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Effects of prevention and harm reduction interventions on gambling behaviours and gambling related harm: An umbrella review



Naoimh McMahon^{a,*}, Katie Thomson^{b,c}, Eileen Kaner^{b,c}, Clare Bamba^{b,c}

^a Faculty of Health and Wellbeing, University of Central Lancashire, Preston PR1 2HE, UK

^b Institute of Health and Society, Newcastle University, Richardson Road, Newcastle upon Tyne NE2 4AX, UK

^c Fuse – UKCRC Centre for Translational Research in Public Health, Newcastle upon Tyne, UK

HIGHLIGHTS

- First umbrella review evaluating the effectiveness of prevention and harm reduction interventions on gambling behaviour.
- Found evidence of 10 reviews reporting 55 unique primary studies.
- Evidence relates mostly to pre-commitment/limit setting, self-exclusion, youth prevention programmes and messages/feedback.
- Review-level evidence is poor, and no review reported differential effects of interventions across sociodemographic groups.

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Gambling
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Harm reduction
Equity

ABSTRACT

Background: Harms related to gambling have been found not only to affect problem gamblers, but also to occur amongst low- and moderate-risk gamblers. This has resulted in calls for a public health approach to address a possible ‘prevention paradox’ in gambling related harm. The aim of this study was to evaluate the systematic review evidence base on the effects of prevention and harm reduction interventions on gambling behaviours, and gambling related harm. We also aimed to examine differential effects of interventions across socio-demographic groups.

Methods: Systematic methods were used to locate and evaluate published systematic reviews of prevention and harm reduction interventions. We designed the review using the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) Equity extension Guidelines. Four databases were searched from their start date until May 2018. The quality of the included articles was determined using A MeaSurement Tool to Assess systematic Reviews (AMSTAR 2).

Results: Ten systematic reviews were identified reporting 55 unique relevant primary studies. Much of the review evidence-base related to pre-commitment and limit setting (24%), self-exclusion (20%), youth prevention programmes (20%), and machine messages/feedback (20%). The effectiveness of harm reduction interventions are limited by the extent to which users adhere to voluntary systems. Less than half of studies examining youth prevention programmes demonstrated positive effects on behaviour. No review extracted data or reported on the differential effects of intervention strategies across sociodemographic groups. The quality of the included reviews (and their primary studies) were generally poor and clear gaps in the evidence base have been highlighted. **Conclusions:** The evidence base is dominated by evaluations of individual-level harm reduction interventions, with a paucity of research on supply reduction interventions. Review conclusions are limited by the quality and robustness of the primary research. Future research should consider the equity effects of intervention strategies.

1. Introduction

The Gambling Act (2005) in Britain represented a dramatic shift in policy from regulation to market-led expansion (Light, 2007). The

consequent proliferation of commercial advertising and gambling opportunities has further increased social acceptability (Moodie & Reith, 2009). However, the now ubiquitous presence of gambling has raised questions about potential negative impacts, not only on individuals who

* Corresponding author.

E-mail addresses: nmcmahon@uclan.ac.uk (N. McMahon), katie.thomson@newcastle.ac.uk (K. Thomson), eileen.kaner@newcastle.ac.uk (E. Kaner), clare.bambra@newcastle.ac.uk (C. Bamba).

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gamble, but also on their wider social network and on society (Pyle, 2017). While once understood as ‘impulse-control disorders’, gambling disorders are increasingly considered in terms of ‘substance-related and addictive disorders’, with a diagnosis of gambling disorder requiring at least four of the nine criteria set out in the fifth edition of the Diagnostic and Statistical Manual (DSM-5) (American Psychiatric Association, 2013). The prevalence of adult problem gambling in Europe has been reported to range from 0.12–3.4%, slightly lower than worldwide variation of 0.12–5.8% (Calado & Griffiths, 2016). Whilst just 0.7% of the population in England meet the criteria for problem gambling, this figure represents approximately 300,000 people, with a further 1.6 million people categorised as low- or moderate-risk gamblers (Gambling Commission, 2018). Problem gambling is reported to be highest amongst men aged between 25 and 34, and amongst those who play electronic gaming machines (EGMs) (Gambling Commission, 2018). EGMs have been consistently implicated in problem gambling due to the high frequency and continuous nature of the play (Parke, Parke, & Blaszczynski, 2017), and steps have just recently been taken in the UK to reduce the maximum stake on such machines from £100 to £2 (Department for Digital Culture Media & Sport, 2018).

