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Use and effectiveness of behavioral economics in interventions for lifestyle risk factors of non-communicable diseases: A systematic review with policy implications

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Abstract

Aim—There is limited evidence on what behavioral economics strategies are effective and can be used to inform non-communicable diseases (NCDs) public health policies designed to reduce overeating, excessive drinking, smoking, and physical inactivity. The aim of the review is to examine the evidence on the use and effectiveness of behavioral economics insights on reducing NCDs lifestyle risk factors.

Methods—Medline, Embase, PhycINFO, and EconLit were searched for studies published between Jan 2002 and July 2016 and reporting empirical, non-pharmacological, interventional research focusing on reducing at least one NCDs lifestyle risk factor by employing a behavioral economics perspective.

Results—We included 117 studies in the review; 67 studies had a low risk of bias and were classified as strong or very strong, 37 were moderate, and 13 were weak. We grouped studies by NCDs risk factors and conducted a narrative synthesis. The most frequent behavioral economics concepts were use of incentives, framing, and choice architecture. We found mixed results for effectiveness of behavioral economics insights on reducing NCDs lifestyle risk factors.

Conclusions—Most studies targeting tobacco consumption, physical activity levels, and eating behaviors from a behavioral economics perspective had promising results with potential impact on NCDs health policies. We recommend future studies to be implemented in real-life settings and on large samples from diverse populations.

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Competing interest

None declared.

Keywords

behavioral economics; non-communicable diseases; lifestyle risk factors

Introduction

Non-communicable diseases (NCDs) result from a combination of biological and lifestyle factors such as tobacco use, excessive alcohol consumption, physical inactivity and overeating (1), and are the major cause of disability and death worldwide (2). In order to curb the current NCDs epidemic, it was proposed for interventions to target the automatic bases of behaviors rather than to encourage conscious reflection upon the (unhealthy) behavior (3). Similarly, behavioral economists capitalize on the psychological underpinnings of the human behavior to predict the decision-making process of individuals and, ultimately, positively influence their behavior without restricting freedom of choice (4).

In the last decade there was considerable and continuously growing research and public policy interest in behavioral economics, with multiple applications being focused on reducing the four major risk behaviors of NCDs (5–7). Yet, our search shows the existence of only five systematic reviews on behavioral economics-related concepts, three focusing on choice architecture interventions (8–10) and two focusing on time discounting (11,12). From a public policy perspective, interest for behavioral economics started to rise in the early 2000's, when the libertarian paternalism approach to public policy has emerged (13,14).

The aim of this systematic review is to evaluate evidence for the application of behavioral economics strategies to reduce NCDs lifestyle risk factors. The specific objectives of the review are: i) to identify effective behavioral economics strategies used to promote tobacco cessation, reduce alcohol consumption, promote healthful diet, and increase physical activity; and ii) assess the extent to which the effective behavioral economics strategies could be used to inform NCDs public health policies.

Methods

This review is grounded in a structured systematic review protocol developed using the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (15,16).

Data/information sources—We searched PubMed, EMBASE, PsycINFO, and EconLit between January 1st 2002 (the year in which Daniel Kahneman was awarded the Nobel Prize in economics and the start of the exponential growth in behavioral economics-related publications - see Figure 1 (17)) and July 1st 2016.

Search strategy—The search strategy consisted of a combination of key words, Medical Subject Headings, and Thesaurus of Psychological Index Terms. We combined six search themes using Boolean operators (see Table 1), and searched databases using individualized search strategies (refer to Appendix 1).

Eligibility criteria—We included studies published in English between January 2002 and July 2016, describing empirical, non-pharmacological research conducted on humans, focusing on reducing one of the four lifestyle risk factors of NCDs, depicting any type of intervention design (19) employed to support behavioral change, and reporting the use of at least one behavioral economics concept. We excluded studies published in abstract or studies for which we could not retrieve their full.

Data management—Documents were handled using the Mendeley Desktop reference manager software (20) and the Rayyan software for conducting systematic reviews (21).

Study selection—Studies were selected for inclusion by two independent reviewers, the inter-rater reliability ($\kappa=.759$, 95% CI; 96% percent agreement among raters) suggesting substantial agreement between reviewers (22). We resolved disagreements through discussion. Figure 2 describes the study selection procedure.

