Developing an Equitable Public Health Approach to Reducing Gambling Harms

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A review of the protocol has been completed and is understood and approved by the following:

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1 INTRODUCTION

1.1 Background

Gambling is now widely acknowledged to be a major public health issue. A 2021 Public Health England (PHE) evidence review[1] and a subsequent 2023 Office for Health Improvement and Disparities (OHID) update[2] found substantial morbidity and mortality associated with gambling. While noting lack of comprehensive data on gambling harms, by using evidence on costs of suicide, depression, unemployment, imprisonment, and homelessness, OHID conservatively estimated that gambling harm was associated with an annual cost of £1.05 - £1.77 billion, in England alone. The National Institute of Economic and Social Research estimate problematic gambling to cost £1.4 billion per year. In response, many experts call for a whole-systems, public health (PH) approach, anchored in population-level interventions to reduce harms.

Early gambling harms research was mainly focused on individual 'problem gamblers', and screening models maintain a focus on individuals.[1, 3-5] However, more recent research has incorporated wider dimensions of harm, including at the population level.[1, 5] Experts who advocate for a PH approach to gambling regularly call for legal and regulatory interventions.[6-9] These interventions include age restrictions on access to products or premises, advertising and marketing limits, bans on particular types of machines or games, stake limits, and restrictions on the physical and temporal availability of gambling. In part in response to these demands, significant legal and regulatory changes, underpinned by concerns about harm, have been enacted in recent years (e.g. changing the age limit for the National Lottery; strengthening the Licensing Conditions and Codes of Practice for remote operators).[10, 11] Further measures were proposed in the 2023 White paper on gambling, with legal changes subsequently introduced around stake limits on online slots, mandatory affordability checks for online gamblers when their spending reaches a certain threshold, and lower online slot stake limits for 18-24 year olds.[12] Further, the Gambling Commission's 2023-6 plan[2] to improve the evidence base for gambling regulation repeatedly identifies the urgent need to assess which interventions are most effective in reducing gambling-related harms, and to improve the use of evaluative approaches. Legal interventions are a crucial focus.

1.2 The need to understand the effects of interventional PH laws and regulations

A wide variety of laws and regulations have incidental impacts on public health, but as noted by Burris et al.[13] the key subset of "interventional public health law" consists of "law or legal practices that are intended to influence health outcomes or mediators directly". While such interventional law can be a powerful PH tool, we know from other sectors that it can sometimes not work as intended, and it can often have differentiated effects on various groups within a jurisdiction. Research outside gambling confirms that interventional public health laws and regulations need to be evaluated for effectiveness,[14] including for their impact on inequalities.[13, 15] However, there is no systematic, comprehensive, up to date review of evidence on the effectiveness of legal interventions intended to address gambling harm.[16] The Lancet Public Health Commission on gambling has gathered descriptive information about trends in gambling legislation in different countries,[17, 18] but there is a paucity of work systematically examining the *effects, including the health equity effects,* of laws and regulations intended to reduce gambling harm.

1.3 The need to understand the wider impacts of gambling

There is broad consensus about the need to widen measures of gambling harm, moving beyond counting the numbers of problem gamblers in society towards more

comprehensive, population-level measures which also capture the impacts of affected others and wider society.[1, 2, 19-21] Additionally much of the evidence base describing the current breadth of harms is undermined by suboptimal methods, including varied definitions of gambling behaviours and a lack of robust study designs.[22] Additionally, structural biases in national datasets can lead to the underrepresentation of certain groups, such as ethnic minorities, older and younger populations, and non-English speakers. As a result, the true impact of gambling on these groups may not be accurately captured. There is also a notable absence of nationally representative datasets that capture the range of gambling behaviours and their impacts, especially among vulnerable and underserved populations.[23]

1.4 The need for a core outcome set (COS) with improved measures

To evaluate and improve PH interventions designed to reduce gambling harms, we require deeper understanding of the full spectrum of patient/population reported outcomes of interest, beyond the narrow definition of clinical gambling disorder, in order that PH interventions can be better designed and evaluated.[24, 25] A mapping review of interventions commissioned by the National Institute for Health and Care Research,[16] designed in part to document the scope and nature of the evidence base, identified 30 papers, 23 of which related to targeted treatment interventions for individuals with an identified gambling addiction. Only seven studies related to whole population preventative interventions (three on demand reduction and four on supply reduction). With existing research on interventions so heavily skewed to addictions treatment, outcomes measures are often very narrow, resting in particular on changes to individual scores in the Problem Gambling Severity Index. Moreover, industry-supported 'responsible gambling' approaches often utilise narrow framings of harm reduction that only measure individual behaviour change.[26] Hence, there is an unmet need for the development of a co-produced interdisciplinary COS relevant to those who gamble across the spectrum of harms, for affected others, and for the wider community and society.

2 OVERARCHING AIMS AND OBJECTIVES

2.1 Study Aim

We are aiming to optimise the delivery of an equitable public health approach to gambling, specifically related to assessing the effects of legal changes and population-based interventions intended to reduce gambling harm.

2.2 Study Objectives

2.2.1 To describe and understand the effects of interventional public health laws and regulations intended to reduce harms associated with gambling (Work Package (WP)1).
2.2.2 To explore the breadth of gambling related harms (WP2).
2.2.3 To develop a core outcome set to design a best practice model for studying gambling related legal and population-based interventions (WP3).

3 WP1: WHAT ARE THE EFFECTS OF INTERVENTIONAL PUBLIC HEALTH LAWS AND REGULATIONS INTENDED TO REDUCE HARMS ASSOCIATED WITH GAMBLING?

As a first step, with patient and public involvement (PPI) input, we generated a preliminary explanatory context-mechanism-outcome configuration (CMOC) model of pathways for unintended interventional effects of laws intended to reduce gambling harms (Figure. 1). This will guide the focus of our systematic review, incorporating factors important to patients and

the wider public. The CMOC also provides a framework for synthesis to be adapted and expanded.

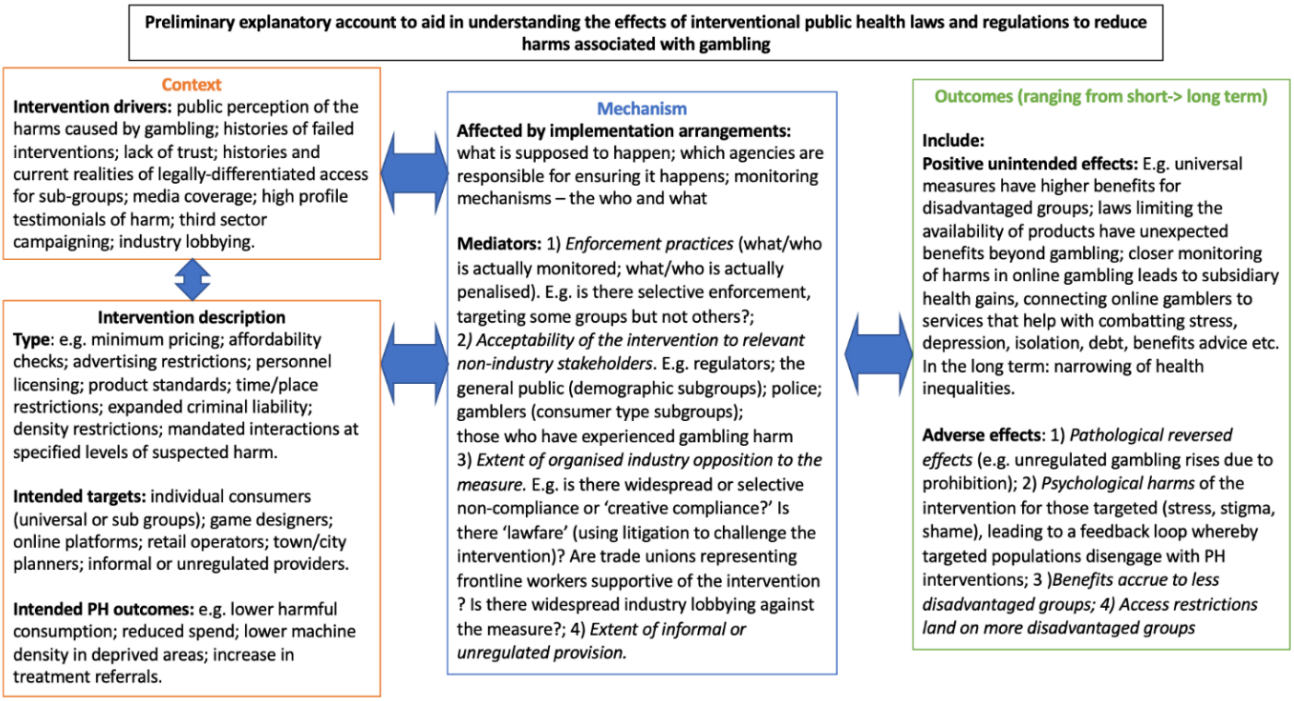

Figure 1. Draft CMOC co-designed with PPI

3.1 What we propose to do

Specifically, to craft effective interventional PH laws and regulations to address gambling harm, lawmakers need researchers to review relevant evidence about what works, for whom, and what the positive and negative effects[27] of specific laws and regulations may be. Negative effects include paradoxical effects (e.g. interventions aiming to reduce gambling that appear to increase it), and harmful externalities (e.g. psychological harms, or equity harms).[27, 28] The methods used to measure intervention effectiveness must be comprehensive, drawing on diverse bodies of evidence, including diverse stakeholder perspectives, and accounting for the breadth of intended/unintended and spillover effects to capture their impact.[29-31] In so doing, we can improve our understanding of intervention efficacy and mechanisms for efficacy and identify lessons for how future interventions should be designed.

3.2 Research questions

3.2.1 What are the effects of interventional PH laws and regulations intended to reduce harms associated with gambling on any global population or sub-population?

3.2.2 What are the mechanisms by which those laws result in their outcomes?

3.2.3 What are the contexts that influence those mechanisms?

3.3 Objectives

3.3.1 Identify the effects of interventional PH laws and regulations intended to address gambling harm.

3.3.2 Conduct a realist synthesis to provide an initial explanatory analysis of how and why legal and regulatory interventions work (or do not work) in particular contexts or settings, for particular sub-groups.[32-34]

3.3.3 Share that initial explanatory analysis (derived from the systematic review evidence) with a range of experts, to co-produce a second iteration, co-designed CMOC.

3.4 Methods

This review will explore all effects of interventional PH laws and regulations intended to address gambling harms. The reporting of the protocol follows the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines.[35]

3.5 Eligibility criteria

In this review we limit our focus to interventional PH laws and regulations "intended to improve the health of a defined population through specific preventive interventions".[13, 36] They consist of primary and secondary legislation (including statutory instruments), and related regulations, ordinances, licensing conditions and codes of practice, and binding guidance. As noted by UK government, the key factor distinguishing legal and regulatory interventions from other types of rules (e.g. within voluntary industry schemes) is whether "failure to comply would result in the regulated entity or person coming into conflict with the law or being ineligible for continued funding, grants and other applied-for schemes".[37] We do not consider case law in this study. We include only interventional PH laws and regulations intended to reduce gambling harms. Hence, we do not include smoking bans, even though there are many studies of the impacts of such bans on gambling premises, because smoking bans were not intended to reduce gambling harm. We would include fiscal measures designed to address gambling harms (e.g. a statutory levy to fund expanded treatment), but not a general shift in gambling duty unrelated to PH, and intended merely to raise revenue.

