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## Meta-analysis

# Electronic screening and brief interventions promoting healthy diet and physical activity among adult patients in medical settings: A systematic review



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## SUMMARY

**Background & aims:** Electronic screening and brief interventions (eSBIs) are promising health promoting approaches but their utilization towards nutrition outcomes has been little documented so far. The aim of this systematic review is to examine the nature and findings of eSBIs targeting diet and/or physical activity (PA) among adult patients in healthcare settings since smartphone technologies emerged.

**Methods:** Three systematic searches in PubMed, ScienceDirect and PsycINFO were conducted from January 2010 to May 2023. We include all studies assessing eSBI towards lifestyle habits (dietary habits and/or PA at least), implemented in healthcare settings and targeting adult participants.

**Results:** Of 1981 articles identified, 15 studies met inclusion criteria. Most of them documented eSBIs implemented in primary care (n = 11), targeting PA (n = 11) and diet (n = 9) alone or combined (n = 5). Some eSBIs targeted additional behaviors (e.g. smoking, drinking). Delivery modes included computer (n = 8), printed documents (n = 8) or phone (n = 2) but only four eSBIs were interactive (or partially automated). In addition to personalized feedback, most common behavior change techniques were “information about social and environmental consequences” (n = 9), “goal setting” (n = 7), and “information about health consequences” (n = 7). Most studies assessing behavior change had a control group (8 in 10), and eight studies found positive changes in behavior.

**Conclusions:** Although implementing eSBIs towards PA/diet among adult patients in medical settings seems promising for primary, secondary and tertiary prevention, common conceptual framework, intervention and outcomes are severely lacking, and the extent to which they follow existing SBI guidelines remains unclear. Demonstrating their effectiveness requires fixing these issues before conducting prospective assessment studies in medical settings.

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## 1. Introduction

Despite the pivotal role of healthy lifestyle habits in chronic disease prevention and management [1,2], adherence to guidelines remain suboptimal for the majority of the adult population. For example, in Europe, only 12 % of the population consume five fruits and vegetables (F&V) a day and more than 45 % never exercise or

play sport [3,4]. Healthcare professionals often have frequent interactions with individuals in various settings, such as clinics, hospitals, community outreach programs, and even in everyday encounters. By benefitting from these interactions effectively, health providers could “Make Every Contact Count” (MECC), *i.e.* improve public health through supporting behavior change in the millions of people with whom they come into contact. Each medical and/or paramedical visit could therefore constitute a “teachable moment” for health promotion [5,6]. Unfortunately, prevention advices are often overlooked during routine medical visit, and tend to cover only a specific pathology or risk factor [7,8]. A systematic review of 36 systematic reviews exploring barriers to delivering

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behavior change interventions for behavioral risk factors identified several, such as perceived lack of time, perceived lack of prioritization, negative perceptions of knowledge and skills, and availability of resources and support [9].

One of the most promising approaches to implement the MECC in medical settings consists in providing time-limited, focused conversation or counseling sessions designed to offer quick support and guidance to individuals who may benefit from targeted assistance [10–12]. Screening and Brief Interventions (SBIs) are cost-effective, require less training time for professionals, and can be adapted to many situations or problems, including diet, physical activity (PA), smoking, drinking, and other types of substance (ab) use [11,13–19]. Recently, the WHO confirmed their considerable potential for improving public health outcomes by publishing SBIs implementation guidelines for primary care practitioners (PCP) [20], making the advice more relevant and actionable. In the recent years, SBIs increasingly incorporated digital tools to provide more accessible, cost-effective, personalized and engaging interventions. Smartphone technologies combining the portability of traditional mobile devices with advanced computing capabilities have the potential to provide platforms for delivering SBIs with increased accessibility, scalability, personalization and engagement [21].