Problem gambling is associated with high levels of mental health and substance use problems (Lorains, Cowlishaw, & Thomas, 2011), and can result in significant gambling related harm. Such harms have been categorised in a recent taxonomy and include financial difficulties; relationship disruption, conflict or breakdown; emotional or psychological distress; decrements to health; cultural harm; reduced performance at work or study; and criminal activity (Langham et al., 2016). The taxonomy additionally highlights the temporal nature of harms from episodic to legacy harms, where the latter can continue to negatively impact individuals and families long after the gambling behaviour itself has ceased (e.g. the impact of poor credit). Gambling related harms have been shown not only to affect the small minority of high-risk and problem gamblers, but also to occur amongst low- and moderate-risk gamblers, resulting in the suggestion of a ‘prevention paradox’ (Canale, Vieno, & Griffiths, 2016; Raisamo, Makela, Salonen, & Lintonen, 2015). As such, it has been suggested that a preventative population approach consisting of general gambling control policies is warranted to shift the distribution of risk and harm across the entire population. Further work however is needed to clarify definitions and measures of both harms and low-risk behaviour, and as such, authors have cautioned the risk of ‘overextending’ the ‘prevention paradox’ argument to the field of gambling (Delfabbro & King, 2017).

Table 1
Matrix of intervention strategies.

	Supply reduction	Demand reduction	Harm reduction
Capability Physical capability: physical skill Psychological capability: the capacity to engage in the necessary thought processes - comprehension, reasoning	n/a	Interventions that reduce gambling demand through changes in knowledge and understanding	Interventions that reduce gambling harm through changes in cognitive processes e.g. gambling fallacies
Opportunity Physical opportunity: e.g. opportunity afforded by the environment Social opportunity: opportunity afforded by the cultural milieu that dictates the way that we think about things (e.g., the words and concepts that make up our language)	Interventions that reduce supply through changes in control and regulation of gambling opportunities	Interventions that reduce gambling demand through changes in the physical and social context of gambling opportunities	Interventions that reduce gambling harm through limiting continuous or excessive opportunity to gamble
Motivation Reflective motivation: reflective processes, involving evaluations and plans Automatic motivation: automatic processes involving emotions and impulses that arise from associative learning and/or innate dispositions – possibly depending on nature of pop-up messages	n/a	Interventions that reduce gambling demand through changes in motivation to participate	Interventions that reduce gambling harm through changes in motivation e.g. feedback on behaviour or performance

Calls for a public health approach are however supported by evidence of a social gradient in gambling and gambling related harm. Castrén et al. found that lower-income individuals had higher average gambling expenditure relative to net income, and suggested that both population and individual-level harm reduction interventions are needed to reduce inequality (Castrén, Kontto, Alho, & Salonen, 2018). Similar findings have been reported in Germany (Henkel & Zemlin, 2016), New Zealand (Tu, Gray, & Walton, 2014), and Australia (Rintoul, Livingstone, Mellor, & Jolley, 2013) where studies have consistently found a relationship between indicators of socioeconomic status and gambling expenditure or harm. Findings have been explained in terms of responses to financial stresses, along with the proximity and density of gambling opportunities and in particular gaming machines. Indeed, the relationship between the location of gaming machines and areas of high deprivation was explicitly highlighted as a factor influencing the £2 maximum stake proposal in the UK (Department for Digital Culture Media & Sport, 2018).

In light of the growing concerns around gambling disorders and harm, and the concomitant growth in the publication of systematic reviews in this field, it is timely to conduct an umbrella review to synthesise the evidence-base and support the development and commissioning of evidence-based interventions. Umbrella reviews are underpinned by systematic review methodology and thus provide a unique opportunity to produce rapid and robust summaries of the evidence base for multiple intervention strategies (Pieper, Buechter, Jerinic, & Eikermann, 2012). We aimed to evaluate the systematic review evidence base on the effects of prevention and harm reduction interventions on gambling behaviours, and gambling related harm. A secondary aim of the review was to examine differential effects of interventions across socio-demographic groups.