A comprehensive search is particularly important as previous efforts to synthesise the evidence in this space have been limited by non-inclusion of important multi-disciplinary sources. This may have underestimated the impacts and/or inequalities generated through interventional PH laws and regulation.

Inclusion criteria follow the *Population, Intervention, Comparator, Outcome, Study design, Timing* (PICOST) format – see Table 1, below.

3.5.1 Inclusion criteria

- Any study on the effects of a PH legal intervention which intends to reduce gambling related harm.
- Studies originating from any country and in any language.
- Any study which reports any gambling-related harm/s as an outcome (defined using a seven-category, PH-related definition of such harms).[5, 21]
- Industry and non-industry funded research. (Industry funded research will be screened separately and act as a comparison group).

3.5.2 Exclusion criteria

- Studies which do not include a PH legal intervention specifically intended to reduce gambling-related harm.
- Studies which do not report outcomes related to gambling related harm.
- Case law.

Subject	Concept
Population	Any study describing any global human population or sub-population.
Intervention	Interventional PH laws and regulations intended to reduce the harms associated with gambling. *Interventions can be single component or part of a multi-component package, as well as universal, selective (e.g. access restrictions targeting young adults), or indicated (e.g. mandated affordability monitoring informed by demographic and individual risk profiles).*
Comparator	None
Outcome	1. Health and health equity outcomes, for gamblers and affected others (e.g. family, friends). For example: • Reduced Problem Gambling Severity Index score. • Reduced gambling spend and/or reported financial harm. • Mental distress, depression, anxiety, and negative emotional consequences. • Negative behavioural consequences including criminal behaviour. • Relationship happiness, relationship assessment. 2. Outcomes by subgroups in the general population (PROGRESS-PLUS categories[38, 39]) to allow us to assess for any inequity generated impacts of a legal/regulatory intervention within a jurisdiction. 3. Measures of compliance and enforcement. 4. Cost effectiveness. 5. Positive, negative and spillover effects (including economic costs, paradoxical effects and harmful externalities, including widened health inequalities).
Study design	1. Randomised and non-randomised controlled trials (RCTs). 2. Prospective and retrospective cohort studies. 3. Controlled before-and-after studies, including econometric studies, interrupted time series studies, and regulatory impact studies. Observational studies, meta-analyses, modelling studies. 4. Impact, process, and economic evaluations (both cost benefit analysis and cost effectiveness analysis).

	5. Studies that seek to relate intervention costs and savings to health and wellbeing outcomes or benefits. 6. Studies of moral hazard (a key law and economics framework for discussing unintended consequences). 7. Any qualitative studies of the health equity effects of relevant legal interventions.
Timing	1. Date of publication 2. Timeframe of measurement of intervention 3. Date on which law/regulation came into effect. 4. Length of time between enactment of law/regulation and measurement of intervention effect.

Table 1. PICOST Table

3.6 Information sources

We aim to include a far wider range of evidence than usually assessed within health research (e.g. including law/socio-legal studies; history; politics; sociology; and anthropology). Accordingly, we plan to implement searches of the following databases:

- CDC's Task Force on Community Preventive Services (Community Guide).
- Health Evidence database (Canada).
- MEDLINE, Embase, CINAHL, PsycInfo, Social Policy and Practice (OvidSP).
- Cochrane Database of Systematic Reviews (CDSR) and the Cochrane Central Register of Controlled Trials (CENTRAL).
- NHS Economic Evaluation Database (via the Centre for Reviews and Dissemination).
- Social Science Citation Index and Conference Proceedings Citation Index (Web of Science, Clarivate Analytics); EconLit, Criminal Justice Abstracts (EBSCOhost); Lexis Nexis; Westlaw; Heinonline; Scopus.
- ProQuest Dissertations & Theses Global, Sociological Abstracts including Social Services Abstracts (ProQuest).
- Trials Register of Promoting Health Interventions (TRoPHI) and Bibliomap (EPPI-Centre).
- Campbell Systematic Reviews (Campbell Collaboration).

Important data for our purposes also exists in grey literature, especially regulatory impact assessments, which use templates and calculators to assess impact, and post-implementation studies of legal interventions commissioned by gambling regulators in various countries. In addition, we will supplement with searches of books and book chapters, and conference proceedings, to ensure inclusion of qualitative case studies, e.g.[40-42]

3.7 Search strategy

An information specialist (JK) will support the searches. The search strategy will be informed using keywords reflecting the concepts listed in the PICOST (Table. 1) described above. Databases will be searched alongside hand searches of citations, grey literature, books/chapters and conference proceedings. To account for the interdisciplinary nature of this review, inclusive search terms will be used to capture all eligible interventions.

We will undertake searches from inception to 31st August 2024, without limitation on date, language or publication type. Translation will be supported by native language speakers in the Institute of Applied Health Research or Birmingham Law School. Where unavailable,

Google Translate will support title and abstract screening. If included for full text screening, funds are allocated to support translation. The search will contain terms relating to the following four themes:

1. Gambling (e.g. gambl*or betting or bet(s) or casino or bookmaker)
2. Legal (e.g. legislat* or statutory or legal* or law or laws or mandat* or ban or banning)
3. Public health (e.g. policy or policies or intervention* or program*or measures)
4. Specific public-health focused consumer protection measures or safeguards (e.g. *social responsibility or *reminder systems)

The search strategy will include both free-text terms (i.e. searches in the title and abstract) and subject headings (e.g. MeSH in MEDLINE). For an example search strategy please see Table 2, below.

#	Query	Results from 27 Aug 2024
1	GAMBLING/	7,236
2	gambling.ti,ab,kw.	10,030
3	(gambler or gamblers).ti,ab.	2,907
4	(gamble not standard gamble).ti,ab,kw.	1,473
5	(betting or bettor* or wager*).ti,ab.	1,155
6	((bets or bet) not ("bet hedging" or hedge* or inhibitor* or inhibition or T Bet or proteins)).ti.	1,782
7	(bingo or lottery or lotteries).ti.	674
8	((gaming or slot or fruit or poker or lottery or lotteries) adj5 (machine* or terminal*)).ti,ab.	930
9	((game or games or gaming or gamer?) adj5 (money or monetization or monetisation or monetary)).ti,ab.	260
10	(lootbox or loot box or lootcrate or loot crate or game credit or microtransaction or in game purchase).ti,ab.	53
11	(Casino* or cashino* or bookmaker* or book maker* or bookie* or amusement arcade*).ti,ab.	764
12	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11	15,431
13	Gambling/pc [Prevention & Control]	226
14	Legislation as Topic/	16,025
15	Legislation & Jurisprudence.fs.	262,722
16	Licensure/	7,557
17	Government Regulation/	21,953
18	(legislat* or statutory or legal* or law or laws or mandat* or ban or banning or bans or prohibit* or reform* or prohibit* or licences or licencing or licenced or jurisprudence or ordinance or forbid* or interdict*).ti,ab.	469,980
19	(act or acts or restrict* or code or requirement).ti.	128,438
20	((regulation* or regulatory or regulate*) not (emotion* adj2 regul*)).ti.	516,133
21	(statutory adj2 (code* or regulation*)).ab.	219

22	(regulatory adj2 (authorit* or approach* or change* or reform*)).ti,ab.	10,069
23	(gambling adj2 (board* or regulat* or commission* or authorit*)).ti,ab.	120
24	(Lawmaker* or law maker* or government* or police).ti,ab.	176,455
25	(Compliant or compliance or enforce* or sanction* or prosecution* or deregulation).ti,ab.	229,725
26	14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25	1,619,960
27	*Public Health/	58,511
28	*Harm reduction/	2,030
29	exp *Government/	46,144
30	exp *policy/	106,837
31	(Harm* adj2 (consumer* or minimi?* or prevent* or reduc*)).ti,ab,kw.	17,925
32	(health adj2 (ministr* or department*)).ti,ab.	51,768
33	"public health".ti,ab,kw.	386,723
34	(policy or policies or intervention* or program* or measures or postpolicy or prepolicy or policymaker* or policy maker*).ti,kw.	628,523
35	((debt* or relationship* or crime*) adj3 (intervention* or program*)).ab.	3,635
36	27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35	1,156,325
37	*Social Responsibility/	8,134
38	*Reminder Systems/	2,315
39	(Reduction adj1 (demand or supply or opportunity or access)).ti,ab.	462
40	consumer protection.ti,ab,kw.	925
41	(Protect* adj2 (play* or behavio?r)).ti,ab.	10,687
42	(responsib* adj1 social*).ti,kw.	1,266
43	((stake* or spending or loss or price or monetary or time or deposit) adj2 (limit* or maximum or capping or restriction)).ti,ab.	33,284
44	Persuasive design.ti,ab.	50
45	(Messag* or warning or pause* or break*).ti.	73,592
46	((messag* or banner) adj1 (static or dynamic or pop-up or safer or warning or health or intervention or responsib*)).ti,ab.	5,497
47	(Advertising or marketing or sponsorship*).ti.	14,955
48	(watershed or pre-watershed).ti,ab.	12,359
49	(feedback adj1 (behavio?r or personalis?*)).ti,ab.	241
50	(risk rating or play tracking or play scan or playscan or cashless or card based or acceptor* or pre commitment or precommitment or affordability check* or self exclusion or self appraisal or break play).ti,ab.	74,522
51	(age adj1 (limit* or legal or minimum)).ti,ab.	4,577
52	(limit or limits or limiting).ti.	45,715
53	37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52	283,811
54	26 or 36 or 53	2,848,828
55	12 and 54	2,548
56	13 or 55	2,625

Table 2. Medline search strategy

3.8 Study records

3.8.1 Data management

The study will be reported in line with Preferred Reporting Items for Systematic Review and Meta-Analysis - Equity (PRISMA - Equity)[43] and Preferred Reporting Items for Systematic Review and Meta-Analysis - Harms (PRISMA - Harms).[44] A flowchart tracking the PRISMA[45] statement will be developed to detail the data collection, selection and extraction process. Search results will be managed using Covidence software.[46]

3.8.2 Data selection and collection process

Using Covidence,[46] two independent reviewers (MF & TP) will remove duplicate items and screen titles/abstracts against the inclusion criteria (KB, GJM-T & PM will resolve conflicts). Full texts that meet the inclusion criteria will be screened by the same reviewers (MF & TP) (KB, GJM-T & PM will resolve conflicts). Data will be extracted to a form, developed by KB, GJM-T and PM, also using the Covidence software.[46]

3.9 Data items

Extracted variables will include:

1. Author and year
2. Study design
3. Population and setting (N, age range of participants, sociodemographics, location)
4. Intervention details (name, description of intervention, content of intervention)
5. Effect size (e.g. measured outcomes from validated assessment scales such as Problem Gambling Severity Index score, and/or reported effect on any other gambling-related harm variables (detailed in the PICOST)), grouped by PROGRESS-Plus criteria[38, 39] where applicable, for example, just in women, just in minority groups, just in areas of deprivation
6. Quality assessment.