Data items, data extraction process, and synthesis—Variables for which data was extracted for each eligible study (see Appendix 2 to review the data extraction form) include: (i) general details (i.e. title, authors, year of publication); (ii) specific details (i.e. study purpose, NCDs risk factor researched, study participants; and (iii) outcomes (i.e. standardized measures assessing the lifestyle risk factors of NCDs; changes in attitudes, beliefs, and social norms; findings' potential to inform public health policies).

We grouped studies included in the review based on the NCDs risk factor they focused on and the behavioral economics principle they employ. We used narrative synthesis was used for this review (23), as it was previously used for other systematic reviews on health behaviors (9,24,25).

Quality of studies included in the review—The quality of studies included in the review was assessed using Symour's et al. methodological quality rating system (26) (see Table 2).

Results

From the 2378 searches, 112 unduplicated records met the inclusion criteria. After searching the reference lists of included articles, we included 5 additional records in our review, rendering a total of 117 articles (refer to Table 3 for the full list of articles included in the review).

From the included studies, 18 were implemented in laboratory settings. The most frequent behavioral economics concept in these studies was use of monetary and nonmonetary incentives ($n=51$), followed by framing ($n=28$), and by choice architecture ($n=12$). The intervention duration ranged from 5 minutes to 3 years. The number of participants ranged from 7 to 304,054.

Study quality assessment—Most of the studies included in this review were of an experimental nature. Thus, they entailed small sample sizes and short duration. Studies

focusing on alcohol abuse were of the poorest methodological quality. In this review, studies targeting the eating behavior of the individuals were found to be less affected by methodological biases.

Studies focusing on reducing alcohol consumption

The 10 studies targeting alcohol consumption included a total of 2528 subjects, with sample sizes ranging from 13 (27) to 660 (28) subjects. Studies were implemented in laboratories of large universities in the USA (27–30), classrooms (31–33), fraternity houses (34), and online environments through email (35) and Facebook (36). All the studies focused on college students, with most targeting heavy drinkers (27,29,33,35), and were based on convenience samples. Seven studies included randomization of participants (29–33,35,36) and four reported using a control group (29,32,33,36). For articles which reported intervention durations, this ranged from 30 minutes (33) to 8 hours (34). For six studies, intervention duration was not reported (28,30–32,35,36).

In terms of employed behavioral economics concepts, four studies focused on changing social and group-specific norms associated with alcohol consumption (28,32,35,36), three on delayed discounting by emphasizing the role of drinking on career goals or constructive alternatives to drinking (27,29,33), one on the prospect theory by testing the effects of loss and gain frames on reported binge drinking (31), one on academic constraints associated with alcohol consumption (30), and one on the use of monetary incentives to prevent excessive alcohol consumption (34). Most studies focused on changes in social norms and self-reported alcohol consumption, and only one study reported biochemical assessment of alcohol consumption (blood alcohol concentration) (34).

Concerning the policy potential of these findings, two studies propose changes in campus policies by (i) increasing availability of self-evaluation of blood alcohol concentrations as a means to promote lower intoxication levels (34), and (ii) manipulation of class schedules as a means to reduce alcohol use in the night prior to early next-day classes (30).

Studies focusing on reducing tobacco use

Reduction in smoking was targeted in 25 interventional studies with a total of 12,278 participants, sample sizes ranging from 43 (37) to 2538 (38) participants. Among the identified articles, seven reported studies implemented in medical settings (39–45), six in educational settings (46–51), while four described online interventions (37,38,52,53). Others were implemented at home (54), in the workplace (55,56) or by telephone (57–59). Regarding participants, interventions focused on pregnant smokers (n=4) (40–42,45), adult smokers (n=5) (37,43,50,52,60), smokers seeking to quit (n=3) (57,58,61), college students (n=4) (47,48,51,53), adolescents (n=3) (46,49,54), employees (n=2) (38,55,56), or other participants categories (n=2) (44,59). Most studies were based on convenience sampling or purposive sampling. We identified randomized controlled trials (n=14) (38,39,41,43–46,49,54,56–58,60), experimental or quasi-experimental studies (n=7) (37,47,48,50–52,61), and pre-post evaluation or post-evaluation only studies (n=4) (40,53,55,59). Reported intervention durations ranged from 10 minutes (48) to 12 months (43).