2. Materials and methods

2.1. Design

Systematic methods were used to locate and evaluate published systematic reviews of prevention and harm reduction interventions for gambling and gambling related harm. We designed the review using the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) Equity extension guidelines. The checklist is presented in Supporting Information Table S1.

2.2. Conceptual framework

We combined two frameworks to create a matrix of intervention strategies (Table 1). The first framework includes the three strands of harm minimisation: (i) supply reduction (strategies that aim to reduce or disrupt the supply and availability of gambling opportunities), (ii) demand reduction (strategies that aim to reduce the desire to gamble and prevent or reduce initiation of problematic gambling), and (iii) harm reduction (strategies that aim to reduce potential harmful impacts of gambling). To differentiate the underlying mechanisms of action of intervention strategies we also used the Capability-Opportunity-Motivation-Behaviour (COM-B) framework which sits at the core of the Behaviour Change Wheel (Michie, Van Stralen, & West, 2011). Using both frameworks we were able to make a further distinction between interventions where the locus of change was at the level of the individual, and interventions which targeted the physical or social environment.

2.3. Inclusion criteria

The inclusion criteria for the review were determined a priori in terms of PICOS (population, intervention, comparison, outcome, and setting (Higgins & Green, 2008)).

- Population: Children and adults of all ages in any country with or without a diagnosed gambling disorder (Diagnostic and Statistical Manual of Mental Disorders (DSM-5)). Reviews limited to populations with diagnosed gambling disorders only were excluded.
- Intervention: Any prevention or harm reduction intervention targeting gambling behaviour or gambling related harm. Reviews of treatment interventions for diagnosed gambling disorders were excluded.
- Comparison: We included systematic reviews that included studies with and without controls, including randomised and non-randomised controlled trials, randomised and non-randomised cluster trials, prospective and retrospective cohort studies (with and/or without control groups), prospective repeat cross-sectional studies (with and/or without control groups) and interrupted time series (with and/or without control groups). Reviews synthesising qualitative studies only were not eligible for inclusion in the review.
- Outcomes: *Primary outcome*: changes in gambling behaviour and/or gambling related harm. *Secondary outcome*: differential effects of interventions across socio-demographic groups (i.e. age, place of residence; race/ethnicity; occupation; gender/sex; religion; education; income).
- Study design: Only systematic reviews were included in the analysis. Following previous umbrella reviews (Bambra et al., 2010; Cairns, Warren, Garthwaite, Greig, & Bambra, 2015) publications needed to meet the three mandatory criteria of the Database of Abstracts of Reviews of Effects (DARE): (i) that there was a defined review question (with definition of at least two of the participants, interventions, outcomes or study designs), (ii) that the search strategy included at least one named database, in conjunction with either reference checking, hand searching, citation searching or contact with authors in the field, and (iii) the presence of some data synthesis.

2.4. Search strategy

Four electronic databases were searched from their start date to the 1st of May 2018: Web of Science (Core Collection); MEDLINE; PsycINFO; EMBASE. Search strategies were developed using key words identified during a scoping search of gambling related systematic reviews and were tailored to each host site. The search strategy for Web of Science is presented in Supporting Information File S1. We have provided the search strategy for this database as a number of target articles

identified during scoping searches were not indexed in MEDLINE. We also searched the reference lists of all eligible reviews to identify additional potentially relevant publications. In keeping with other public health umbrella reviews (Bambra & Gibson, 2016), searches were limited to reviews that had been subject to peer-review and were published in English.