3.10 Outcomes and prioritisation

The primary outcome is to ascertain the effects of interventional PH laws and regulations on gambling-related harms. Main outcomes will include all changes in gambling-related harms measures including financial harm, crime, societal harm, familial harm, and self-reported measures (for example, a reduction in the reported Problem Gambling Severity Index score). Secondary outcomes will include but are not limited to 1) the effectiveness of interventions at compliance and enforcement level, 2) the cost effectiveness of interventions, and 3) any other positive, negative and spillover effects (including economic costs, paradoxical effects, and harmful externalities, including widened health inequalities).

3.11 Risk of bias in individual studies

The risk of bias and quality of the included studies will be assessed using different tools for different types of study. Randomised controlled trials will be assessed using the Cochrane risk of bias tool (RoB 2).[47] ROBINS-I[48] will be used for other non-randomised studies. Qualitative studies will be appraised using the EPPI reviewer software for systematic reviewing.[49] Two independent reviewers will perform the assessment (MF & TP), with any conflicts adjudicated by a third reviewer (KB, GJM-T, or PM). Where possible, the quality will be scored (inadequate, adequate, good, excellent, or unclear). Inclusion will not be

determined by quality rating, due to anticipated heterogeneity between studies and the planned comparison between industry and non-industry funded studies.

3.12 Data synthesis

Included studies will be heterogeneous. We will conduct a narrative synthesis to interpret the data. Narrative synthesis will be guided by existing literature that categorises the effects (including unintended and spillover effects (e.g. the INTENTS framework[50]) of interventional PH laws. Any additional categories reported in the studies we encounter will also be considered. It is anticipated that studies will be synthesised by type of law/regulation (e.g. a universal prohibition; a targeted prohibition); key outcomes; types of unintended effect; and/or sub-groups impacted.

We will undertake an iterative process of developing CMOCs to explain the effects we uncover and define a theory of change. Preliminary CMOCs (Figure. 1) will be refined further after the narrative synthesis stage of the review. In addition, we will identify demi-regularities linked to specific explanatory factors[51] after broadening our analysis to generate new questions and fields of discovery.[52, 53] Analysis will stop when no new configurations can be developed and supported based on the collective evidence. CMOCs will be labelled with respect to the strength and diversity of the evidence supporting them.

We are aware that industry-funded studies – in gambling and other sectors – routinely suggest that interventional PH laws and regulations impose fiscal harms in terms of lost revenue and impose costs on businesses and consumers.[54] Without effective segmentation of industry-funded research, there is a risk that reviews of evidence may be skewed to a pro-industry, anti-regulation perspective focused on outcomes for businesses, rather than health and health equity outcomes.[55] We will segment our search results and narrative synthesis such that industry-funded/conflicted research on intervention effects can be considered separate from the main pool. This will enable a sub-study of how industry-funding of studies impacts findings on the effects of interventional PH laws and regulations oriented to reducing gambling harm.

3.13 Ethics and dissemination

Our review is registered with PROSPERO (International prospective register of systematic reviews) at the National Institute for Health Research and the Centre for Reviews and Dissemination (CRD) at the University of York [CRD42024574502] and will follow the RAMESES reporting guidance for realist reviews.[56]

We aim to define a theory of change and produce a context-mechanism-outcome framework with relevant experts using the findings. We plan to disseminate the findings through peer-reviewed publications, meetings with relevant experts, international conference presentations, a Delphi consensus study (workshops and/or focus groups).

3.14 Co-producing an analytical framework

The development of CMOCs will include a collaborative exercise with relevant experts. Following the data synthesis, the findings will be shared with a group of relevant experts (n = 15). These will include experts by experience in gambling harm, gambling researchers, charities, service providers, and regulators. Alongside the research team, and using a focus group format, these experts will co-produce a revised analytical framework. The outcome will be the 2nd iteration of CMOCs (see section 1.1.1 for the 1st iteration). The revised analytical

framework will also assist the research team to negate meta-biases and confidence in the cumulative evidence by enabling an additional level of expert appraisal of the systematic review evidence.

3.15 Meta-bias

The evidence will be carefully extracted and scrutinised by an interdisciplinary team of law and applied health research specialists (KB, MF, & TP). Any disagreements in screening, extraction and appraisal will be presented to the wider research team for discussion (JS-C, SM, GJM-T, & PM), with decisions reached by consensus. A subsequent co-production activity will assist in addressing researcher bias by incorporating expert opinion to the evidence synthesis during CMOC development and subsequent definitions of theory of change.

In addition, to address bias and improve awareness from a health equity perspective, we plan to formally integrate an equity lens into the systematic review process by utilising the FOR EQUITY tool.[57] FOR EQUITY was developed by NIHR as a toolkit to integrate 'intersectional health inequity' in health research. FOR EQUITY assists the research team to critically and conceptually understand the drivers of inequalities relevant to this review. Conceptualisation of the determining factors underpinning health inequities is achieved using a three-step approach of 'REFLECT, INVOLVE and DIVE DEEPER', alongside structured reflections on responsibilities of the research team, and research institution, to involve under-represented groups in analysis.

3.16 Confidence in cumulative evidence

We will follow the RAMESES reporting guidance for realist reviews.[56] Applying the context of realist theory means outcomes are considered conditionally to the circumstances in which they were reported. We will also consult the GRADE guidelines[58] to test that our overall recommendations are of a high quality.

Evidence will reflect a real-world context, with our narrative synthesis enhanced by contributions from relevant experts through the co-production of an analytical framework (CMOCs) and definition of theory of change. Once we have gathered evidence from the realist review of legal PH interventions on what works, why, for whom, in what context, and on unintended effects and mechanisms for actions, we will develop an explanatory account of the effects of gambling law and regulation on gambling harm.

This explanatory account will be co-produced with key stakeholders (see section 2.1 above). We have budgeted for a face-to-face interactive workshop consisting of 15 key stakeholders (academics, practitioners, policymakers and members from our PPI panel). In this workshop, we will present the findings of the review to key stakeholders and then undertake a two stage exercise (table level focus groups and a wider group discussion) to develop consensus on the mechanisms explaining the outcomes associated with interventional PH laws and regulations.

The research team will undertake a convergence step to integrate the findings of the workshop with the key messages of the review. We will produce a refined explanatory account building on the draft proposed above. The initial draft of this framework will be reviewed in a virtual meeting by our PPI panel, and refinements made collectively with their input to finalise the output in accessible formats (peer-reviewed publication, infographic and brief video)

4 WP2: WHAT ARE THE BREADTH OF HARMS ASSOCIATED WITH GAMBLING IN THE UK?

4.1 Study aims

1. To create an openly accessible directory of datasets in the UK that describe the incidence and prevalence of gambling as well as its associated harms.
2. To undertake a series of longitudinal studies (to be determined by extent of pair-wise associations) to estimate the associated harms in a variety of UK longitudinal datasets.
3. To undertake a national survey to ascertain the prevalence of gambling and its associated harms in a diverse sample.

Study Aim 2 will employ a series of population-based retrospective cohort studies, while Study Aim 3 will use a cross-sectional study design.

4.2 Study flow chart

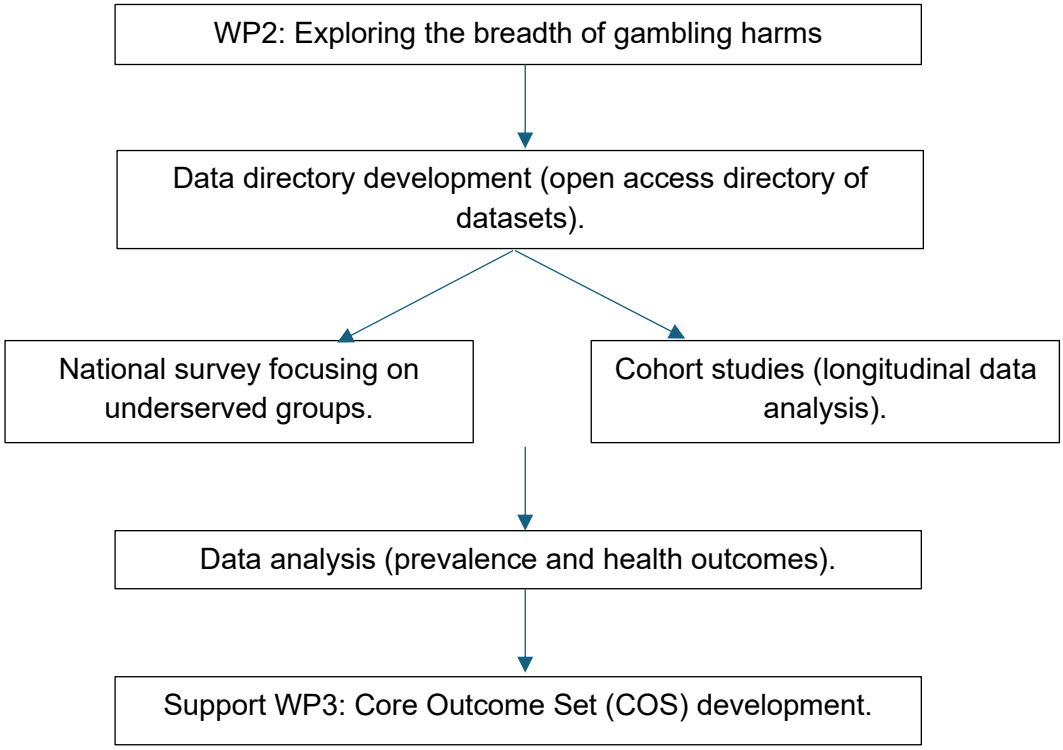

Figure 2. The study flowchart

4.3 Study participants

4.3.1 Study population

Study Aims 1 and 2: We will undertake a systematic mapping exercise to identify all datasets that could inform future research into gambling-related harms. These datasets will be used for a series of studies describing which subgroups of the population (as per the NIHR INCLUDE[59] and PROGRESS-Plus[38, 39] criteria) experience the greatest burden of harms associated with gambling and the breadth of these harms.

Study Aim 3: Our survey is targeted at groups underserved (underrepresented) in whole population-level public health research to understand the prevalence and breadth of

gambling-related harms present in these groups. Our definition of underserved is in line with NIHR INCLUDE,[59] which includes broad proportions of the population and recognises groups generally deemed as under-represented in research (e.g. 18-25 years old, women of childbearing age, those from minority ethnic backgrounds). However, it will not be possible to undertake a survey targeting all of these listed groups. Our selection of key groups to include will be informed by literature review and PPIE, to target where the greatest need is. Our initial PPIE work to date indicated that those aged 18-25 years, and those from minority ethnic groups, were priority groups to include.

4.3.2 Eligibility criteria

4.3.2.1 Inclusion criteria for Study Aims 1 and 2

Datasets will be prioritised based on the following criteria:

- Nationally representative: datasets that are representative of the entire UK population or specific regions with a diverse demographic profile.
- Coverage of under-represented groups: datasets that include data on under-represented or marginalised population groups, for example, ethnic minorities and low-income groups.
- Validated methods: datasets that employ validated tools for recording exposure to gambling, and/or measures of gambling harm, such as the Problem Gambling Severity Index (PGSI).
- Peer-reviewed publications: datasets that are associated with a peer-reviewed publication.