According to available evidence, some elements are pivotal for SBI design, implementation and effectiveness. The FRAMES model (Feedback, Responsibility, Advice, Menu, Empathy, and Self-efficacy) [22] offers a blueprint of six elements that produce change following brief intervention (BI), and the inclusion of behavior change techniques (BCTs) may enhance their effectiveness, tailor interventions to individual needs, and empower individuals in taking control over their behavior and habits. Since they were firstly developed to reduce alcohol consumption for decades [23–25], their utilization towards other behaviors in adults is just starting to emerge and has been little documented so far [26–29]. The aim of this systematic review is to examine the nature and findings of eSBIs that have sought to improve nutritional counseling among adult patients in medical settings since smartphone technologies emerged. Specific objectives are 1) to identify and describe eSBIs targeting diet and/or PA among adult patients in healthcare settings, 2) to investigate the behavior change techniques used; and 3) to estimate the effectiveness of these interventions.

**Table 1**  
Keywords used in the database search.

Screening and brief intervention	Physical activity/diet	Electronic component	Healthcare setting
- SBI	- Life style	- Internet	- Hospital
- Screening and brief intervention*	- Nutrition*	- Website*	- Medical center*
- Brief intervention*	- Food intake	- Web-based	- Health center*
- SBIRT	- Food habits	- Online-treatment*	- Medical institution
- Screening, brief Intervnetio interventions and referral to treatment	- Feeding behaviors	- Computer*	- Medical set*
- Health screen*	- Eating	- Telephon*	- Primary care
- Motivational interviewing	- Diet* intake	- Computer-delivered intervention*	- Health set*
- Personalized feedback	- Diet* behavior*	- Website-interactivity	- Health facilities
- Personalized feedback	- Diet* quality	- Computer-based	
- PFI	- Diet* pattern*	- Online	
- Personalized feedback In intervention*	- Diet* habit*	- Interactive technolog*	
- Tailored feedback	- Diet* guideline*	- App*	
- Feedback	- Eating behavior*	- m-health	
- Brief motivational Intervention*	- Eating pattern*	- e-health	
- BFI	- Eating habit*		
- Brief feedback intervention*	- Physical activit*		
- Screen* intervention*	- Exercise*		
- Screen* feedback	- Sedentary behavior		
	- Health risk behavior		

## 2. Methods

We conducted a systematic review according to the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [30].

### 2.1. Search strategy

In the present review, the term “eSBI” labelled an intervention targeting lifestyle habits (dietary habits and/or PA at least) comprising screening, BI and providing personalized feedback. The eSBI must use at least one electronic device (e.g. phones, smartphones, computers, tablets, apps) for the screening and/or the brief intervention. BI can be fully automated (e.g. computer-based) or interactive (provided by a person). In the absence of standard definition, the intervention is considered brief if including less than four sessions without a time limit [15,25]. We retrieved studies written in English or French from three databases (PubMed, ScienceDirect, PsycINFO) published from January 2010 (when smartphone technology first appeared) to May 2023. No registration was made and no protocol was prepared. The search terms (Table 1) combined keywords and MeSH terms describing SBI (n = 20), digital tools (n = 14), PA/diet (n = 20) and healthcare settings (n = 8).

### 2.2. Eligibility criteria

We included studies meeting the following criteria: Original research on eSBI towards lifestyle habits (dietary habits and/or PA at least), implemented in healthcare settings and targeting adult participants.

### 2.3. Study selection and data extraction

Firstly, the first author (CF) examined titles and abstracts to remove obviously irrelevant materials. Secondly, the same author examined the full text for compliance with eligibility criteria, leading to the flowchart for study inclusion and exclusion (Fig. 1). Information on participants, setting, study design, outcomes, screening and intervention, comparator and follow-up duration are presented in Table 2, together with main results of studies. The first

