SUPPLEMENTARY MATERIALS

Table 1: Search strings

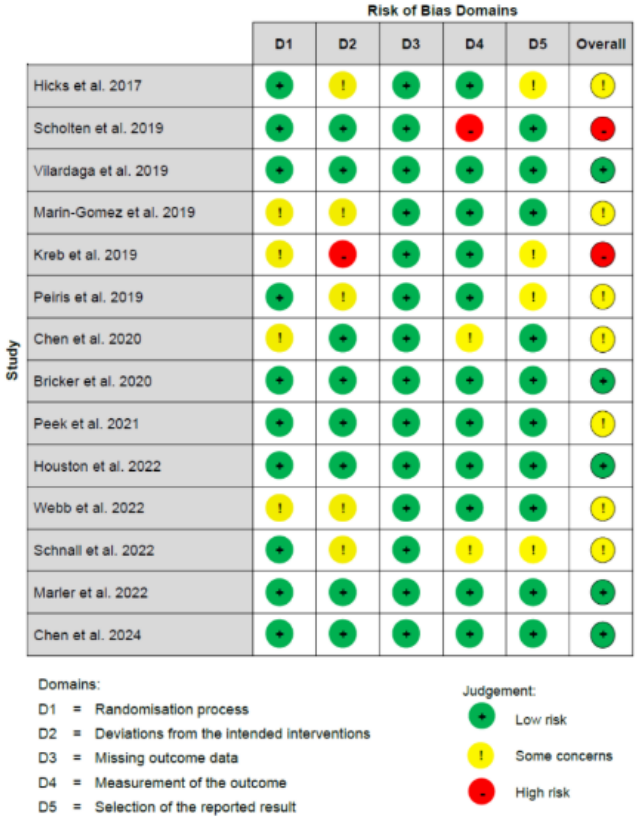
Database and Date of search	Search string	No of hits
PubMed (11 Nov 2024)	((((((((((Gamification[Title/Abstract]) OR (game-based[Title/Abstract])) OR (digital game[Title/Abstract])) OR (serious game[Title/Abstract])) OR (game design*[Title/Abstract])) OR (game mechanic*[Title/Abstract])) OR (game intervention*[Title/Abstract])) OR (game element*[Title/Abstract])) OR (mobile app*[Title/Abstract])) OR (digital intervention[Title/Abstract])) AND ((((((((((smok*[Title/Abstract]) OR (tobacco*[Title/Abstract])) OR (cigar*[Title/Abstract])) OR (vape*[Title/Abstract])) OR (vaping[Title/Abstract])) OR (e-cig*[Title/Abstract])) OR (nicotine*[Title/Abstract])) OR (heated tobacco[Title/Abstract])) OR (cigar*[Title/Abstract])) OR (ENDS[Title/Abstract])) OR (electronic nicotine delivery system*[Title/Abstract])) OR (electronic cigarett*[Title/Abstract]))) AND ((((quit*[Title/Abstract]) OR (abstain*[Title/Abstract])) OR (cessat*[Title/Abstract])) OR (abstinence[Title/Abstract]))	255
Web of Science (3 Nov 2024)	((((((((((TI=Gamification OR AB=Gamification)) OR ((TI=game-based OR AB=game-based))) OR ((TI="digital game" OR AB="digital game"))) OR ((TI="serious game" OR AB="serious game"))) OR ((TI="game design*" OR AB="game design*"))) OR ((TI="game mechanic*" OR AB="game mechanic*"))) OR ((TI="game intervention*" OR AB="game intervention*"))) OR ((TI="game element*" OR AB="game element*"))) OR ((TI="mobile app*" OR AB="mobile app*"))) OR ((TI="digital intervention" OR AB="digital intervention"))) AND ((((((((((((TI=smok* OR AB=smok*)) OR ((TI=tobacco* OR AB=tobacco*))) OR ((TI=cigar* OR AB=cigar*))) OR ((TI=vape* OR AB=vape*))) OR ((TI=vaping OR AB=vaping))) OR ((TI=e-cig* OR AB=e-cig*))) OR ((TI=nicotine* OR AB=nicotine*))) OR ((TI="heated tobacco" OR AB="heated tobacco"))) OR ((TI=cigar* OR AB=cigar*))) OR ((TI=ENDS OR AB=ENDS))) OR ((TI="electronic nicotine delivery system*" OR AB="electronic nicotine delivery system*"))) OR ((TI="electronic cigarett*" OR AB="electronic cigarett*")))) AND (((((TI=quit* OR AB=quit*)) OR ((TI=abstain* OR AB=abstain*))) OR ((TI=cessat* OR AB=cessat*))) OR ((TI=abstinence OR AB=abstinence)))	283
Scopus (3 Nov 2024)	((((((((((TITLE-ABS(Gamification)) OR (TITLE-ABS(game-based))) OR (TITLE-ABS("digital game"))) OR (TITLE-ABS("serious game"))) OR (TITLE-ABS("game design*"))) OR (TITLE-ABS("game mechanic*"))) OR (TITLE-ABS("game intervention*"))) OR (TITLE-ABS("game element*"))) OR (TITLE-ABS("mobile app*"))) OR (TITLE-ABS("digital intervention"))) AND ((((((((((TITLE-ABS(smok*)) OR (TITLE-ABS(tobacco*))) OR (TITLE-ABS(cigar*))) OR	360