We will include datasets not (yet) published in academic journals and those reporting gambling data using non-validated methods, i.e. self-reported gambling harm.

4.3.2.2 Inclusion criteria for Study Aim 3

Participants from underserved communities, which is in line with the NIHR INCLUDE[59] and PROGRESS-Plus[38, 39] criteria.

4.3.3 Sample size

4.3.3.1 Sample size calculation for Study Aim 2:

Feasibility: To assess for feasibility, we have identified the relevant SNOMED clinical codes (Figure. 3) indicating exposure to gambling in Clinical Practice Research Datalink (CPRD) AURUM database. We recognise the considerable heterogeneity in how gambling is defined using SNOMED clinical codes. Therefore, in addition to comparing those exposed vs. unexposed to gambling, we will conduct stratified analyses to understand for example, what the implication of having a code for "gambling" in comparison to pathological gambling-related codes.

Description	SNOMED code
Pathological gambling	18085000
[X]Compulsive gambling	18085000
[X]Pathological gambling	18085000
[V]Gambling and betting	105523009
Pathological gambling disorder	18085000
[V]Gambling and betting	105523009
Gambling	105523009
Gambling disorder	18085000

In a feasibility extract conducted in May 2022, we identified 10,557 patients with these codes. Although we will aim to explore a variety of outcomes associated with gambling, the Public Health England (PHE) review highlighted that mental ill health was commonly explored.[1]

Figure 3. SNOMED clinical codes identified in the CPRD AURUM database

Sample size: Using major depressive disorder (MDD) as an example, we identified that a sample size of 20,000 (10,000 exposed and 10,000 unexposed) patients would give over 90% power to detect a relative risk of 1.5 of MDD. Hence, we are confident to have power to undertake meaningful analyses. In addition, we have calculated a variety of sample sizes needed over a variety of different outcomes, all of which seem feasible within our calculation with evidence derived from published reviews or longitudinal studies as to the proposed incidence in the exposed cohort (Table 3). The sample size required to detect meaningful differences in health outcomes has been calculated based on prior literature and estimated outcome incidences.

Incidence of outcome in gamblers	Incidence of outcome in non-gamblers	RR	Power	Sample size	Some example outcomes (The examples do not precisely align with the incidence values on the left-hand side but are comparable)
30.0%	20.0%	1.5	90	800 (400 exposed/400 unexposed)	Nicotine dependence[60] and anxiety disorder[61]
10.0%	6.7%	1.5	90	3000 (1500 exposed/1500 unexposed)	Cannabis use disorder,[60] attention deficit hyperactivity disorder[60] and cardiovascular disease[62]
5.0%	3.3%	1.5	90	6000 (3000 exposed/3000 unexposed)	Bipolar disorder[60] and alcohol dependence[63]
1.5%	1.0%	1.5	90	21000 (10500 exposed/10500 unexposed)	Major depressive disorder[1] and suicide attempts[64]

Table 3. Sample size calculation for various health outcomes in the exposed and unexposed gambling groups based on relative risk and power analyses

4.3.3.2 Sample size calculation for Study Aim 3:

Based on the estimate that more than 50% of the population gamble, we opted to have a more conservative estimate (30%) as we undertook our sample size. We identified that a population of 7,635 participants would give us sufficient discriminatory power (CI 95% and margin of error 0.5%) to not only describe the prevalence of gambling but also to capture some of our key outcomes, such as depression. To account for partial completion (for approximately 25% of the completions), we aim to capture 10,000 responses in our survey.

4.3.4 Recruitment

4.3.4.1 Recruitment for Study Aims 1 and 2:

Information sources and search strategy

A comprehensive search strategy will be developed to identify relevant datasets or publications on national and regional datasets, including data on gambling and health outcomes in adult populations with no limit on the years that data were collected or on the duration of data collection. With the support of an information specialist and librarian, we will

search across multiple electronic databases, including PubMed, Scopus, Web of Science, and PsycINFO. The search strategy will include the following keywords or phrases shown in Table 4. While there is no agreed method on how to identify and report on available datasets, we will adapt the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines[35] to systematically review the available datasets.

Gambling	Health outcomes	Dataset	United Kingdom
Gambling – including and word variants e.g. gamble(s) Betting, bet(s) Wager Fruit machine(s) Slot machine(s) Lottery or lotteries or lotto EGM (Electronic Gaming Machine) or Electronic Gambling Machine Pokies Pokey puggy fruities Lootbox /Loot box or skins scratch card(s) scratchcard(s) raffle(s) sweepstake(s) prize draw(s) amusement arcade(s) or cashinos social casino game(s) dice card(s) Poker roulette blackjack baccarat or baccara or punto banco crap, craps keno, casino(s) bingo mahjong Dominoes	Health Status Indicator* Health outcome* Health impact* Health effect* Mental health Physical health Disease / disease outcome* Comorbidity / Comorbidities Psychiatric disorder* Mental disorder* Substance use / Substance use disorder* Addiction* Disordered gambling Depression Anxiety Stress-related disorder* Suicid*/ Suicidal behaviour* Self-harm Cardiovascular disease Financial instability	Dataset or administrative dataset or epidemiolog* dataset or biomedical dataset or national dataset or open-access dataset or routine health dataset or case-control study dataset or survey panel dataset Registry or national registry Database Longitudinal study Case-control study Cohort study Population-based cohort Health records Data repository Survey data Public health database Routine data Linked data" Surveillance data" Registry-based study Electronic medical records or EMR or electronic health data or EHD	United Kingdom / UK Britain / Great Britain Scotland Wales Northern Ireland England Welsh Scottish British English

VLT (video lottery terminal) Punt Flutter Accumulator BTTS (Both Teams to Score Betting) Bettor In-game purchase Game credit Lootcrate / Loot crate Microtransaction Football pool Sports bet Decentralised gambling or crypto-gambling or blockchain gambling Stocks Trading or swing trading or leverage trading or trading on margins Esports FOBT (Fixed odds betting terminal) Wheel of fortune Video (Animated) live sports betting Online live blackjack or online live poker or video poker In-game gambling (i.e., betting on next corner, next goal) Sic Bo or Dai Siu			

Table 4. Summary of search terms used

Other methods used for identifying relevant datasets

- Contacting experts in the field.
- Google Dataset search.
- UK Data Service: a repository of social and economic data.
- Government Data Portals: including data.gov.uk and the Office for National Statistics.
- Gambling Research Centres (e.g. the Bristol Gambling Harms research Hub).

- The Gambling Commission, and relevant research teams working therewith (e.g. Greo evidence insights; Natcen).

4.3.4.2 Recruitment for Study Aims 1 and 2:

Potential participants will also be sent a 'consent pack' via e-mail or as a hard copy through the partner organisation, including the "Participant Information Sheet" (PIS) containing further detailed information about participation in the study and the informed consent form. Prior to participating in the surveys, all potential participants are required to give their consent. Where potential participants do not respond to receipt of the 'consent pack', there will be a maximum of 2 further follow-ups from the research team (unless there is an ongoing dialogue where the potential participant is engaged in the discussion). Recruitment documents will be disseminated through media, social media channels, posters, flyers and letters.

4.3.5 Informed consent

4.3.5.1 Recruitment for Study Aims 1 and 2:

We will engage in separate scientific review committee processes to use national datasets such as the CPRD or UK Biobank. Access to anonymised data provided from the dataset will be subject to a full licence agreement containing detailed terms and conditions of use. Individual patients consent to this process at the practice level and have the right to opt-out.

4.3.5.2 Recruitment for Study Aim 3:

Initially, we will provide participants with a comprehensive information sheet detailing the purpose of the survey, the nature of the questions, the estimated time required, and any potential risks or benefits associated with participation. This information will be presented clearly and accessible through our Qualtrics landing page. Following this, we will display an explicit consent form, where participants must affirmatively agree to proceed by clicking a consent button, indicating their informed consent. We will emphasise that participation is entirely voluntary, and participants can withdraw at any time without any negative consequences. Additionally, we will provide assurances regarding the confidentiality and security of their data, along with contact information for any questions or concerns. Where participants use the postal option for the survey, we will accept a signed wet ink signature on the consent form.

4.4 Methods

Field	Field description
Gambling harms	Gambling which negatively impacts the health and well-being of individuals, families, communities, and/or society.[65]
Gambling	As defined in the Gambling Act 2005, gambling includes gaming (playing a game of chance for a prize); betting (a transaction based on the outcome of a race or likelihood of an event happening), and lottery (paying to participate, with prizes allocated on a chance basis).[66, 67]
Affected others	Individuals, such as family members, friends, or colleagues, whose health, well-being, or financial situation is negatively

	impacted by someone else's gambling behaviour. This can include emotional distress, financial hardships, or interpersonal conflicts.[21, 68]

Table 5. Definitions used for the review

4.5 Data collection

4.5.1 Data collection for Study Aim 1:

Selection of studies

Two reviewers will independently screen all titles and abstracts of the search results to exclude datasets or studies that do not meet the inclusion criteria. We will acquire the full text of all articles appearing to meet the inclusion criteria for this review. After retrieving the full texts of relevant articles, their reference lists will be examined to identify additional articles not captured during our search. Any disagreements will be resolved by discussion, and another author will be consulted if necessary. The results will be compared at each stage of the PRISMA flowchart.

Data extraction and management

Extracted data will include the data source, study design, population, recruitment/sampling method, years available, geographical coverage, measures of gambling, data on the prevalence of gambling, data on health outcomes, other relevant outcomes and accessibility of data.

Each dataset will be normalised and integrated into the unique data extraction for epidemiological research (DExtER) tool developed by our team to automate data cleaning and analytics processes. The tool provides transparent and reproducible interactive outputs which stakeholders can navigate. For example, annual point prevalence; the proportion of patients with gambling exposure (numerator) divided by the eligible population (denominator), incidence rate; the number of patients who for the first time, meet the gambling exposure criteria (numerator) divided by the total number of person-years at risk (denominator). Where possible, age and sex data will be standardised. We are particularly interested in reporting the incidence/prevalence by markers of inequality as defined by the NIHR INCLUDE[59] and PROGRESS-Plus[38, 39] criteria.

Outcome	Description
Data source	Name of the dataset and institution, if available.
Study design	Type of study (e.g. cross-sectional or cohort study).
Population	Characteristics of the study population (e.g. gender, age and ethnicity).
Recruitment/Sampling method	The method used to recruit participants or sample the population.
Years available	The time period covered by the dataset.
Geographical coverage	The regions or areas covered by the dataset.
Measures of gambling	The tools or criteria used to measure gambling (e.g. PGSI, DSM-5 criteria).
Data on the prevalence of gambling	The prevalence of gambling based on either self-reported measures or clinically validated assessments of gambling behaviour.