2.5. Study selection and data extraction

Two reviewers (NMCM and KT) independently screened titles and abstracts and applied the eligibility criteria to full text articles. Two reviewers (NMCM and KT) independently conducted data extraction of the included reviews. Any discrepancies on selection and extraction were resolved through discussion between two lead reviewers (NMCM and KT) and the research team (EK and CB). The following data were extracted: review details, intervention, search strategy, inclusion/exclusion criteria, number of studies in the review, outcomes evaluated, methods used to synthesise the findings, the results obtained, and the authors' conclusions and research recommendations. An example Data Extraction Record is provided in Supporting Information Table S2. As is recommended for umbrella reviews, we checked the primary studies contained in each review for relevance, with data only extracted from included reviews on studies deemed relevant to the review question (Pollock, Fernandes, Becker, Featherstone, & Hartling, 2016). Data extraction only utilised the information from the systematic reviews (and any relevant supplementary material); we did not extract data from the original primary studies. Reviewers' descriptions and categorisations of interventions were therefore used in mapping intervention strategies to our conceptual framework. In order to illustrate the degree of overlap of primary studies we generated a citation matrix provided in Supporting Information Table S3.

2.6. Quality appraisal and data synthesis

A Measurement Tool to Assess systematic Reviews (AMSTAR 2) was used to determine the methodological quality of included reviews (Biondi-Zoccai, 2016). Unlike its predecessor, the original AMSTAR instrument, it is recommended that reviewers do not use the AMSTAR 2 to derive an overall quality score as such scores may act to disguise critical weaknesses which would diminish confidence in the review findings (Shea et al., 2017). The systematic reviews were narratively synthesised in accordance with the conceptual framework.

2.7. Changes from protocol

The protocol is registered with PROSPERO (CRD42018095501). We made one minor change which was that the reviews needed to meet all three of the DARE criteria (not just two as stated in our protocol).

3. Results

The flow of studies through the review is shown in Fig. 1. In total, 5317 citations were retrieved through database searching and downloaded to Endnote reference management software. De-duplication using both Endnote functions and manual identification of duplicates resulted in 3226 unique citations. Ten systematic reviews reporting on 55 unique relevant studies met the criteria to be included in the umbrella review. A list of excluded citations is provided in Supporting Information File S2.

Due to the methodological quality of the primary studies, all of the included reviews were limited to producing a narrative synthesis of the empirical research. AMSTAR 2 assessments found significant methodological weakness across all included reviews (see Supporting Information Table S5). No reviews reported funding by gambling industry organisations, but review funding was not consistently reported. Six of the ten reviews provided details on their funding sources. A