Database and Date of search	Search string	No of hits
	(TITLE-ABS(vape*))) OR (TITLE-ABS(vaping))) OR (TITLE-ABS(e-cig*))) OR (TITLE-ABS(nicotine*))) OR (TITLE-ABS("heated tobacco"))) OR (TITLE-ABS(cigar*))) OR (TITLE-ABS(ENDS))) OR (TITLE-ABS("electronic nicotine delivery system*"))) OR (TITLE-ABS("electronic cigarett*")))) AND ((((TITLE-ABS(quit*)) OR (TITLE-ABS(abstain*))) OR (TITLE-ABS(cessat*))) OR (TITLE-ABS(abstinence)))	
CENTRAL (8 Nov 2024)	In Title Abstract Keyword: ((gamification OR game-based OR (digital NEXT game*) OR (serious NEXT game*) OR (game NEXT design*) OR (game NEXT mechanic*) OR (game NEXT intervention*) OR (game NEXT element*) OR (mobile NEXT app*) OR "digital intervention") AND (smok* OR tobacco* OR cigar* OR vape* OR vaping OR e-cig* OR nicotine* OR "heated tobacco" OR cigar* OR ENDS OR "electronic nicotine delivery system*" OR (electronic NEXT cigarett*)) AND (quit* OR abstain* OR cessat* OR abstinence))	318
ClinicalTrials.gov (8 Nov 2024)	(smoking cessation OR "smoking abstinence") | Other terms: (smok* OR tobacco* OR cigar* OR vape* OR vaping OR "e-cig*" OR nicotine* OR "heated tobacco" OR cigar* OR ENDS OR "electronic nicotine delivery system*" OR "electronic cigarett*") | (gamification OR "game-based" OR "digital game*" OR "serious game*" OR "game design*" OR "game mechanic*" OR "game intervention*" OR "game element*" OR "mobile app*" OR "digital intervention") | Studies with results	14
WHO ICRTP (8 Nov 2024)	(gamification OR "game-based" OR "digital game*" OR "serious game*" OR "game design*" OR "game mechanic*" OR "game intervention*" OR "game element*" OR "mobile app*" OR app* OR "digital intervention") AND (smok* OR tobacco* OR cigar* OR vape* OR vaping OR "e-cig*" OR nicotine* OR "heated tobacco" OR cigar* OR ENDS OR "electronic nicotine delivery system*" OR "electronic cigarett*") AND (quit* OR abstain* OR cessat* OR abstinence) * Search with Result	148

Supplementary figures 1 – 4: Risk of bias assessment using the RoB2 tool assessing the risk of bias in RCT (individually randomised, parallel-group trial) studies

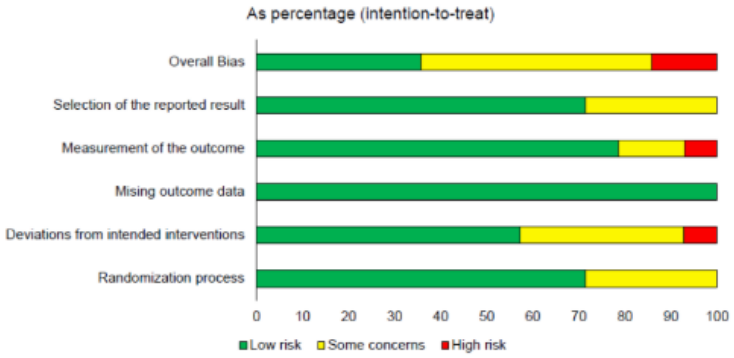
Supplementary Figure 1.