Data on 'affected others'	Data on how gambling affects individuals around the individual gambler, such as family members, friends, and colleagues. This includes emotional distress, financial hardships, and relationship breakdowns.
Data on health outcomes	Health outcomes (e.g. mental health, physical health).
Other relevant outcomes	Data on additional outcomes considered but not limited to:
	Socioeconomic data: data on how gambling affects employment status, housing stability, financial stability, and poverty levels.
	Data on family and community relationships: data on family breakdowns, domestic violence, neglect, etc.
	Access to support services: data on the availability and utilisation of support services in underserved communities.

Table 6. Example of outcome measures to be extracted from the included datasets

Assessment of methodological quality and risk of bias

Two reviewers will independently assess the risk of bias and quality of each included dataset using the Risk of Bias in Non-randomised Studies of Interventions (ROBINS-I)[48] and by adapting the Harmonised Data Quality Assessment Framework developed by Kahn et al.[69] respectively. The two reviewers will grade the domains of included datasets as low, moderate, serious, or critical risk of bias. Any disagreements will be resolved through discussion, and a third author will be consulted if necessary.

Domains of Bias to be assessed

The ROBINS-I[48] tool assesses bias across several domains. We will adapt these domains to fit the context of gambling and health outcomes, including the addition of a new domain that assesses industry influence (Table 7). This new domain is informed by the team's links to a new project developing an instrument to estimate risk of funding-related bias in gambling research.[70] The domains to be assessed in our adapted tool will include:

1. **Bias due to confounding**: we will assess whether the dataset adequately accounts for potential confounders, such as socioeconomic status, age, gender, and pre-existing mental health conditions, which could influence gambling behaviours.
2. **Bias in selection of participants:** we will assess the recruitment or sampling method used and determine if the selection process resulted in a non-representative sample, particularly within vulnerable or underserved populations.
3. **Bias in classification of exposure:** we will assess the validity and reliability of methods used to classify gambling behaviours. We will also examine whether different definitions of gambling exposure could result in misclassification.
4. **Bias due to missing data:** we will assess the bias due to missing data within the dataset.

5. **Bias in measurement of outcomes:** we will assess how the outcomes were measured.
6. **Bias in selection of reported results:** we will assess the bias due to selective reporting of results.
7. **Bias due to industry influence:** We will examine potential conflicts of interest or funding sources from the gambling industry, which may influence data collection, interpretation or reporting of the results. This includes whether the datasets are industry sponsored; and whether an industry funder played a role in selecting populations and/or participants.
8. **Overall risk of bias:** a summary judgement of the overall risk of bias for the dataset.

Dataset	Bias due to confounding	Bias in selection of participants	Bias in classification of exposure	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of reported results	Bias due to industry influence	Overall risk of bias
Dataset 1								
Dataset 2								
Dataset 3								

Table 7. Draft version of risk of bias summary table

Domains of dataset quality to be assessed

The Harmonised Data Quality Assessment Framework developed by Kahn et al.[69] assesses the quality of datasets across several domains. We will adapt these domains to fit the context of gambling and health outcomes (Table 8).

Data Quality Category	Subcategory	Assessment Criteria	Findings	Recommendations
Conformance	Value conformance	Data values for gambling and health outcomes in correct format (e.g., numeric, categorical)		

	Relational conformance	Relationships between patient ID, gambling, and health outcomes correctly represented.		
	Computational conformance	Derived values (e.g., risk scores) match predefined formulas.		
Completeness	Data Presence	All relevant data fields populated (e.g., gambling, health outcomes).		
	Temporal completeness	Consistent data collection over time periods relevant to study.		
Plausibility	Uniqueness plausibility	No duplicate entries for the same individual regarding gambling and health outcomes.		
	Atemporal plausibility	Data values for health outcomes align with expected ranges.		
	Temporal plausibility	Sequence of events logical (e.g., gambling before health deterioration).		
Verification	Internal consistency	Consistency within the dataset itself (e.g., consistent use of units, coding).		
Validation	External comparison	Comparisons with external standards or benchmarks (e.g., national health data).		

Table 8. Draft version of quality appraisal checklist

4.5.2 Data collection for Study Aim 2:

The following PICOST will be adapted for each dataset identified in study aim 1 depending on the exposure definitions and information pertaining to incidence, prevalence and health outcomes available. As an example, we will describe the study information for use of the Clinical Practice Research Datalink (GOLD/AURUM)-Hospital Episode Statistics (HES)-Office for National Statistics (ONS) mortality record linked data.

PICOST for health outcomes study:
Population: The study population will be derived from general practices (GPs) contributing data to CPRD on or after 1st January 2001.

Exposure (Intervention): Those with a clinical code indicating exposure to gambling. The index date for any individual will be defined as when they become eligible for study participation and from which point they will begin contributing person-years of follow-up.

Comparator: Up to four unexposed people matched by age, sex, general practice, ethnicity, and socio-economic deprivation (indices of multiple deprivation).

Outcomes: In line with the GBD study design, we aim to explore the risk (e.g. described as a hazard ratio (HR)) of the following outcomes (following exposure to gambling) listed here: https://www.thelancet.com/gbd/summaries (e.g. mental ill health, cardiovascular disease but excluding those not biologically plausible, e.g. congenital malformations) in addition to hospitalisation and cause-specific death. In addition, where datasets allow, we are committed to also including economic outcomes related to gambling, e.g. debt or spending data where available.

Study type: Retrospective cohort study.

Timeframe: 1st January 2001-Latest date available of data.

4.5.3 Data collection for Study Aim 3:

We will undertake a national survey that targets groups experiencing the burden of gambling harm but underrepresented in public health research on gambling to understand the prevalence and breadth of gambling-related harms present in these groups. Guided by the NIHR INCLUDE[59] and PROGRESS-Plus[38, 39] criteria, such groups include young people and older adults, women of childbearing age, those from minority ethnic backgrounds. Our list of sub-groups experiencing the greatest burden and those under-represented in datasets will be further enhanced after feedback from our PPIE panel.

The survey will be self-completed, using elements of the ‘push to web’ methodology as recommended by the Gambling Commission.[71] The survey will be conducted online using the GDPR compliant Qualtrics platform. The survey will be conducted in English but can be translated into languages appropriate to the target groups within Qualtrics. Additional translation resources are available in our grant application and will be utilised depending on which groups we find the greatest burden as noted above. As our focus is on sampling underrepresented groups, as defined above (e.g. young people and older adults, women of childbearing age, those from minority ethnic backgrounds), we have also budgeted for alternative completion approaches, including postal (this is crucial for those facing digital

exclusion). The survey will be fully accessible in terms of language and suitable for those with any range of impairments (e.g., online and offline options, including Braille, large print, and telephone options).

4.6 Payment for Participation

Study Aim 3: Survey participants will receive a £12.50 gift voucher for completing the survey as a token of appreciation for their time.

4.7 Data Analysis

Study Aim 1: To enable the identification of sub-groups experiencing the greatest burden and those underrepresented in each dataset, we will also undertake descriptive statistics (accounting for weighting categories in household surveys) to calculate the incidence and prevalence of gambling where possible.

Study Aim 2: We will calculate an incidence rate ((IR) per 100,000 person years) for each of the outcomes of interest, patients with pre-existing illness (for each outcome of interest) will be excluded to ensure the IR reflects outcomes which occur following cohort entry. We will then apply a Cox regression model (provided assumptions are met-otherwise alternate regression models will be employed) to calculate HR for the occurrence of outcomes (described in section 4.5.2) comparing gambling exposed and matched unexposed patients adjusted for covariates recorded at index date. We will consider potential confounders specific to each outcome (e.g. cardiovascular risk factors may include those included in QRISK®- 3).[72] We will undertake subgroups defined by age, sex, ethnicity, deprivation group and region to assess whether the associations between gambling and health outcomes differ in these subpopulations.

Study Aim 3: We will undertake descriptive statistics to describe the prevalence of gambling, outlining the frequency and prevalence of gambling harms across different demographics. These figures will be compared to the prevalence of gambling within the Health Survey for England (HSE)[73] and the Gambling Commission's survey,[74] which, due to the design, will be the most comparative survey. As our focus will be on underserved communities, comparing rates and health outcomes directly may be challenging. Therefore, we will standardise the findings to different population strata to produce comparable estimates where possible. Secondly, we will describe the proportion of ill health among participants who undertook the survey and undertake regression analyses to describe the risk of having ill health whilst co-exposed to gambling.

4.8 Missing Data

Study Aim 3: We will enter the data from the surveys into a password-protected electronic spreadsheet twice to ensure accuracy. If any data is missing, we will compare it with the original hard copy to find out why it is missing. To minimise missing data from online surveys, we will take the following steps:

1. Qualtrics will automatically save survey responses as participants move through the survey until they either finish the survey or their response is considered abandoned.
2. We will insert page breaks at intervals to effectively capture partial responses, as progress is only saved when participants move from one page to the next.
3. We will set a time frame for how long partial responses remain active.

Incomplete responses will be identified in the password-protected electronic spreadsheet by filtering for responses where the "Finished" field is set to "False."

5 WP3: WHAT ARE THE CORE OUTCOMES THAT SHOULD FEATURE IN A BEST PRACTICE MODEL FOR STUDYING GAMBLING RELATED LEGAL AND POPULATION-BASED INTERVENTIONS?

We will develop a core outcome set (COS), in accordance with COS standards that should be included in best practice evaluations of interventional PH laws and population-based interventions.[75]

5.1 Objective 1: Updating existing systematic reviews

We will expand on existing systematic reviews[1, 2] which currently describe the breadth of gambling harms (described in detail below). We also plan to update the findings of an existing review[16] on population-level interventions (not described in detail below) to include any recently published outcome measures.

5.1.1 Systematic review methods

The systematic review will follow the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P).[35] The review will focus on the health impacts of gambling and gambling-related harms.

5.1.2 Aims of the review

This review aims to identify and synthesise all available data on the health impacts of exposure to gambling-related harms. This data will be used to assess the relationships between gambling exposure and health outcomes and to quantify the contribution of gambling-related harms to the overall burden of disease and disability.

Specific Review Questions

5.1.2.1 How does exposure to gambling impact health across different stages of life?

5.1.2.2 What is the strength of evidence on the associations between gambling exposure and various health outcomes?

5.1.2.3 Do the estimates of association vary based on the type or frequency of gambling, global region, characteristics of the gambler, and/or characteristics of affected others?

5.1.3 Definitions of gambling harms

Our searches will include the following terms to capture the full spectrum of gambling-related harms:

- Gambling disorder
- Problem gambling, pathological gambling, compulsive gambling.
- Online gambling, casino gambling, sports betting, lotteries
- Financial harm, debt, economic stress
- Family breakdown, relationship harm, interpersonal conflict

- Mental health impacts related to gambling (e.g. depression, anxiety, suicidal thoughts)
- Substance use associated with gambling (e.g. alcohol, drugs)
- Social isolation, stigma, social harm
- Work-related problems, absenteeism, job loss
- Criminal activity, fraud related to gambling
- Intimate partner violence, interpersonal violence, domestic violence
- Affected others (e.g. family members, friends, or individuals affected by someone else's gambling behaviour).

We recognise that definitions and methods of measuring gambling exposure may vary between studies. We will accept all definitions used by study authors and document these definitions and the measurement techniques employed as part of our study-level quality assessment.