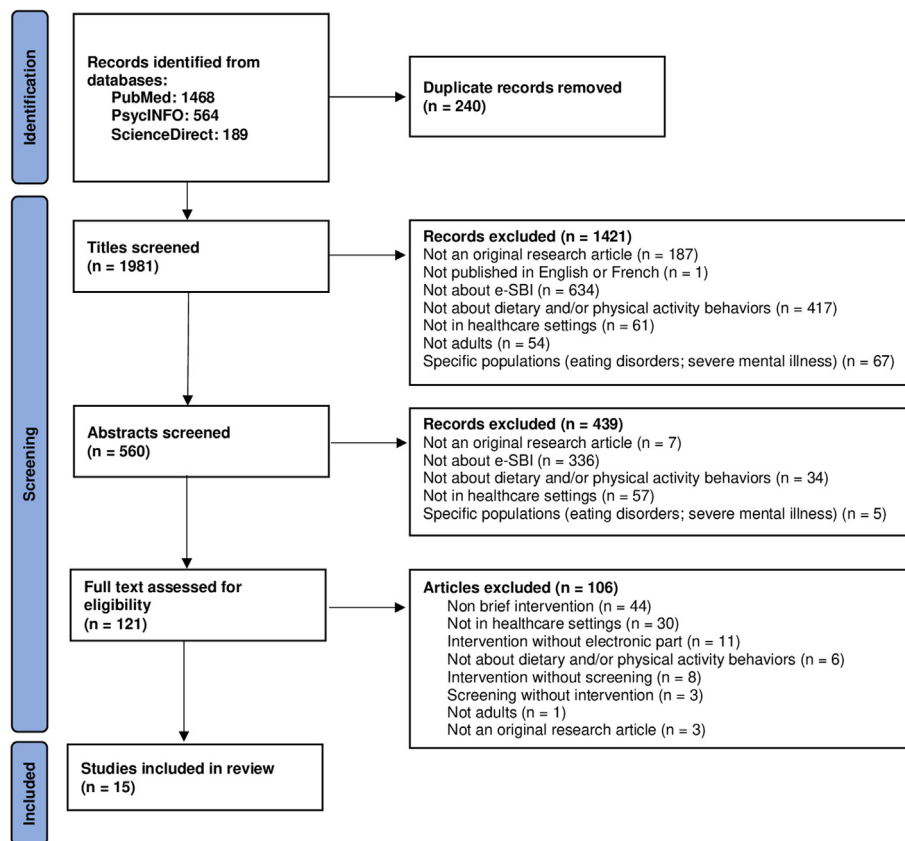


Fig. 1. Flow-chart for study inclusion.

author (CF) attended the online training on behavior change techniques (BCTs) taxonomy ([www.bct-taxonomy.com/](http://www.bct-taxonomy.com/)) to classify BCTs according to this framework.

### 3. Results

#### 3.1. Description of studies included

Out of the 1981 studies identified at first step, fifteen meeting the inclusion criteria were included (Fig. 1), conducted mainly in primary care ( $n = 11$ ). Nine studies were randomized controlled trials (RCT) and thirteen were prospective with a median follow-up of 4 months (IQR: [1–6]). Eleven studies had a comparator group consisting of a routine care control group ( $n = 6$ ), a target behavior different from the outcome ( $n = 2$ ), or a standard non-personalized intervention ( $n = 3$ ). All these studies included 12,533 participants (median: 200; IQR: [113–1235]).

#### 3.2. Targeted behaviors

Four studies had a single outcome, either PA [31–33] or F&V consumption [34] while the others ( $n = 11$ ) had multiple outcomes. The most common behaviors targeted were PA ( $n = 11$ ), smoking ( $n = 7$ ), alcohol consumption ( $n = 5$ ) and diet ( $n = 9$ ). Additionally, two studies targeted outcomes such as sleep or drug use. Components of eating behaviors in eSBIs towards diet varied from 1 to 12 (median: 3; IQR: [1.50–8.25]), and one study omitted their detailed description [35]. For the most part ( $n = 7$ ), eating components were types of food/nutrients (e.g. F&V = 7, fat intake = 3), but also calorie intake ( $n = 1$ ) and chemical elements (e.g. phosphorus, sodium) in one study including patients with kidney disease [36].