The behavioral economics concept most frequently reported was incentives, either alone (n=11) (39–41,44,45,49,54,56,61,62) or in combination with other behavioral economics concepts (n=3) (38,55,60). Framing was used in eight studies (37,48,51–53,57–59), while two studies employed pledges (46) or use of priming (47).

The policy implications of three studies included in the review refer to the development of positively framed anti-smoking Public Service Announcements (PSAs) (48) for individuals who have low nicotine addiction, while negatively framed anti-smoking PSAs have the potential to be more effective for individuals who are aware that smoking is an unhealthy behavior and intend to change (53); at a population level, variation in terms of warning content was found to have sustained effectiveness (52). A study conducted in Thailand which used incentives combined with peer-pressure and a pre-commitment contract to reduce smoking suggested that team-based approaches are more cost-effective in poor communities (60), while the results of a study conducted in the UK suggest that spirometry and providing information about lung age to smokers has the potential to be cheaper and more effective than other available smoking cessation programs (43).

Studies focusing on improving nutrition

From the 117 articles included in the review, 45 articles focused on improving the eating behavior of a total sample of 40,528 individuals. Sample sizes ranged from 13 (63) to 8,000 (64) participants. Only 4 of the identified studies described interventions implemented in a laboratory setting (65–68), 12 were implemented in cafeterias or canteens (69–80), and 7 were implemented in schools (64,81–86). In terms of participants, 17 studies focused on primary or secondary school children (63,64,68–71,79,80,82–90), 8 focused on adults (67,81,91–96). Special populations targeted by these studies include overweight children (63) and obese women (91), postpartum women (95), adolescents and young adults with intellectual disabilities (97), adolescent girls at risk of obesity, and low-income individuals (88,98). All studies were based on convenience or purposive samples, with the exception of three studies which used a probabilistic (99), a clustered (85), and a stratified random (80) sampling design. Thirteen studies were randomized controlled studies (63,75,82,85–87,89,91,92,96,98,100,101), ten described field experiments (64,74,75,79,80,88,99,102–104), and two were quasi-experimental studies (71,97). Reported intervention durations ranged from 7 minutes (89) to 24 months (77).

Ten of these studies employed the concept of choice architecture (66,71,76–78,82,85,97,102,104) to make changes to serving lines (66,78,97), to vending machines (85), or to indicate healthful and unhealthful foods by using traffic lights-like labels (76,77). Incentives, both monetary and non-monetary, used alone or in combination with other behavioral economics concepts (99), were reported in 8 studies (65,75,90,95,98,100,105). Framing was used to influence the normative size of food portions (74), to negatively or positively frame the incentives received after selecting a healthful/unhealthful food item (88), and to emphasize healthier choices using a “tick” (92) or single-/dual-column nutritional labels (81). Other studies made use of defaults rules by encouraging the selection of at least one serving of fruits or vegetables for a meal (84), by using a bowl of the same size for every meal (91), and by pre-preparing vegetables in containers (87,101).

In term of findings with policy implications, the studies included in this review propose: the use of traffic-light labels as means to promote healthy food choices (76,77); the use of incentives in combination with education to decrease consumption and reduce waste (88); changes in serving lines as a means to influence choice of healthful foods (72,78,81,102); and making the healthier choice the easiest choice (97) and the unhealthy choice more difficult to get (70).