5.1.4 Health outcomes

We will not restrict our searches to predefined health outcomes. Instead, we will include all literature reporting associations between gambling exposure and health-related outcomes. Where applicable, definitions of health outcomes and risk factors will be guided by established case definitions from the Global Burden of Disease (GBD) study.[76]

However, studies that report on biomarkers without a clinical diagnosis (e.g. cortisol levels as a stress response, neural connectivity patterns) or those that report the presence of symptoms without a formal health outcome diagnosis will not be eligible for inclusion.

Reviewers will meet regularly to discuss and resolve any questions regarding the eligibility of health outcomes, with consensus decisions documented and circulated via written guidelines. Variations in measurement methods or case definitions of health outcomes will be documented as part of the quality assessment process. The final selection of associations to be synthesised will depend on the availability of studies that examine comparable forms of gambling exposure and reported health outcomes.

5.1.5 Eligibility criteria

5.1.5.1 Inclusion criteria

Study Design: Observational studies which allow for description of temporality (e.g. case-control, cohort, or case-crossover studies) will be included if they report on associations between gambling behaviours and health outcomes. Systematic reviews and meta-analyses will be included to identify relevant studies and will be excluded following full-text screening.

Participants: Exposed groups will be defined as individuals who have engaged in any form of gambling behaviour or who have experienced gambling-related harm. This definition also includes family members or friends affected by an individual's gambling behaviour, and local communities impacted by gambling premises. In contrast, non-exposed control groups will consist of individuals or study groups/communities that have no reported exposure to gambling behaviours.

Exposure measurement: Studies reporting self-reported and clinically validated measures of gambling exposure will be included.

Outcome Measures: Studies that report specific health outcomes associated with gambling (e.g. mental health disorders, physical health impacts, or non-communicable diseases), will be included. Studies that provide sufficient data on gambling harm outcomes, including both personal and social impacts, such as relationship strain and financial instability, will also be included. Studies reporting an effect measure (e.g., relative risk, odds ratio, hazard ratio or similar) or providing data to calculate these measures will meet the inclusion criteria.

No restrictions on publication date, language and geographical location will be applied.

5.1.5.2 Exclusion criteria

Study Design: Cross-sectional, ecological, case series or case studies, experimental designs and commentaries. Cross-sectional studies will be excluded due to limitations in assessing the temporality between exposure and outcomes, aligning with the GBD study risk factor analyses.

Participants: Studies which only include either an exposed or comparator population will be excluded. As we are assessing the risk of outcomes, we will only include populations where it is possible to derive information on both exposed and exposed participants.

Exposure measurement: Studies that report only a composite measure of exposure along with unrelated factors (e.g. a composite score that combines gambling with other experiences such as substance use or abuse), will be excluded.

Minimum reporting requirement: Studies missing essential data, such as effect sizes, confidence, intervals, sample sizes or the data needed to impute an effect size with uncertainty information will be excluded.

Studies reporting on the same exposure and outcome using the same data: Studies with the longest follow-up period or most comprehensive dataset will be included.

5.1.6 Information sources

Electronic databases such as PubMed, Embase, CINAHL, PsycINFO, Cochrane, and Web of Science will be searched to identify studies from 1 January 1990 to the latest available date. Grey literature such as unpublished research, reports, and conference proceedings will be considered if they contain relevant data. To ensure the inclusion of all relevant studies, we will also screen the references of eligible studies.

5.1.7 Search strategy

The search strategy will include terms related to gambling disorders, gambling-related health impacts, and public health outcomes (Table 9).

Gambling	Study Type	Risk
Gambling – including and word variants e.g. gamble(s) Betting, bet(s) Wager	Case-control / case-control stud* Cross-over / cross-over stud*	Statistics as Topic Risk / Risk ratio Odds / Odds ratio

Fruit machine(s) Slot machine(s) Lottery or lotteries or lotto EGM (Electronic Gaming Machine) or Electronic Gambling Machine Pokies Pokey puggy fruities Lootbox / Loot box or skins scratch card(s) scratchcard(s) raffle(s) sweepstake(s) prize draw(s) amusement arcade(s) or cashinos social casino game(s) dice card(s) Poker roulette blackjack baccarat or baccara or punto banco crap, craps keno, casino(s) bingo mahjong Dominoes VLT (video lottery terminal) Punt Flutter Accumulator BTTS (Both Teams to Score Betting) Bettor In-game purchase Game credit	Cohort / cohort stud* Systematic review* Meta-analysis Review* Twin stud* Prospective Retrospective Longitudinal Follow-up / Followup	Cross-product ratio Hazards ratio Hazard ratio HR OR RR aOR Relation* Correlat* Associat* Likel*

Lootcrate / Loot crate Microtransaction Football pool Sports bet Decentralised gambling or crypto-gambling or blockchain gambling Stocks Trading or swing trading or leverage trading or trading on margins Esports FOBT (Fixed odds betting terminal) Wheel of fortune Video (Animated) live sports betting Online live blackjack or online live poker or video poker In-game gambling (i.e., betting on next corner, next goal) Sic Bo or Dai Siu		

Table 9. Summary of search terms used

5.1.8 Study records

5.1.8.1 Data management

A flowchart tracking the PRISMA[45] statement will be developed to detail the data collection, selection and extraction process. Search results will be managed using Covidence software.[46]

5.1.8.2 Data selection and collection process

Search results will be merged, and duplicates will be removed using the systematic review management software Covidence.[46] All reviewers will initially screen the first 50 search results to ensure consistency in applying the inclusion criteria. After this initial phase, reviewers will meet to discuss and clarify any screening decisions and address any uncertainties about the inclusion criteria.

For the title and abstract screening phase, two reviewers will screen the first two-thirds of the articles independently. If the rate of conflicts is low (less than 10%), the remaining third of the articles will be screened by a single reviewer to balance the priorities of independent review and the timely completion of the review process. Non-English language publications will be reviewed using the language fluencies available within the team (e.g. Spanish, French, Portuguese). For articles in other languages, reviewers will collaborate with colleagues fluent in those languages to assess eligibility and extract relevant data.

Once the title and abstract screening is complete, the team will proceed to full-text screening. Studies that meet the inclusion criteria during title and abstract screening will undergo a full-text review to ensure they do not meet any exclusion criteria. Following PRISMA guidelines,[45] each exclusion will be documented with a specific reason. Covidence offers several built-in exclusion options (e.g. wrong study design, wrong setting) and custom exclusion reasons can be created as needed.[46] Reviewers will meet regularly to discuss and agree on any new custom exclusion criteria during the full-text review.

For the full-text screening process, 10% of the articles will be reviewed by two independent reviewers to ensure consistency. Any discrepancies will be resolved in a meeting to ensure all reviewers have a clear understanding of the inclusion and exclusion criteria. A single independent reviewer will review the remaining 90% of the articles. If the full text of a publication is not accessible, the reviewers will contact the corresponding author and allow up to one month for a response. The article will be excluded from the review if no response is received.

Data extraction will take place in parallel with the full-text review. Data extraction will begin once a sufficient number of articles have been accepted. The entire team will conduct a consensus-building exercise before data extraction, during which all reviewers will extract data from the same 10 accepted articles. A group meeting will then be held to compare the extractions and resolve any questions or discrepancies.

5.1.9 Data items

Data from the accepted articles will be extracted using a standardised form created in Covidence.[45] The data extraction form will capture the following variables:

- **Study characteristics:** author, year of publication, study design, sampling method, follow-up duration, location and funding sources.
- **Study population characteristics:** age, gender, sample size, socioeconomic status, gambling behaviours.
- **Exposure and outcome measurements:** types of gambling, frequency of gambling, mental/physical health outcomes, economic and social impacts if reported .
- **Effect size measure** (e.g. relative risk, odds ratio, incidence rate ratio, hazard ratio) and associated uncertainty (e.g. confidence intervals).

5.1.10 Risk of bias in individual studies

Sources of bias will be assessed and documented during the data extraction process, following the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) framework.[77, 78] We will adapt these domains to fit the context of gambling and health outcomes, including the addition of a new domain[70] that assesses industry influence (described below). The risk of bias criteria for individual studies will include:

- **Exposure measurement:** How gambling exposure was assessed (whether standardised, specific, acts-based questions were asked, e.g. "Have you ever engaged in online gambling?" compared to broader questions that rely on the participants' own definitions e.g. "Have you ever experienced gambling?"). Additionally, whether the exposure was self-reported or derived from another source (e.g. health records).
- **Outcome measurement:** How the reported health outcomes were measured (e.g. by physician diagnosis, validated survey instruments or electronic health records).
- **Representativeness of the study population:** Whether the study sample is based on the general population or a specific subgroup where different results might reasonably be expected.
- **Control for confounding**: Whether studies statistically adjusted for known confounders such as age, gender, education, income, and other determinants that could influence the health outcome.
- **Selection bias:** The risk of selection bias will be assessed by examining the follow-up rates for longitudinal studies and by reviewing the proportion of cases and controls with available exposure data in case-control studies.
- **Reverse causation:** Whether the study is at risk of reverse causation will be evaluated based on study design and the potential for recall bias, particularly in case-control studies.[79]
- **Funding-related bias:** The risk of funding-related bias on studies included in our review will be assessed using a new instrument being developed for this purpose.[70] This assesses domains such as involvement of the funder in the research process.

5.1.11 Data synthesis

If at least three studies are identified that report on the same gambling exposure and health outcome, we will synthesise effect sizes using a meta-regression Bayesian regularised trimmed (MR-BRT) model.[76, 80] This approach allows us to conduct a meta-regression analysis for each risk-outcome pair, comparing the health risks for individuals exposed to gambling relative to those not exposed. For risk-outcome pairs with sufficient data points, we will use likelihood-based trimming to detect and exclude outliers before fitting the model, with an inlier fraction of 90%.[80]

For each meta-analysis of risk-outcome pairs, we will adjust for study-level covariates that could bias the reported effect size. The MR-BRT tool includes an automated covariate selection process using the Lasso strategy to identify statistically significant covariates at a threshold of 0.05.[80, 81] This model also quantifies between-study heterogeneity, incorporating uncertainty due to small sample sizes.[80] The uncertainty estimate will reflect both the posterior uncertainty of the fixed effects and the 95% quantile of the heterogeneity parameter, accounting for study design and reported effect size uncertainty.

Additionally, we will assess and report publication bias using Egger's regression, which tests for correlations between standard error and effect size. Funnel plots will also be generated to visualise potential bias.[82, 83]

5.1.12 Additional analyses

If meta-analysis is not feasible for all studies, we will synthesise the results using graphical methods in accordance with the systematic review without meta-analysis (SWiM) guidelines.[84] This will include forest plots, which will display effect estimates for each health

outcome and gambling exposure, using a comparable metric e.g., percentage change across studies.[85] Harvest plots will illustrate disparities in exposure effects, such as differences by age, socioeconomic status, gender, and geographical location.[86] If data needed for transformations are not available, findings will be summarised in supplementary tables and discussed in the text. We may also consider using albatross plots, where appropriate, to summarise results visually.[87]

5.1.13 Confidence in cumulative evidence

We will assess confidence in the results for each risk-outcome pair using the Burden of Proof Risk Function (BPRF) methodology developed by the GBD 2020 Risk Score Collaborators.[76] For harmful exposures, the BPRF represents the 5% quantile of the risk function, interpreted as the lowest level of risk consistent with the available evidence. BPRF values across studies will be summarised into star-rating categories, providing a policy-relevant interpretation of the strength of evidence for each risk-outcome pair. Higher star ratings indicate stronger evidence of association.