#### 3.3. Description of the e-SBI delivery mode

Screening used e-surveys in eleven studies, sent via e-mail or completed on a website, completed at home or in healthcare settings (on a tablet or computer). The survey of Parekh et al.'s intervention [37] was sent by mail and Mc Clish et al. [38] conducted the intervention by phone. Information on the screening delivery mode was lacking in two studies [39,40]. When it comes to BI, which includes at least a personalized feedback, eight studies used computer-based brief interventions, while three of them were interactive, *i.e.* including face-to-face interactions with a healthcare provider [34,39,40]. Eight studies used printed BI that could be provided in the healthcare setting or sent by mail ( $n = 2$ ), and one of them involved an interview with PCP [31]. Two studies used telephone calls to provide follow-up interventions, four days and five weeks after baseline [40], or two weeks after baseline [38]. Several studies used multimodal interventions [31,41].

#### 3.4. Description of brief intervention with behavior change technique (BCTs) used

The majority of studies reported single-session eSBIs. The printed intervention of Agarwal et al. [31] was provided to patient at baseline, and sent by mail or e-mail two weeks later. Concerning Katz et al.'s intervention [40], the BI at baseline focused on personalized feedback, goal setting and action planning while follow-up phone calls (3–5 days and 4–6 weeks after baseline) focused on reviewing behavioral goals and problem solving. In Parekh et al.'s study [37], the number of sessions depended on the group: The “dual intervention” group received the same intervention as the “single intervention” group but twice (at baseline and 3

**Table 2**  
Summary of included articles.

Study	Participants and setting	Target behaviors	Mode of provision (Duration)		Interactive Bl. provider	Design (Sample size)	Follow-up	Comparator	Main outcomes	Results
			Screening	Intervention						
Agarwal et al., 2020 Canada	All patients Primary care	PA	E-mail or on tablet in the waiting room	Printed onsite, then sent by email or mail	Yes, PCP	Step wedge CRT (437)	M4	Usual care	MET minutes per week	No difference between groups.
Almeida et al., 2015 US	Patients of a health care visit Treadmill center	PA	Computer interactive session	Computer interactive session (20 min with screening)	No	RCT (415)	M1	C1: eSBI on healthy eating C2: Fitness facilities voucher	Moderate and vigorous PA per week % Of participants meeting PA guidelines	Intervention and intervention + C2 increased weekly PA participation compared to the C1 and C2. No difference between C2 and C1 or between intervention and intervention + C2. Intervention and intervention + C2 groups had significantly higher prevalence of meeting PA guidelines than C1 and C2.
Hess et al., 2014 US	All patients Primary care	PA Smoking	Tablet	Printed	No	CRT (98)	BL	Usual care	% Of patient reporting discussion with PCP (about PA, smoking)	No difference between groups.
Hrolfsdottir et al., 2019 Iceland	Overweight pregnant women University hospital	12 food groups	Not specified (5–10 min)	Web-based	Yes, nutritionist	RCT (88)	M3, M6	Usual care	Dairy products (g/d) Vegetables (g/d) Fruits (g/d) Fish (% ≥300 g/week) Processed meat (g/d) Soft drinks (g/d) French fries, chips (% ≥100 g/week), Cakes, biscuits, sweets (g/d)	Only soft drink consumption was significantly lower in the intervention group.
Katz et al., 2017 US	Patients with CVD risk factor  Emergency unit	Fat F&V Cholesterol PA Smoking	Not specified	Computer session (1 h) Follow-up calls (30 min)	Yes, Health educator	RCT (124)	M2, M6	Minimal counseling	Saturated fat calories F&V servings/day PA hours/week Number of cigarettes/day	No difference between groups.