Studies focusing on increasing physical activity

We identified 37 articles describing 39 interventional studies focused on increasing physical activity. The sample sizes of these studies ranged from 7 (106) to 30,4054 (107), resulting in a total of 449,406 participants. Twelve studies were web- or mHealth-based (108–119), eight were implemented in educational settings (120–126), five were conducted in laboratory settings (106,127–130), while four were implemented in sports facilities (131–134). Other studies reported interventions conducted at the workplace (135–137), in medical centers (115,138), in a senior center (130), or outdoors (139). Participants were employees (n=7) (108,109,115–117,119,120,131,135–137), college students (n=8) (106,113,124,127,128,131,134) and school children (n=6) (114,121–123,133,139). Participants were further described as sedentary or overweight (115,116,126,128,138,140), older adults (115,127,129,130,141), or members in health programs (106,107,110–112,118). Regarding the selection of participants, 38 studies employed a convenience sampling design and one study (127) used snowball sampling. The articles included in the review describe randomized controlled designs (n=14) (112–117,119,126,132–134,138,139), experimental and quasi-experimental designs (n=14) (111,121,123,124,127,130,131,135–137,140,141), pre-post evaluation or post-evaluation only designs (n=9) (106,109,110,118,120,122,125,128,129), while two studies had an observational design (107,108). The intervention durations ranged from 5–7 minutes (111) to 3 years (107); three studies (112,113,129) did not mention the length of intervention.

The researchers used incentives in more than half of the studies (n=24), either alone (n=19) (106–110,115,116,119,121,122,124,125,131,134,135,137,139) or combined with other behavioral economics concepts (n=5) (114,117,126,136,140). Other employed behavioral economics concepts included framing (n=10) (111,113,118,123,127–130,138), anchoring (112,133), nudging (112,132), use of pre-commitments (112,141), default options (112) or disconnected values models (120).

Some studies suggest that using incentives could increase physical activity and subsequently minimize the health risks of sedentarism (106,107,116,122,131), but not among currently active individuals (124). On the other hand, commitment contracts or money deposits have the potential to be more scalable with minimal resources and could be similar or more cost-effective than offering monetary incentives from the interventionist's part (112,141). The use of *exergames* – video games prompting the player to move – can promote physical activity among school-children (123). Older adults could benefit from programs including positively-framed messages and meant to improve their physical activity (130). Finally, nudging was also proposed as an effective way to increase physical activity by sending reminders about the targeted behavior or feedback regarding participants' behaviors (132).

Discussions

The aim of this review was to evaluate evidence on the use and effectiveness of behavioral economics strategies to reduce lifestyle risk factors for the development of non-communicable diseases. Due to the heterogeneity of primary outcomes and the weak or moderate quality of included studies, we could not determine the effectiveness of interventions targeting NCDs risk factors and using behavioral economics underpinnings in this review. Therefore, this review should be seen as an indicator of the current research in this field and a starting point for future research to be conducted in this area.

The relatively poor quality of studies focusing on alcohol consumption and behavioral economics identified in this review calls for more non-laboratory-based, randomized controlled studies on this specific topic.

Our findings show that the behavioral economics concepts employed across the studies included in the review vary by the nature of the targeted NCDs risk behavior. More specifically, studies reporting interventions designed to reduce alcohol consumption employed concepts such as social norms and delayed discounting. On the other hand, interventional studies focusing on reducing smoking and those targeting an increase in physical activity levels were more likely to use incentives as part of their strategy to diminish tobacco use and/ or increase physical inactivity. The use of incentives was also frequent in nutrition-related studies, but a large proportion of these studies also employed choice architecture and framing strategies to increase fruit and vegetable intake or reduce consumption of unhealthful foods.

Offering incentives was the most common technique used to change the NCDs health risk behaviors we focused on in this review. The purpose of this review was not to focus on interventions using incentives provided contingent on smoking cessation, reduced alcohol intake, improved nutrition, or increased physical activity, as this has been the focus of previous reviews (142–147). The results of this review suggest a potentially more cost-effective alternative to the use of monetary and non-monetary incentives. Such a strategy could consist in asking participants to make pre-commitments, either by signing a contract to change a behavior (46,55,60,112,136,148) or by making a monetary deposit as a guarantee for behavioral change (141).