5.1.14 Narrative Synthesis

Narrative synthesis will categorise studies by the type of gambling exposure and the associated health outcomes. We will explore the range of evidence across these categories and identify health outcomes and gambling types for which the evidence is strongest, drawing on results from meta-analyses and star-rating categories. This synthesis will inform recommendations for future research and provide insights into how different forms of gambling harm affect health.

5.2 Objective 2: Focus groups

Six focus groups (10 participants in each group) will be conducted to capture a broad range of perspectives on gambling-related harms. Participants will include intervention providers, regulators, policymakers, individuals with lived experience of gambling harm, and members of the general public. These focus groups aim to identify outcomes not captured in the literature, with a specific focus on understanding the economic impacts of gambling and how these may translate to subsequent health harms. The interviews will be conducted using a semi-structured interview guide and recorded using an audio tape for in-person sessions. For online focus groups, we will use Microsoft Teams to ensure compliance with GDPR regulations. The topic guide will be refined based on patient and public involvement (PPI). The recorded sessions, both online and in-person, will be transcribed and analysed using NVivo software. Data analysis will adopt an inductive approach, following a structured, multistage method to thematic analysis.

5.3 Objective 3: Longlisting outcomes

We will undertake a synthesis exercise identifying the list of relevant outcomes from WP1, WP2, objective 1, 2 and the existing quality of life/COS measures.[88, 89] We will present this longlist to our expert by experience panel as part of a full day workshop where the team will combine outcomes that are similar to avoid redundancy. Outcomes will be categorised to those which affect directly affect the individual engaging in gambling and those relevant to affected others and the wider community.

5.4 Objective 4: Delphi surveys

5.4.1 Methods

The Delphi study will consist of three rounds to reach consensus on the most important outcomes related to gambling harms:

Pilot round: Prior to the commencement of the Delphi rounds, the survey will undergo a pilot phase to validate its face validity and to ascertain the time needed for the completion of each subsequent Delphi round.

Round 1: Participants will receive a Participant Information Sheet that outlines the objectives and explains the concept of a Core Outcome Set (COS) using plain language, describing the outcomes of interest. A survey containing a long list of potential outcomes, informed by the systematic review, will be shared with 200 key stakeholders (e.g. experts by experience, including affected others, intervention providers, regulators, policymakers and members of the general public). Each outcome will be rated using a 9-point Likert scale to assess its importance. At the end of the survey, participants will have the opportunity to suggest up to two additional outcomes through an open question. Two more rounds of the survey will follow, using the same group of invitees, to further refine areas of consensus.

Round 2: Participants who responded to the first round will be invited to participate in the second round Based on feedback from Round 1, outcomes with the highest agreement will be retained. New outcomes suggested in the first round will also be incorporated.

Round 3: Those who completed the second round will be invited to the third round. The final round will aim to refine consensus further by narrowing the list to the most critical outcomes. During this round, participants will be asked about their willingness to attend the consensus meeting.

Consensus meeting: The consensus meeting will be held with a smaller group of purposively selected participants from the third Delphi round, in addition to members of the core research team and PPI panel. This hybrid workshop (both in-person and online) will involve anonymous binary voting on the final outcomes, ensuring a broad agreement on the core outcome measures that should guide evaluations of gambling-related interventions.

5.4.2 Recruitment

Initial list generation:

We will start by gathering a preliminary list of potential participants from various resources. This includes suggestions from our partners, such as the PPI panel, Community Connexions,[90] and the CRN. Additionally, we will utilise lists generated from earlier phases of our work and individuals who have expressed willingness to participate in the focus groups.

Diverse representation:

Our aim is to achieve a balanced representation across all relevant stakeholder groups, ensuring diversity by gender, ethnicity, age, disability and other relevant demographic factors.

This will involve creating a long list of potential participants, which will be carefully reviewed to maintain this balance.

Recruitment continuation:
We will continue to recruit participants until we reach our target of 200 individuals. If necessary, additional participants will be sourced and approached based on recommendations and the criteria outlined above. Prior to participating in the focus groups and/or the surveys, all potential participants are required to give their consent either in electronic format or in person using the prepared consent forms.

6 REFERENCES

1. Public Health England. *Gambling-related harms evidence review* 2019 (updated 2023) [cited 2024 21 October]. Available from: https://www.gov.uk/government/publications/gambling-related-harms-evidence-review.

2. Office for Health Improvement and Disparities. *The economic cost of gambling-related harm in England: evidence update 2023* London, UK: Office for Health Improvement and Disparities; 2023 [cited 2024 1 November]. Available from: https://assets.publishing.service.gov.uk/media/63bc25b4d3bf7f262c5ad31f/The-economic-cost-of-gambling-related-harm-in-England_evidence-update-2023.pdf.

3. Browne M, Greer N, Rawat V, Rockloff M. A population-level metric for gambling-related harm. *Int Gambl Stud*. 2017;17(2):163-75.

4. Browne M, Rawat V, Greer N, Langham E, Rockloff M, Hanley C. What is the harm? Applying a public health methodology to measure the impact of gambling problems and harm on quality of life. *J Gambl Issues*. 2017;36:28-50.

5. Marionneau V, Egerer M, Raisamo S. Frameworks of gambling harms: a comparative review and synthesis. *Addict Res Theory*. 2023;31(1):69-76.

6. Wardle H, Degenhardt L, Marionneau V, Reith G, Livingstone C, Sparrow M, et al. The Lancet Public Health Commission on gambling. *The Lancet Public Health*. 2024;9(11):e950-e94.

7. Livingstone C, Rintoul A. Moving on from responsible gambling: a new discourse is needed to prevent and minimise harm from gambling. *Public Health*. 2020;184:107-12.

8. Gambling Research Exchange Ontario. *Applying a public health perspective to gambling harm*: Gambling Research Exchange Ontario; 2017 [cited 2024 1 November]. Available from: https://www.greo.ca/en/programs-services/resources/Applying-a-public-health-perspective-to-gambling-harm---October-2017.pdf.

9. Royal Society for Public Health. *Treating Gambling Policy like other potentially harmful products* 2022 [cited 2024 1 November]. Available from: https://www.rsph.org.uk/about-us/news/treating-gambling-policy-like-other-potentially-harmful-products.html

10. *The National Lottery (Revocation and Amendment) Regulations 2021*, SI 2021/1009. Sect. Regulation 3 (2021).

11. Gambling Commission. *Licence Conditions and Codes of Practice (LCCP) 3.4.3 - Remote customer interaction* 2022 [cited 2024 1 November]. Available from: https://www.gamblingcommission.gov.uk/licensees-and-businesses/lccp/condition/3-4-3-remote-customer-interaction.

12. Regan M, Smolar M, Burton R, Clarke Z, Sharpe C, Henn C, et al. Policies and interventions to reduce harmful gambling: an international Delphi consensus and implementation rating study. *The Lancet Public Health*. 2022;7(8):e705-e17.

13. Burris S, Wagenaar AC, Swanson J, Ibrahim JK, Wood J, Mello MM. Making the Case for Laws That Improve Health: A Framework for Public Health Law Research. *Milbank Q*. 2010;88(2):169-210.

14. Burris S, Mays GP, Douglas Scutchfield F, Ibrahim JK. Moving from Intersection to Integration: Public Health Law Research and Public Health Systems and Services Research. *Milbank Q*. 2012;90(2):375-408.

15. Thomas S, Fayter D, Misso K, Ogilvie D, Petticrew M, Sowden A, et al. Population tobacco control interventions and their effects on social inequalities in smoking: systematic review. *Tob Control*. 2008;17(4):230-7.

16. Blank L, Baxter S, Woods HB, Goyder E. Interventions to reduce the public health burden of gambling-related harms: a mapping review. *The Lancet Public Health*. 2021;6(1):e50-e63.

17. Ukhova D, Marionneau V, Nikkinen J, Wardle H. Public health approaches to gambling: a global review of legislative trends. *The Lancet Public Health*. 2024;9(1):e57-e67.

18. Wardle H, Degenhardt L, Ceschia A, Saxena S. The Lancet Public Health Commission on gambling. *The Lancet Public Health*. 2021;6(1):e2-e3.

19. Wardle H, Reith G, Best D, McDaid D, Platt S. Measuring gambling-related harms: a framework for action. Birmingham, UK: Gambling Commission; 2018.

20. Beynon C, Pearce-Smith N, Clark R. Harms associated with gambling: abbreviated systematic review protocol. *Syst Rev*. 2020;9(1):148.

21. Langham E, Thorne H, Browne M, Donaldson P, Rose J, Rockloff M. Understanding gambling related harm: a proposed definition, conceptual framework, and taxonomy of harms. *BMC Public Health*. 2016;16:80.

22. Newall PWS, Weiss-Cohen L, Thoma V, Ayton P. Differences Amongst Estimates of the UK Problem Gambling Prevalence Rate Are Partly Due to a Methodological Artefact. *Int J Ment Health Addiction*. 2024;22(1):361-3.

23. Hahmann T, Hamilton-Wright S, Ziegler C, Matheson FI. Problem gambling within the context of poverty: a scoping review. *Int Gambl Stud*. 2021;21(2):183-219.

24. Sharman S, Butler K, Roberts A. Psychosocial risk factors in disordered gambling: A descriptive systematic overview of vulnerable populations. *Addict Behav*. 2019;99:106071.

25. Roberts A, Rogers J, Sharman S, Melendez-Torres GJ, Cowlishaw S. Gambling problems in primary care: a systematic review and meta-analysis. *Addict Res Theory*. 2021;29(6):454-68.

26. Limb M. Gambling: call to end industry funded education materials that “stigmatise” people with addictions. *BMJ*. 2023;381:p766.

27. Bonell C, Jamal F, Melendez-Torres GJ, Cummins S. 'Dark logic': theorising the harmful consequences of public health interventions. *J Epidemiol Community Health*. 2015;69(1):95-8.

28. Lorenc T, Oliver K. Adverse effects of public health interventions: a conceptual framework. *J Epidemiol Community Health*. 2014;68(3):288-90.

29. Petticrew M, Shemilt I, Lorenc T, Marteau TM, Melendez-Torres GJ, O'Mara-Eves A, et al. Alcohol advertising and public health: systems perspectives versus narrow perspectives. *J Epidemiol Community Health*. 2017;71(3):308-12.

30. Petticrew M, Roberts H. Evidence, hierarchies, and typologies: horses for courses. *J Epidemiol Community Health*. 2003;57(7):527-9.

31. Parkhurst J, Ettelt S, Hawkins B. *Evidence use in health policy making: an international public policy perspective*: Springer; 2018.