Risk of Bias Summary: Individual Domains for Each Included Randomised Controlled Trial (Parallel-Group Design)



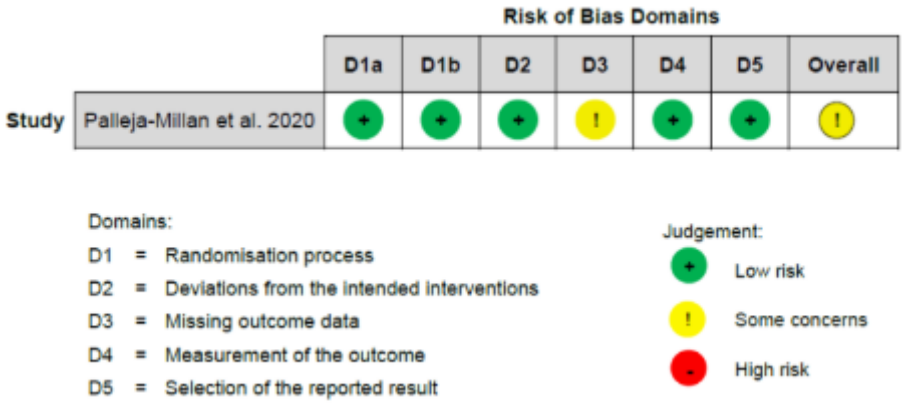
Supplementary Figure 2.

Risk of Bias Graph: Proportion of Studies Rated at Low, Some Concerns, or High Risk Across Domains (Parallel-Group Design)



Supplementary Figure 3.

Risk of Bias Summary: Individual Domains for Cluster-Randomised Trial



Supplementary Figure 4.

Risk of Bias Graph: Overall Assessment for Cluster-Randomised Trial

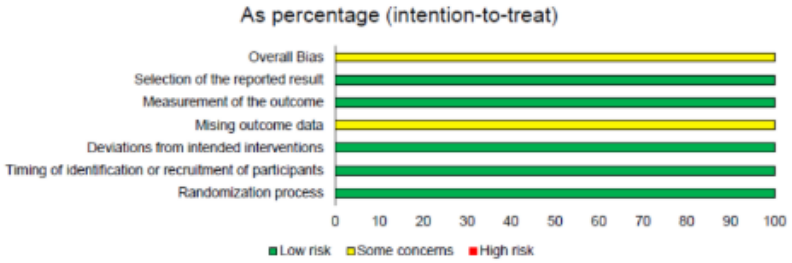


Table 2: Effectiveness of gamification for smoking cessation (results from individual studies)

Mode of reporting	Mode of biochemical verification	Duration of continuous abstinence	Assessed at	RR / OR (CI)	p-value	Author (Year)
Bioverified	Carbon monoxide	7-day	7-day	RR 0.6	-	Hicks et al. (2017)
			2 weeks	RR 0.9	-	Hicks et al. (2017)
			4 weeks	OR 0.48 (0.10–2.21)	0.347	Vilardaga et al. (2019)
			8 weeks	OR 13.9 (0.75–259)	0.077	Vilardaga et al. (2019)
			12 weeks	OR 1.35 (0.21–8.7)	0.752	Vilardaga et al. (2019)
				2.8 (1.3-6.1)	0.08	Marler et al. (2022)
				RR 1.27 (0.42 - 3.78)	0.66	Schnall et al. (2022)
			16 weeks	OR 3.86 (0.41–36)	0.239	Vilardaga et al. (2019)
			24 weeks	1.92 (1.01-3.68)	0.048	Houston et al. (2022)
			26 weeks	2.3 (1.1-4.8)	0.03	Marler et al. (2022)
				RR 1.70 (1.22 to 2.37)	0.003	Webb et al. (2020)
			52 weeks	RR 1.71 (1.17 to 2.5)	0.005	Webb et al. (2020)
		30-day	16 weeks	OR 3.86 (0.41–36)	0.239	Vilardaga et al. (2019)
		Since quit date	12 weeks	HR 4.31 (1.87-9.97)	p<0.001	Marin-Gomez et al. (2019)
				1.31 (0.82-2.09)	0.26	Palleja-Milan et al. (2020)
			24 weeks	0.5% (1/22) event group. 0% (0/24) control group.	-	Peiris et al. (2019)