Krist et al., 2016 US	All patients  Primary care	F&V Sweetened beverage Fast food PA Smoking Drinking Drug use Sleep	Online survey/phone before the visit Or printed onsite	Printed	No	CRT (2913)	W2	Usual care	Self-reported goals and improved behaviors	Increases in self- reported goal settings on diet, PA, drinking and sleep. No difference for drug use. More improvement reported in diet, PA, and sleep. No difference in alcohol, smoking and drug use. Increased PA days at follow-up.
Leijon et al., 2011 Sweden	All patients  Primary care	PA	Touch-screen kiosk in or close to the waiting room Phone	Printed	No	Prospective (311)	M3	N/A	Number of PA days	
McClish et al., 2014 US	All patients  Primary care	Fat Fiber F&V		Printed, and phone call (15 min)	No	Prospective (113)	M1	N/A	For fat and fiber intake: Score of FFB F&V servings/day Self-efficacy	Improvements in fat, fiber and F&V intake at follow- up. No change in self- efficacy levels before and after exposure.
Murali et al., 2013 US	Patients with chronic kidney disease Nephrology department	Na, P, K Protein Calorie Carb Fat Saturated fat Cholesterol	Web-based (20 min)	Web-based	No	QE, pre-post trial (12)	BL	None		
Nagykaldi et al., 2013 US	Middle-aged and older adults, with multiple health conditions  Primary care	Diet PA Smoking Drinking Drug use	Web-based (45 min)	Web-based	No	QE CT (200)	M12	Usual care	Estimated life expectancy Wellness score	Increase in estimated life expectancy within the intervention group and compared to the control group. Increase in wellness score in the intervention group and compared to the control group. Increase in the likelihood of discussing PA with physician. No differences for drinking. OR of meeting recommendations higher in dual intervention group for all food except spreads and meat intake, physical activity and smoking as compared to dual
Ozanne et al., 2019 US	Women aged 40- 74  Primary care	Drinking PA	On tablet in the waiting room (5 min)	Printed	No	RCT (1235)	W1	Usual care	Discussion with the physician about alcohol and PA	
Parekh et al., 2014 Australia	All patients  Primary care	Fish Spreads Salt F&V Milk Meat Smoking PA Drinking	Printed, sent by mail	Printed at baseline and M3 for dual intervention	No	RCT (3065)	M12	eSBI on other behaviors at baseline and M3 for dual control	Adherence to guidelines	

(continued on next page)

Table 2 (continued)

Study	Participants and setting	Target behaviors	Mode of provision (Duration)		Interactive BI, provider	Design (Sample size)	Follow-up	Comparator	Main outcomes	Results
			Screening	Intervention						
										control. OR of meeting recommendations higher in single intervention group for all foods, alcohol (but not for salt and meat intake, physical activity and smoking) as compared to single control.
Plaete et al., 2016 Belgium	Patients recruited either by PCP or researcher  Primary care	F&V	Tablet in waiting room or website	Web-based	Yes, only for PCP's patients	QE CT (139)	M1	Feedback with general information	F&V intake	Increase in F&V intake in the PCP and the researchers' intervention group as compared to control group.
Ruffin et al., 2011 US	Healthy adults aged 35–65 yrs  Primary care	F&V PA Smoking	Web-based or physician office computer or by phone	Mail or e-mail or during visit	No	CRT (3254)	M6	Standardized prevention messages	Adherence to guidelines	The intervention group was more likely than the control group to move from not at goal status to at goal for both fruit and vegetable intake and physical activity.  There was no intervention effect on smoking cessation.
van den brekel-Dijkstra et al., 2016 Netherlands	Healthy aged 45–70  Primary care	PA Smoking Drinking	Web-based	Web-based	No	Prospective pilot (129)	M6	N/A	Initiation of behavior change (single-item) for diet, PA, smoking, alcohol use	32 % reported to have improved PA, 28 % to have improved their diet, 24 % of current drinkers reported to have reduced alcohol intake, 44 % of current smokers reduced tobacco use.

Note: BL: baseline; CRT: cluster randomized trial; CT: cluster trial; CVD: cardiovascular diseases; eSBI: electronic screening and brief intervention; FFB: fat- and fiber-related behavior questionnaire; F&V: fruit & vegetable; M: month; MET: metabolic equivalent of task; PA: physical activity; PCP: primary care physician; QE: quasi-experimental; RCT: randomized controlled trial; W: week; %: percentage.



months after). The same applies to the “dual control” group that received the control intervention twice. The intervention included a printed personalized feedback indicating poor adherence to guidelines. Finally, the intervention of Plaete et al. [34] comprised a baseline session focusing on feedback, action planning, problem solving and self-monitoring, and two follow-up sessions (one week and one month) focusing on feedback, goals and action plan revision.