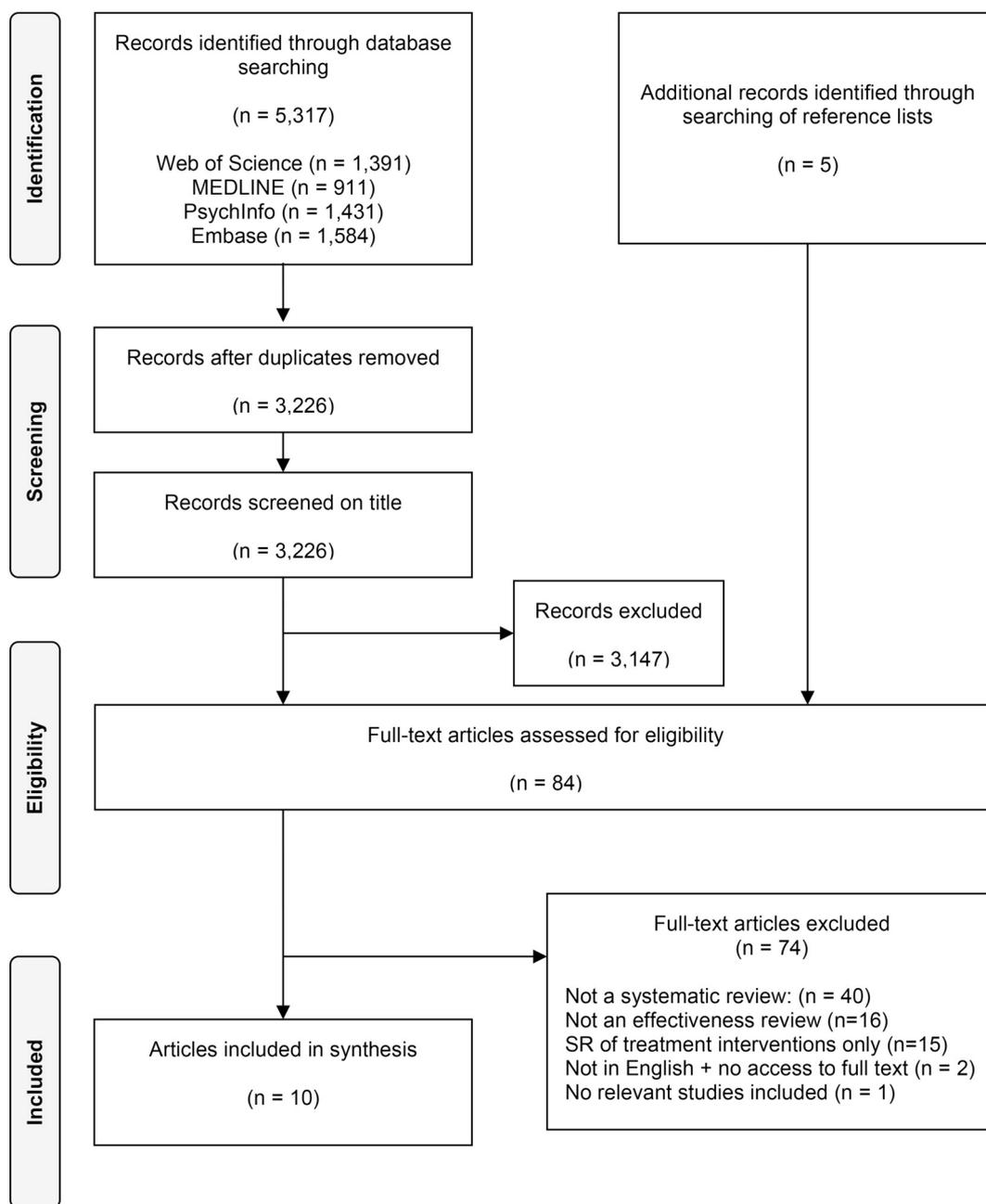


Fig. 1. PRISMA flow diagram of studies.

further two reviews, which did not detail their funding sources, reported no competing interests. None of the included reviews reported the funding sources for the primary studies included in the reviews. Just a single review by [Ladouceur, Blaszczynski, and Lalande \(2012\)](#) made reference to government funded evaluations but funding was not systematically reported for all included evaluations. We found significant duplication of primary studies across reviews with 25 of the 55 unique studies appearing in at least 2 reviews (see Supporting Information Table S3). Characteristics of the included reviews are described in Supporting Information Table S4.

As four of the ten included reviews evaluated evidence for multiple interventions we have opted to illustrate the distribution of primary research by intervention strategies and number of studies (Fig. 2). As primary studies often reported evaluations of multiple intervention strategies the numbers in the Fig. 2 do not add to 55.

We used our conceptual framework to classify reviews. One review evaluated evidence for two supply reduction interventions (reduced

opening hours of gaming machines and caps on EGMs). Five reviews evaluated evidence for two demand reduction interventions (youth prevention programmes and smoking bans). Six reviews evaluated evidence for 7 harm reduction interventions, five of which targeted individual behaviour (pre-commitment/limit setting, machine message/feedback, self-exclusion, personalised feedback interventions) and three of which targeted the gambling context (removal of large note acceptors, maximum bets, removal of ATMs).

3.1. Supply reduction interventions

3.1.1. Reduced opening hours

One review identified four studies which examined the effects of reduced opening hours and shutdowns of electronic gaming machines ([Tanner, Dawson, Mushquash, Mushquash, & Mazmanian, 2017](#)) (Table 2). Studies found that few individuals reported being affected by shutdowns. One study reported a reduction of 3.3% for gaming