Our findings emphasize several behavioral economics strategies to reduce smoking, poor nutrition, and physical inactivity which warrant future research, due to their potential policy implications. In the case of tobacco use, we found that positively framed anti-smoking public service announcements may be more effective in the case of individuals with low nicotine addiction, whereas negatively framed anti-smoking public service announcements may be more effective in individuals who are in the contemplation phase (53). In addition, offering information to smokers regarding the age of their lungs could be an effective way to encourage them to stop using tobacco (43). Regarding potential policies designed to impact nutrition and eating behaviors, these could incorporate traffic-light labels (76,77) and changes in serving lines (72,78,81,102) as means to promote healthy food choices. To reduce physical inactivity, researchers recommend policy makers to implement programs

with a commitment contract or money deposit component (112,141), focus on development of exergames (123), and nudge individuals by offering constant feedback regarding the status of their physical activity level (132).

Conclusions and future research

This review found inconclusive evidence regarding the success of behavioral economics strategies to reduce alcohol consumption, but suggests several strategies with policy-level implications which could be used to reduce smoking, improve nutrition, and increase physical activity. This review has highlighted some studies which showed potential to reduce smoking and overeating, and to increase physical activity. Yet, the majority of these studies have to be replicated over longer periods of time, and among more diverse populations, to demonstrate the generalizability of their findings. We also recommend future studies to compare their outcomes against those of established health promotion interventions designed to deter the lifestyle risk factors of NCDs, in order to establish if interventions grounded on behavioral economics concepts are more effective than other strategies to reduce overeating, smoking, excess drinking, and lack of physical activity.

Strengths and limitations

Strengths of this review include the existence of a systematic review protocol and the use of two reviewers for the selection of the relevant studies. Limitations consists in the use of only four electronic databases as data sources and the exclusion of articles published in non-English languages, possibly resulting in selection bias.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Medline trend: automated yearly statistics of PubMed results for “behavioral economics” query (17)

Figure 2.
Review flowchart

Table 1

List of search themes and terms used for the searching strategies

Search themes	Search terms
(i) Behavioral economics (18)	behavioral economics, anchoring, <i>choice architecture</i> , confirmation bias, default, framing, intertemporal choice, incentive, loss aversion, mental accounting, nudge, partitioning, social norm, social proof, status quo bias, time discounting
(ii) Study design	allocated, assigned, clinical trial, comparative studies, controlled, controlled clinical trial, cross-over studies, experiment, intervention, placebo, pre-post, randomization randomized controlled trial, RCT
(iii) Tobacco use	cessation, smoking, tobacco use, nicotine
(iv) Lack of physical activity	active, energy expenditure, exercise, exercise behavior, fundamental movement skill, motor activity, motor skill, movement, physical activity, physical exertion, physical fitness, sedentary, sport, training
(v) Poor nutrition	beverages, carbonated beverages, diet, dietary behavior, eating feeding behavior, food, nutrition, soda, soft drink, sugar intake, sweetened beverage, carbonated beverage, unhealthy diet
(vi) Alcohol consumption	alcohol use, alcohol abuse, alcoholic beverage, alcoholism, binge drinking, drinking, ethanol, liquors

Table 2

Methodological quality system employed to assess quality of studies included in the review

Rating	Definition	Study description	Design and methods
*	Weak	Many details missing (three or more of the following: setting, intervention design, duration, intensity, population, or statistical analysis), irrelevant design or methods.	Methodologic flaws (in statistical methods used, design of intervention, etc.).
**	Moderate	Some details missing (one or two).	Small sample size (<50) or short duration (<1 month).
***	Strong	Some details missing (one or two).	Larger sample size (≥ 50) and longer duration (>1 month).
****	Very strong	Very clear, all details provided.	Larger sample size (≥ 50), longer duration (>1 month), and all of the following criteria: population randomly allocated or matched for intervention or control, generalizable results, or validated assessment.

Note: Instrument reproduced from Seymour et al. (2004)

Table 3

Quality assessment of studies included in the review

	Weak		Moderate		Strong		Very strong		Total	
	n	%	n	%	n	%	n	%	n	%
NCDs risk factor										
Alcohol	4	40	6	60	0	0	0	0	10	10
Nutrition	4	8.88	14	31.11	15	33.33	12	26.66	45	45
Physical activity	4	10.81	10	27.03	11	29.73	12	32.43	37	37
Smoking	1	4	7	28	8	32	9	36	25	25
Total	13	11.11	37	31.62	34	29.06	33	28.20	117	117