32. Pawson R, Greenhalgh T, Harvey G, Walshe K. *Realist Synthesis: An Introduction*. ESRC Research Methods Programme University of Manchester: RMP Methods Paper 2/2004. 2004.

33. Bonell C, Melendez-Torres GJ, Warren E. *Realist Trials and Systematic Reviews: Rigorous, Useful Evidence to Inform Health Policy*: Cambridge University Press; 2024.

34. Kantilal K, Hardeman W, Whiteside H, Karapanagiotou E, Small M, Bhattacharya D. Realist review protocol for understanding the real-world barriers and enablers to practitioners implementing self-management support to people living with and beyond cancer. *BMJ Open*. 2020;10(9):e037636.

35. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015;4(1):1.

36. Moulton AD, Mercer SL, Popovic T, Briss PA, Goodman RA, Thombley ML, et al. The scientific basis for law as a public health tool. *Am J Public Health*. 2009;99(1):17-24.
37. HM Treasury. *Magenta Book: Central Government guidance on evaluation*. London, UK; 2020.

38. Cochrane Methods Equity. *PROGRESS-Plus* 2024 [cited 2024 28 October]. Available from: https://methods.cochrane.org/equity/projects/evidence-equity/progress-plus.

39. O'Neill J, Tabish H, Welch V, Petticrew M, Pottie K, Clarke M, et al. Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. *J Clin Epidemiol* 2014;67(1):56-64.

40. Livingstone C, Rintoul A, de Lacy-Vawdon C, Borland R, Dietze P, Jenkinson R, et al. Identifying effective policy interventions to prevent gambling-related harm. Melbourne VIC Australia: Victorian Responsible Gambling Foundation; 2019.

41. Hörnle JL, Alan. Tyson, Gareth. Padumadasa, Eranjan. Schmidt-Kessen, Maria José. Ibosiola, Damilola Isaac. *Evaluation of regulatory tools for enforcing online gambling rules and channelling demand towards controlled offers.* . Luxembourg; 2019.

42. Nikkinen J, Marionneau V, Egerer M. *The Global Gambling Industry: Structures, Tactics, and Networks of Impact.* 1 ed. Wiesbaden: Springer Gabler; 2022. 286 p.

43. Welch V, Petticrew M, Tugwell P, Moher D, O'Neill J, Waters E, et al. PRISMA-Equity 2012 Extension: Reporting Guidelines for Systematic Reviews with a Focus on Health Equity. *PLoS Med*. 2012;9(10):e1001333.

44. Zorzela L, Loke YK, Ioannidis JP, Golder S, Santaguida P, Altman DG, et al. PRISMA harms checklist: improving harms reporting in systematic reviews. *BMJ*. 2016;352:i157.

45. 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.

46. Covidence systematic review software. Veritas Health Innovation. Melbourne, Australia2024.

47. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898.

48. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919.

49. Thomas J, Graziosi S, Brunton J, Ghouze Z, O'Driscoll P, Bond M, et al. *EPPI-Reviewer: advanced software for systematic reviews, maps and evidence synthesis* London UK: EPPI Centre, UCL Social Research Institute, University College London; 2023.

50. Francetic I, Meacock R, Elliott J, Kristensen SR, Britteon P, Lugo-Palacios DG, et al. Framework for identification and measurement of spillover effects in policy implementation: intended non-intended targeted non-targeted spillovers (INTENTS). *Implement Sci Commun*. 2022;3(1):30.

51. Hedström P, Ylikoski P. Causal Mechanisms in the Social Sciences. *Annu Rev Sociol*. 2010;36(Volume 36, 2010):49-67.

52. Sohlberg P. A thick description of Robert K. Merton's middle range theory–Manifest properties and latent ambivalence. Theory in Action: Brill; 2017. p. 180-98.

53. Tilly C. Mechanisms of the middle range. In: Calhoun C, editor. Robert K Merton: Sociology of Science and Sociology as Science: Columbia University Press; 2010.

54. Bero L. Implications of the tobacco industry documents for public health and policy. *Annu Rev Public Health*. 2003;24:267-88.

55. Petticrew M, Katikireddi SV, Knai C, Cassidy R, Maani Hessari N, Thomas J, et al. 'Nothing can be done until everything is done': the use of complexity arguments by food, beverage, alcohol and gambling industries. *J Epidemiol Community Health*. 2017;71(11):1078-83.

56. Wong G, Greenhalgh T, Westhorp G, Buckingham J, Pawson R. RAMESES publication standards: realist syntheses. *BMC Med*. 2013;11(1):21.

57. Popay J, Chekar CK, Griffiths A, Halliday E, Kaloudis H, Leiper R, et al. Strengthening the equity focus of applied public health research: introducing the FOR EQUITY platform. *Public Health*. 2023;215:12-6.

58. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336(7650):924-6.

59. NIHR. *Improving inclusion of under-served groups in clinical research: Guidance from the NIHR-INCLUDE project* UK: NIHR; 2020 [Available from: www.nihr.ac.uk/documents/improving-inclusion-of-under-served-groups-in-clinical-research-guidance-from-include-project/25435.

60. Dowling NA, Cowlishaw S, Jackson AC, Merkouris SS, Francis KL, Christensen DR. Prevalence of psychiatric co-morbidity in treatment-seeking problem gamblers: A systematic review and meta-analysis. *Aus N Z J Psychiatry*. 2015;49(6):519-39.

61. Lorains FK, Cowlishaw S, Thomas SA. Prevalence of comorbid disorders in problem and pathological gambling: systematic review and meta-analysis of population surveys. *Addiction*. 2011;106(3):490-8.

62. Pilver CE, Potenza MN. Increased incidence of cardiovascular conditions among older adults with pathological gambling features in a prospective study. *J Addict Med*. 2013;7(6):387-93.

63. Pavarin RM, Fioritti A, Marani S, Gambini D, Turino E, Piazza A. Who Are the Subjects with Gambling-Related Problems Requiring Treatment? A Study in Northern Italy. *J Clin Med*. 2018;7(4).

64. Wardle HD, Simon. John, Ann. McManus, Sally. *Problem gambling, suicidal thoughts, suicide attempts, and non-suicidal self-harm in England: Evidence from the Adult Psychiatric Morbidity Survey 2007.* Birmingham, UK: Gambling Commission; 2019.

65. Wardle H, Reith G, Langham E, Rogers RD. Gambling and public health: we need policy action to prevent harm. *BMJ*. 2019;365:l1807.

66. *Gambling Act 2005,*, (2005).

67. Gambling Commission. *Definitions of terms* 2024 [cited 2024 28 October]. Available from: https://www.gamblingcommission.gov.uk/about-us/guide/page/definitions-of-terms.

68. Goodwin BC, Browne M, Rockloff M, Rose J. A typical problem gambler affects six others. *Int Gambl Stud*. 2017;17(2):276-89.

69. Kahn MG, Callahan TJ, Barnard J, Bauck AE, Brown J, Davidson BN, et al. A Harmonised Data Quality Assessment Terminology and Framework for the Secondary Use of Electronic Health Record Data. *EGEMS (Wash DC)*. 2016;4(1):1244.

70. Young MM, Stark S, Rogers J, Roberts A, Baxter C, Dymond S, et al. *Developing an Instrument to Estimate Risk of Funding-Related Bias in Gambling Research*: Open Science Framework; 2023 [cited 2024 1 November]. Available from: https://osf.io/ey3gx.

71. Gambling Commission. *Participation and Prevalence: Pilot methodology review report (updated 2023)* UK: Gambling Commission; 2022 [cited 2024 1 November]. Available from: https://www.gamblingcommission.gov.uk/about-us/guide/participation-and-prevalence-pilot-methodology-review-report.

72. Hippisley-Cox J, Coupland C, Brindle P. Development and validation of QRISK3 risk prediction algorithms to estimate future risk of cardiovascular disease: prospective cohort study. *BMJ*. 2017;357:j2099.

73. NHS England. *Health Survey for England* UK: NHS England; 2024 [cited 2024 1 November]. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england.

74. Gambling Commission. Gambling Survey for Great Britain (GSGB): Gambling Commission; 2024 [Available from: https://www.gamblingcommission.gov.uk/about-us/statistics-and-research/gambling-survey.

75. COMET Initiative. *Core Outcome Measures in Effectiveness Trials*: COMET Initiative; 2024 [cited 2024 1 November]. Available from: https://www.comet-initiative.org/.

76. GBD 2021 Risk Factors Collaborators. Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet*. 2024;403(10440):2162-203.

77. GRADE. *Welcome to the GRADE working group. From evidence to recommendations – transparent and sensible.* [cited 2024 1 November]. Available from: https://www.gradeworkinggroup.org/.

78. Guyatt GH, Oxman AD, Vist G, Kunz R, Brozek J, Alonso-Coello P, et al. GRADE guidelines: 4. Rating the quality of evidence-study limitations (risk of bias). *J Clin Epidemiol*. 2011;64(4):407-15.

79. Chouinard E, Walter S. Recall bias in case-control studies: an empirical analysis and theoretical framework. *J Clin Epidemiol*. 1995;48(2):245-54.

80. Zheng P, Barber R, Sorensen RJD, Murray CJL, Aravkin AY. Trimmed Constrained Mixed Effects Models: Formulations and Algorithms. *J Comput Graph Stat*. 2021;30(3):544-56.

81. Tibshirani R. Regression Shrinkage and Selection via the Lasso. *J R the Soc Ser B*. 1996;58(1):267-88.

82. Sterne JAC, Egger M. *Regression Methods to Detect Publication and Other Bias in Meta-Analysis*. Publication Bias in Meta-Analysis2005. p. 99-110.

83. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. 1997;315(7109):629-34.

84. Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. *BMJ*. 2020;368:l6890.

85. Humphreys DK, Ogilvie D. Synthesising evidence for equity impacts of population-based physical activity interventions: a pilot study. *Int J Behav Nutr Phys Act* 2013;10(1):76.

86. Ogilvie D, Fayter D, Petticrew M, Sowden A, Thomas S, Whitehead M, et al. The harvest plot: A method for synthesising evidence about the differential effects of interventions. *BMC Med Res Methodol* 2008;8(1):8.

87. Harrison S, Jones HE, Martin RM, Lewis SJ, Higgins JPT. The albatross plot: A novel graphical tool for presenting results of diversely reported studies in a systematic review. *Res Synth Methods*. 2017;8(3):281-9.

88. Bonfils N, Aubin H-J, Grall-Bronnec M, Caillon J, Perney P, Limosin F, et al. Development and Psychometric Properties of a New Patient-Reported Outcome Instrument of Health-Related Quality of Life Specific to Patients with Gambling Disorder: The Gambling Quality of Life Scale (GQoLS). *Int J Environ Res Public Health*. 2022;19:10806.

89. Walker M, Toneatto T, Potenza MN, Petry N, Ladouceur R, Hodgins DC, et al. A framework for reporting outcomes in problem gambling treatment research: the Banff, Alberta Consensus. *Addiction*. 2006;101(4):504-11.

90. Community Connexions. *Community Connexions* Birmingham, UK: NHS Birmingham Community Healthcare NHS Foundation Trust; 2024 [cited 2024 1 November]. Available from: https://www.bhamcommunity.nhs.uk/community-connexions/.