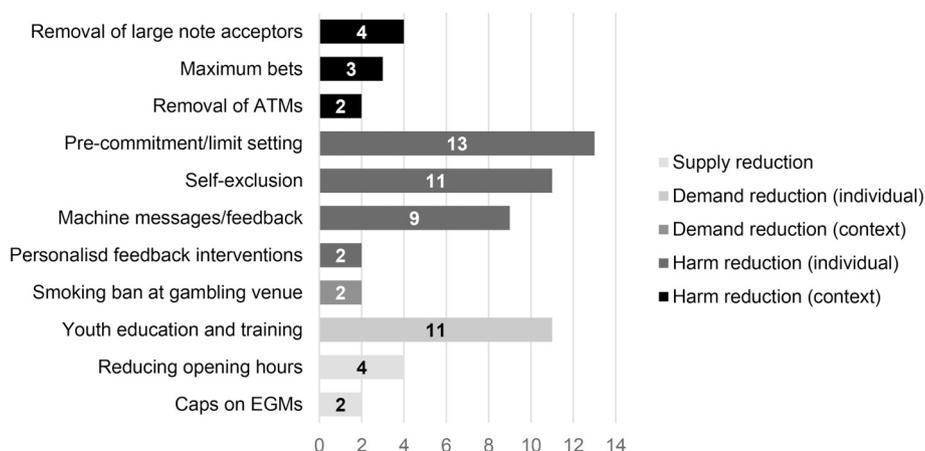


Fig. 2. Intervention strategies and number of unique studies across reviews.

expenditure in venues with reduced opening hours.

3.1.2. Caps on electronic gaming machines

One review identified two studies which examined the effects of caps on the number of electronic gaming machines (Tanner et al., 2017) (Table 2). No differences were found for gambling expenditure or venue profits due to the introduction of EGM caps.

3.2. Demand reduction interventions

3.2.1. Youth prevention interventions

Four reviews identified 11 unique studies which examined the effects of youth prevention programmes on gambling behaviour (Table 3) (Keen, Blaszczynski, & Anjoul, 2017; Kourgiantakis, Stark, Lobo, & Tepperman, 2016; Ladouceur, Goulet, & Vitaro, 2013; Oh, Ong, & JMY, 2017). Nine of the 11 primary studies were duplicated across the reviews (see Supporting Information Table S3). Six of the 11 studies found no significant difference in gambling behaviours following the intervention. Of the five studies that reported significant effects, four studies reported a reduction in the number of gamblers, and gambling problems in the intervention group. In the two studies that did report effect sizes, one study of moderate quality found that frequent gamblers in the intervention group reduced problem gambling ($d = 0.41$) and frequency ($d = 0.45$) compared to non-frequent gamblers. The second study, rating as weak quality, reported a medium reduction in at-risk/problem gamblers in the intervention group ($\phi = 0.32$).

3.2.2. Smoking bans

One review identified two studies which examined the effects of smoking bans at gambling venues (Tanner et al., 2017) (Table 3). Although the majority of participants in one study (89%) reported no change in gambling behaviour, a second study reported a significant reduction in gambling expenditure as a consequence of a smoking ban (no outcome data provided in the review).

Table 2

Summary of findings for supply reduction interventions.

Intervention type and intervention	Mechanism of action	Reviews [number of studies]	Summary of findings
Reduced opening hours of gaming machines	Physical opportunity	Tanner et al. (2017) [4]	One study reported a 3.3% reduction in gaming expenditure for venues that reduced their hours.
Caps on electronic gaming machines	Physical opportunity	Tanner et al. (2017) [2]	No change in gambling expenditure or profits.

3.3. Harm reduction interventions

3.3.1. Pre-commitment/limit setting

Five reviews identified 13 unique studies which examined the effectiveness of pre-commitment systems and limit setting (Drawson, Tanner, Mushquash, Mushquash, & Mazmanian, 2017; Harris & Griffiths, 2017; Ladouceur et al., 2012; Ladouceur, Shaffer, Blaszczynski, & Shaffer, 2017; Tanner et al., 2017) (Table 4). Seven studies reported no positive effects, finding that users continue to gamble even after receiving messages that daily limits had been reached. One study reported that 80% of users exceeded limits, while a second study reported a lower figure of 30.2%. Six studies reported positive effects of limit setting strategies. Limit setting was found to result in reduced duration of play and reduced overall gambling activity. In two studies users self-reported positive changes in gambling behaviour. One study reported a reduction in EGM turnover by 31.7% after the introduction of a pre-commitment system. Review authors highlight that as limits are often determined by the individual, the risk of possible negative unintended consequences of limit setting has also been identified, whereby individuals who experience problem gambling are more likely to both set higher limits, and exceed these limits, thus resulting in potential increased gambling expenditure.