Mode of reporting	Mode of biochemical verification	Duration of continuous abstinence	Assessed at	RR / OR (CI)	p-value	Author (Year)
			26 weeks	2.7 (1.1-6.4)	0.03	Marler et al. (2022)
			52 weeks	1.02 (0.58-1.79)	0.94	Palleja-Milan et al. (2020)
	Salivary cotinine	7-day	4 weeks	30% (4/13) event group. 18% (2/11) control group.	-	Krebs et al. (2019)
		7-14 day	12 weeks	0	-	Hicks et al. (2017)
			24 weeks	0	-	Hicks et al. (2017)
		30-day	6 weeks	RR 5 (1.2-21.4)	0.03	Chen et al. (2020)
Self-reported		24-hour	4 weeks	RR 1	-	Scholten et al. (2019)
			12 weeks	RR 0.96	-	Scholten et al. (2019)
		7-day	1 week	2.39 (1.78-3.22)	0.003	Chen et al. (2024)
			2 weeks	3.36 (2.43-4.64)	p<0.001	Chen et al. (2024)
			3 weeks	2.97 (2.16-4.07)	p<0.001	Chen et al. (2024)
			4 weeks	3.42 (2.48-4.70)	p<0.001	Chen et al. (2024)
				3.46 (1.38-8.69)	0.007	Chen et al. (2020)
				RR 1.55 (1.23 to 1.96)	p<0.001	Webb et al. (2020)
			6 weeks	2.25 (0.92-5.52)	0.07	Chen et al. (2020)
			12 weeks	1.4 (0.8-2.7)	0.28	Marler et al. 2022
				RR 1.27 (0.26 - 6.76)	0.77	Schnall et al. 2022

Mode of reporting	Mode of biochemical verification	Duration of continuous abstinence	Assessed at	RR / OR (CI)	p-value	Author (Year)
				2.04 (1.64-2.54)	p<0.001	Bricker et al. (2021)
			24 weeks	1.73 (1.42-2.10)	p<0.001	Bricker et al. (2021)
			26 weeks	1.7 (0.9-3.2)	0.12	Marler et al. (2022)
				RR 1.32 (1.03 to 1.69)	0.03	Webb et al. (2020)
			52 weeks	RR 1.20 (0.94, 1.54)	0.19	Webb et al. (2020)
				1.35 (1.12-1.63)	0.002	Bricker et al. (2021)
		30-day	12 weeks	1.4 (0.7-2.8)	0.32	Marler et al. 2022
			12 weeks	2.20 (1.68-2.89)	p<0.001	Bricker et al. (2021)
			24 weeks	2.03 (1.63-2.54)	p<0.001	Bricker et al. (2021)
			26 weeks	1.7 (0.9-3.4)	0.12	Marler et al. 2022
			52 weeks	1.49 (1.22-1.83)	p<0.001	Bricker et al. (2021)
		90-day	52 weeks	2.00 (1.45-2.76)	p<0.001	Bricker et al. (2021)
		Since quit date	4 weeks	OR 5.92 (3.78-9.26)	p<0.001	Chen et al. (2024)
				0.5% (1/22) event group. 0% (0/24) control group.	-	Peiris et al. (2019)
			12 weeks	1.2 (0.6-2.3)	0.56	Marler et al. (2022)
				2.1 (0.4-10.8)	0.42	Peek et al. (2021)
			26 weeks	1.6 (0.9-3.1)	0.13	Marler et al. (2022)

Mode of reporting	Mode of biochemical verification	Duration of continuous abstinence	Assessed at	RR / OR (CI)	p-value	Author (Year)
				RR 1.82 (1.29 to 2.58)	p<0.001	Webb et al. (2020)
			52 weeks	RR 1.93 (1.29 to 2.90)	0.002	Webb et al. (2020)

NB:

RR = relative risk; OR = odds ratio; 95% CI = 95% confidence interval

PRISMA 2020 Checklist

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	5
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	5
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	6
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.	6
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	6 & supp. 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.	7
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.	7
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.	7
	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.	6-7
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.	8
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.	8
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)).	8
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	8
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	8
	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.	8
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	8
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	8
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	8
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	-

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
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.	10
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	10
Study characteristics	17	Cite each included study and present its characteristics.	12-13
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	11
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.	27-29
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	11
	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.	27-29
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	27
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	27
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	-
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	-
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	30
	23b	Discuss any limitations of the evidence included in the review.	33
	23c	Discuss any limitations of the review processes used.	33
	23d	Discuss implications of the results for practice, policy, and future research.	33
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.	6
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	-
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	-
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	35
Competing interests	26	Declare any competing interests of review authors.	35
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.	6

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