A total of 75 BCTs [42] were used in the studies under review (Table 3), with a median value of 4 BCTs per intervention (IQR = [3–6]). The most common techniques (taxonomy#: name) used were “2.2 Feedback on behavior” (n = 15), “5.3 Information about social and environmental consequences” (n = 9) and “1.1 Goal setting” (n = 8).

### 3.5. Outcomes

#### 3.5.1. Controlled studies assessing behavior change

In the two controlled studies focusing on PA, the study by Almeida et al. [32] reported an increase in PA time per week in groups with an interactive computer session. This session focuses on action planning and problem solving (with or without gym membership voucher), as compared with the same computer intervention focused on healthy eating, and a group with only a one-year voucher. One study showed no difference in the number of Metabolic Equivalent of Task (MET) per minute between two groups (intervention and usual care) at 4-month follow-up [31]. When it comes to diet, Plaete et al. [34], using a website intervention to improve F&V intake, showed that the PCP intervention group (PCP recruited the participants) and the researchers' intervention group (researchers recruited the participants) increased their F&V intake, as compared to the control group. Hrolfsdottir et al. [39], using a website intervention providing personalized feedback on diet, showed a decrease in soft drinks consumption in the intervention group as compared to the control group, but no changes otherwise.

Four controlled studies targeted multiple behaviors, and two of them assessed adherence to guidelines. In the study by Parekh et al. [37], intervention targeted food choices (6 components), PA, smoking and alcohol. Estimates of adherence to guidelines were significantly higher for dual intervention group compared to dual control group for fish, F&V, milk, salt, alcohol, but not for spreads and meat, PA and smoking at 12 months. They were significantly higher for the single intervention group compared with control group for fish, spreads, F&V, milk and alcohol but not for salt and meat intake, PA and smoking at 12-month follow-up. In the study by Ruffin et al. [41], the intervention targeted F&V, PA and smoking. Estimates of adherence to guidelines were significantly higher in the intervention than in the control group for F&V and PA, but not for smoking. Katz et al. [40], found no difference in F&V, fat intake, PA or smoking between intervention and control group at 6-month follow-up. Nagykaldi et al. [35] showed that the estimated life expectancy in the intervention group was higher than in the control group at 12-month follow-up. The intervention focused on diet, PA, smoking, alcohol and drug use.

#### 3.5.2. Uncontrolled studies assessing behavior change

Two prospective uncontrolled studies evaluated behavior change. One study aimed to increase fiber and F&V consumption while reducing fat consumption, with personalized feedback explaining how to improve these outcomes. Results showed an increase in fiber and F&V consumption and a decrease in fat

consumption at 3-month follow-up compared with baseline [38]. The other study used tailored printed feedback on the current PA level, and found an increase in the number of days meeting the PA guidelines at 3-month follow-up [33].

#### 3.5.3. Others outcomes

Two studies assessed the rate of patients reporting discussion with the physician about the targeted behavior. The study by Hess et al. [43] targeting smoking and PA reported no difference between the e-SBI and the routine care group. The study by Ozanne et al. [44], targeting drinking and PA, reported a significant difference only for discussions about PA but not drinking between intervention and routine care group. Two others studies evaluated the rate of patients self-reporting behavior change. One uncontrolled study focused on smoking, alcohol and PA, showing that 32 % of patients reported improvements in PA, 28 % in diet (not targeted), 24 % of current drinkers reported reductions in alcohol consumption and 44 % of current smokers reduced smoking 6 months after baseline [45]. The other study targeted diet (three components), PA, smoking, drinking, drug use and sleep [46]. More patients in the intervention than in the control group reported substantial improvements in diet, PA, and sleep. Finally, a study using an intervention providing specific feedback for patients with chronic kidney disease assessed patients' self-efficacy to improve diet (*i.e.* belief on self-ability to achieve change) showed no difference over time [36].