3.3.2. Self-exclusion

Two reviews identified 11 unique studies which examined the effects of self-exclusion programmes (Drawson et al., 2017; Ladouceur et al., 2017) (Table 4). Five studies found that gambling severity decreased following a period of self-exclusion but changes were not maintained once excluders returned to gambling. Similar to limit-setting, individuals must avail of the opportunity to self-exclude, with many of those who do, breaching the agreement at some point (26% - 60%) (Drawson et al., 2017). Self-exclusion was additionally found to have positive effects on gambling related harm. Studies reported improved psychological function including reduced anxiety and depression, along with reduce family and work related difficulties. A further breakdown of findings across studies was not available within the reviews. No outcome data was reported.

Table 3
Summary of findings for demand reduction interventions.

Intervention type and intervention	Mechanism of action	Reviews [number of studies]	Summary of findings
Targeting individuals Youth prevention interventions	Psychological capability/ reflective motivation	Four reviews evaluated evidence for 11 unique studies. Keen et al. (2017) [9] Kourgiantakis et al. (2016) [7] Oh et al. (2017) [6] Ladouceur et al. (2013) [5]	Five of the 11 studies demonstrated a reduction in gambling behaviours or gambling problems.
Targeting contexts Smoking bans	Social opportunity/ reflective motivation	Tanner et al. (2017) [2]	Smoking bans had mixed effects. Most people reported no change in spending due to the smoking ban, but a single study found a significant reduction in gambling expenditure following a ban.

3.3.3. *Machine messages/feedback*

Five reviews identified 9 unique studies which examined the effectiveness of messaging on gaming machines (e.g. general information, warning, self-appraisal) ([Drawson et al., 2017](#); [Harris & Griffiths, 2017](#); [Ladouceur et al., 2012](#); [Ladouceur et al., 2017](#); [Tanner et al., 2017](#)) (Table 4). Eight studies reported some positive effects on gambling behaviour. In a number of instances participants needed to play long enough to receive a feedback message, however one study found that for those who did, they were significantly more likely to terminate play in response to a self-appraisal message compared to a session length message (Cohen's $d = 0.42$). In a study on self-report change in

behaviour, one in four people reported that session length reminders improved their control over both time and expenditure. An additional study also found that 22% of gamblers who used an on-screen clock ceased their session in response to the clock. Evidence is however limited in terms of offering a clear understanding of the mechanisms of action of the different styles of messages and the possible role of the break in play that messages provide in modifying behaviour ([Harris & Griffiths, 2017](#)).

3.3.4. *Personalised feedback interventions*

One review identified two relevant studies which examined the

Table 4
Summary of findings for harm reduction interventions.

Intervention type and intervention	Mechanism of action	Reviews [number of studies]	Summary of findings
Targeting individuals Pre-commitment /limit setting	Voluntary and not-enforced: reflective motivation Mandatory and enforced: physical opportunity	Five reviews evaluated evidence for 13 unique studies Drawson et al. (2017) [7] Ladouceur et al. (2012) [7] Harris and Griffiths (2017) [3] Ladouceur et al. (2017) [3] Tanner et al. (2017) [2]	Seven studies found no change in gambling behaviour. Six studies reported positive reductions in duration of play and gambling activity. Time and monetary limits were found to be more likely to both be set, and exceeded, by problem gamblers.
Self-exclusion	Physical opportunity	Two reviews evaluated evidence for 11 unique studies Drawson et al. (2017) [11] Ladouceur et al. (2017) [5]	Studies found positive effects on gambling behaviour during the exclusion period. Positive effects on gambling related harm were also identified e.g. reduced anxiety and depression, reduced family and work difficulties. Problem gambling status increased once excluders returned to gambling.
Machine messages/ feedback	Psychological capability/ reflective motivation/ automatic motivation	Five reviews evaluated evidence for 9 unique studies Tanner et al. (2017) [7] Harris and Griffiths (2017) [4] Ladouceur et al. (2017) [2] Drawson et al. (2017) [3]	Eight of the nine studies reported some positive effects of machine messages/feedback on gambling behaviour. Self-appraisal messages were found to be more effective than informational messages on session length.
Personalised feedback interventions	Psychological capability/ reflective motivation	Marchica and Derevensky (2016) [2]	Both studies showed greater decreases in gambling behaviour in the PFI groups compared to the cognitive intervention groups.
Targeting contexts Removal of large note acceptors	Physical opportunity	Two reviews evaluated evidence for 4 unique studies Tanner et al. (2017) [3] Harris and Griffiths (2017) [2]	Two studies found no self-reported change in behaviour. Two studies found a reduction in gambling frequency, along with money and time spent gambling. Reductions were greater for high risk groups.
Maximum bets	Physical opportunity	Tanner et al. (2017) [3]	Two studies report no self-reported effects. One study reported reduced time spent gambling and reduced losses.
Removal of ATMS	Physical opportunity	Tanner et al. (2017) [2]	One study reported no change. One study identified a 7% reduction in EGM expenditure.

