---|
| overweight | overweight | |
| obesity | obesity | obesity |
| physical activity | physical activity | physical activity |
| sedentary behaviour | sedentary behavior | life style, sedentary |
| food | food | food |
| diet | diets | diet |

Bibliographies of included studies will be manually screened for additional studies.

Table 3 Preliminary list of data items to be extracted from included studies

| Data items | Characteristics |
|---|---|
| Bibliographic data | First author, year of publication, author country, health domain (nutrition/PA/SB),[30 55] digital nudge, recommender system or a combination |
| Intervention characteristics | Study design, population, sample size, dose, digital nudge combination |
| Recommender system delivery channel | Mode of delivery (delivery channels: for example, visual, audio, haptic) and delivery devices (eg, desktop, mobile, wearable, ambient)[6] |
| Recommender system methods | Hybrid methods, content-based filtering, collaborative filtering, graph-based methods |
| Classification of digital nudges | Social nudges (guide the user's behaviour by providing references to how other users behave), reinforcement nudges (reinforce behaviours and choices by increasing their salience in the mind of the user), disclosure nudges (adding information that is accessible, clear and relevant to the choice that the user is about to make), friction nudges (encouraging or discouraging behaviour by removing or adding friction), feedback nudges (information about a past or current behaviour of a user), default nudges (assumed desired behaviour), warning nudges (different kinds of warnings and graphics to grab attention), scarcity nudges (information that something is difficult to acquire), deception nudges (affect how users perceive choice alternatives), commitment nudges (to motivate the user to behave)[6 55 56] |
| Digital nudge mechanisms | Decision information (translate information, increase the salience of information, make information visible or change the phrasing of information)<br>Decision structure (change range of composition, change choice defaults, change option consequences, change option-related effort)<br>Decision assistance (provide reminders or facilitate commitment)<br>Social decision appeal (increase the reputation of the messenger, provide a social reference point, instigate empathy)[1] |
| Personalisation | None, partial (study gathers user data (eg, location, user demographics, user actions) to infer the potential influence of the nudge on user behaviour), full (such information is used to personalise the choice architecture of individual users dynamically)[6] |
| Interconnection | None, partial (study investigates how information from other users affects user behaviour), full (study investigates how actions of one user, in turn, dynamically modify the choice architecture of other users)[6] |
| Implementation information | Any information about implementation and user engagement |
| Effects | Primary outcome: outcomes related to weight, weight management, PA/SB<br>Secondary outcome: outcomes related to mental health, user engagement, user satisfaction |

PA, physical activity; SB, sedentary behaviour.

software will be used for title/abstract screening. Full-text screening was done with COVIDENCE. Titles, abstracts and full-texts will be screened independently according to the eligibility criteria by at least two researchers. All conflicts will be discussed. If no agreement can be reached, a third researcher will be consulted. A final decision will be made by consensus during discussion.

The PRISMA flowchart will be reported to show the study selection procedure. After the full-text assessment, a list of included and excluded studies with individual reasons for exclusion will be reported.

## Data items

Two researchers will independently extract data from eligible studies. A data extraction sheet will be pre-developed in Excel to address our scoping review objectives. A preliminary list of data items and their characteristics is shown in table 3. The data extraction sheet will be pre-tested based on three randomly selected studies from the included studies to standardise data extraction. The qualitative information on the data items will be extracted as author statements from the articles.

In the next step, these data will be processed by quantifying them into categories developed deductively from the scoping review objectives or inductively from the data by one researcher (SF). The processed data will be checked and discussed within a team to reach a category consensus.

## Data synthesis

Results will be synthesised using descriptive statistics (eg, relative frequencies) to address the scoping review objectives. A narrative synthesis will be used to describe evidence gaps in the literature. Various forms of visualisation, such as tables and charts, will be used to report the data synthesis.

To increase the usability of the results, the data synthesis includes two steps, if applicable. First, SciModeler will be used to analyse the results and to link the theoretical constructs with empirical data by (1) recording study findings and contexts in a knowledge representation that facilitates querying, (2) mapping study outcomes with theoretical constructs to refine scientific theory and (3) making replicable predictions on the impact of

a particular intervention strategy in a specific context, based on actual empirical data.[51 52] The annotators will use the SciModeler web interface to annotate the included articles with highlights in terms of data items listed in table 3 (eg, marking those terms that relate to the classification of nudges, the nudging mechanisms, the personalisation mechanisms and the delivery channels). Some elements link to theories/techniques, while others relate to the study design (eg, intervention characteristics). The items will be labelled, and a graph-based database will be generated based on the types used while annotating the articles. Second, results can be exported from the graph-based database to JSON, an open standard file and data interchange format, to be imported into the digital application (eg, GameBus[53] or tabular views).

## ETHICS AND DISSEMINATION

No ethical approval for the scoping review is required, as data will be obtained from publicly available materials. The results of this scoping review will be submitted for publication in a peer-reviewed journal and presented at conferences. They will further inform the co-creation process with target group representatives and stakeholders and provide information on how the intervention developed within the HealthyW8 project (www.healthyw8.eu) can be adapted to different target groups.

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**Correction notice** This article has been corrected since it was published. Author name, Pieter van Gorp was misspelled.

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