## 4. Discussion

This review examined the nature and findings of eSBIs that have sought to improve nutritional counseling among adult patients in medical settings since smartphone technologies emerged. Out of the 1981 studies initially screened, fifteen met the inclusion criteria. Most of them documented eSBIs implemented in primary care (n = 11), targeting PA (n = 11) and diet (n = 9) alone or combined (n = 5). Some eSBIs targeted additional behaviors, mostly smoking (n = 7) and/or alcohol consumption (n = 5). Delivery modes included computer (n = 8), printed documents (n = 8) or phone (n = 2) but only four eSBIs were interactive (or partially automated). In addition to personalized feedback, most common BCTs were “information about social and environmental consequences” (n = 9), “goal setting” (n = 7), and “information about health consequences” (n = 7). Most studies assessing behavior change had a control group (8 in 10), and eight studies found positive changes in behavior.

Of the eight controlled studies in the review evaluating behavior change, six showed positive results for PA and/or diet, which concur with other reviews [15,18]. However, our findings showed an important clinical heterogeneity in the interventions and outcomes. Only three of the controlled studies showed improvement in PA [32,35,41], while others assessed other outcomes such as “discussing about PA”, “wellness score” or “PA goals”. For diet alone, indicators varied from one (F&V) to twelve different food/nutrient categories across studies. There was also a wide range of possible controls, such as usual care, non-personalized BI, or personalized interventions targeting other behaviors. Also, five studies evaluated outcomes other than behavior change [36,43–46], such as self-reported behavior change without baseline assessment, self-efficacy, and discussions with the physician.

Eight interventions targeted other behaviors besides PA/diet, mostly drinking alcohol and smoking, which are major risk factors for chronic diseases [2], and therefore constitute important target



**Table 3**  
Behavior change techniques used according to the Behavior Change Taxonomy v1 [42] for each article.

Study	1.1 Goal setting (behavior)	1.2 Problem solving	1.3 Goal setting (outcome)	1.4 Action planning	1.5 Review behavior goal(s)	1.6 Discrepancy between current behavior and goal	1.7 Review outcome goal(s)	2.2 Feedback on behavior	2.3 Self-monitoring of behavior	2.7 Feedback on outcome(s) of behavior
Agarwal et al., 2020								✓		
Almeida et al., 2015	✓	✓						✓		
Hess et al., 2014								✓		
Hrolfsdottir et al., 2019								✓		
Katz et al., 2017			✓	✓			✓	✓	✓	✓
Krist et al., 2016	✓			✓				✓		
Leijon et al., 2011								✓		
McClish et al., 2014	✓							✓		
Murali et al., 2013	✓							✓		
Nagykaldi et al., 2013	✓							✓		
Ozanne et al., 2019								✓		
Parekh et al., 2014	✓							✓		
Plaete et al., 2016	✓	✓		✓	✓	✓		✓	✓	
Ruffin et al., 2011								✓		
van den brekel-Dijkstra et al., 2016										✓

for eSBI in the adult population. Since interventions focusing on both diet and PA seem more effective than interventions focusing on just one of these two behaviors [47], adopting a multiple behavior approach in eSBI could improve health outcomes for patients [48].

While eSBIs delivery modes included phone, e-mail or web, the screening included mostly web-based tools on computer and tablet. Web-based screening produces immediate personalized report, saving time for the healthcare professional when delivering the intervention [21]. However, only five studies measured the screening durations [32,35,36,39,44], which varied from five to 45 min according to the number of behaviors assessed. While multicomponent interventions tend to be more effective than single-component interventions [47,48], a 45-min-long feedback could tire patients and jeopardize eSBI completions. Similarly, only three studies measured the duration of interventions [32,38,40], which varied from 15 to 20 min in primary care to 1 h for CVD risk-factor patients at emergency department. Since SBI are time-limited focused counseling sessions, undocumented time limit, or total durations exceeding 30 min is concerning for feasibility in medical settings. In addition to feedback, we identified 20 different other BCTs used in eSBIs. “information about social and environmental consequences” (N = 9) and “goal setting” (N = 8) were the most frequently used techniques, which is congruent with this type of intervention [49]. It must be noted that the effectiveness of PA/diet interventions seems unrelated to the number of BCTs [50,51]. After setting behavioral goals according to the individual's needs (feedback), providers should ensure that goals align with the person's values, priorities, and motivations using motivational counseling for optimal efficiency. Indeed, face-to-face interventions are more effective than digital interventions and mixed interventions, i.e. a combination of digital format and face-to-face contact with a professional [52]. Moreover, mobile technologies have the potential to increase the effectiveness of these interventions [53] by providing comprehensive personalized feedback on the individual's health behaviors in a limited time [54]. Nevertheless, most eSBIs were automated, and only a quarter of patients received face-to-face interventions in the study by Ozanne et al. [44], while personalized feedback failed to increase discussions about alcohol consumption in the study by Agarwal et al. [31]. These poor results

from interactive eSBIs contradict previous findings [52], and remain difficult to interpret given the ambiguous or poor descriptions of BI components. For instance, information is lacking on whether interactive BIs included low-level (i.e. general advice on how to change behavior) or high-level motivational feedback (i.e. provides more individually tailored messages based on factors such as readiness to change or developing personal goals) [25]. Despite the existence of a large body of knowledge, information about the use of BI conceptual frameworks such as FRAMES [22] is missing, and the extent to which eSBIs follow existing guidelines remains unclear. Since the necessity for proper training constitutes barrier to SBI for providers [9], addressing these problems before implementation could be pivotal for their success.

#### 4.1. Limitations

##### 4.1.1. Limitations of studies included

Some studies have methodological limitations, such as the absence of a control group or randomization. Moreover, many studies had small sample sizes and short or no follow-up, making it difficult to draw conclusions about the eSBIs long-term effectiveness. Some studies provided little detail on the BI, which precluded a comprehensive assessment of implemented BCTs. In addition, several studies failed to indicate eSBIs durations, although of utmost importance for feasibility and acceptability. Finally, the high number of missing data in studies increases the risk of bias, as the least satisfied participants had lower response rates than others.

##### 4.1.2. Limitations of the review

To our knowledge, this is the first review analyzing evidence of eSBIs targeting diet/PA in healthcare setting. Despite the restrictive search terms applied in this review, we found important differences in types or timing of outcome measurements and intervention characteristics in the 15 studies included. This clinical heterogeneity makes their comparison difficult, and precludes understanding on what approaches are likely to be effective or not. Contrary to other outcomes though, adherence to PA/diet guidelines provides precise behavioral goals to be met for improving clinical conditions [55,56], and could therefore constitute the most relevant outcome for eSBI in medical settings.

3.1 Social support (unspecified)	3.3 Social support (emotional)	4.1 Instruction on how to perform the behavior	5.1 Information about health consequences	5.2 Saliency of consequences	5.3 Information about social and environmental consequences	9.1 Credible source	10.4 Social reward	10.5 Social incentive	12.5 Adding objects to the environment	13.2 Framing/reframing	15.4 Verbal persuasion about capability
✓		✓	✓	✓	✓	✓			✓	✓	✓
			✓		✓	✓		✓			
✓			✓		✓						
		✓			✓	✓					
		✓			✓						
	✓		✓		✓						
✓			✓		✓						

### 5. Conclusion and future directions

Although implementing eSBI towards PA/diet among adult patients in medical settings seems promising for primary, secondary and tertiary prevention, common conceptual framework, intervention and outcomes are severely lacking, and the extent to which they follow existing SBI guidelines remains unclear. Demonstrating their effectiveness requires fixing these issues before conducting prospective assessment studies in medical settings.

### Author contributions

**Camille Forcier:** Conceptualization, Formal analysis, Investigation, Data curation, Writing – Original Draft, Writing – Review and Editing, Visualization. **Aymery Constant:** Conceptualization, Data Curation, Writing – Original Draft, Writing – Review and Editing, Visualization, Supervision. **David Val-Laillet:** Writing – Review and Editing, Visualization. **Ronan Thibault:** Writing – Review and Editing, Visualization. **Romain Moirand:** Conceptualization, Writing – Review and Editing, Visualization, Supervision.

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### Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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