effectiveness of personalised feedback interventions (PFI) (Marchica & Derevensky, 2016) (Table 4). PFI interventions are intended to work through highlighting erroneous beliefs that an individual may hold about the behaviours of their peer group in order to reduce a particular behaviour. Both studies demonstrated that the personalised feedback intervention was more effective in changing behaviour compared to the cognitive intervention groups. One study, for which outcome data was provided, found that the PFI group demonstrated a decrease in gambling frequency (Cohen's $d = 0.34$) and endorsed fewer DSM-IV criteria (Cohen's $d = 0.60$) relative to controls.

3.3.5. Removal of large note acceptors

Two reviews identified four unique studies which examined the effectiveness of prohibiting large note acceptors on gaming machines (Harris & Griffiths, 2017; Tanner et al., 2017) (Table 4). Two of the four studies reported no effects. However, substantial effects were found in the remaining two studies. One study found that slot machine gambling frequency reduced by 20%, with a 10% reduction in overall gambling frequency. In a second study, 15–20% of gamblers reported reductions in gambling behaviour. Effects were found to be greater for problem gamblers and for those in high-risk categories.

3.3.6. Maximum bets

One review identified three studies which examined the effectiveness of maximum bets (Tanner et al., 2017) (Table 4). Two studies found no self-reported change in gambling behaviour. One study found that machines modified to accept the \$1 maximum bet resulted in reduced gambling time and losses for individuals compared to \$10 maximum bet machines. No further outcome data was provided in the review.

3.3.7. Removal of ATMs

One review identified two studies which examined the effectiveness of ATM removal (Tanner et al., 2017) (Table 4). One study found that 97% of people reported no change in spending. A second study found that expenditure on EGMs was reduced by 7% overall after the removal of ATMs. High risk and problem gamblers were also found to spend less time and money at gambling venues, with problem gamblers experiencing reduced scores on a measure of gambling severity.

3.4. Differential effects of intervention strategies

No review extracted data or reported on the differential effects of intervention strategies across sociodemographic groups.

3.5. Assessment of study quality in systematic reviews

Nine of the ten included reviews did not conduct an adequate quality assessment of primary studies in line with the AMSTAR 2 criteria. In two of these reviews, the authors justified the lack of quality assessment in terms of the quality of the primary research where it was suggested that all studies, if assessed, would have been rated as 'weak' (Drawson et al., 2017; Tanner et al., 2017).

4. Discussion

4.1. Overview of the evidence-base and gaps identified

We identified a systematic review evidence-base of ten reviews, comprising 55 unique primary studies. Much of the review evidence-base related to pre-commitment and limit setting (24%), self-exclusion (20%), youth prevention programmes (20%), and machine messages/feedback (20%). Despite some positive findings for pre-commitment and limit setting, such interventions are limited by the extent to which users adhere to voluntary systems. Additionally, reviews have highlighted potential negative unintended consequences of this strategy for

high-risk and problem gamblers. While the positive effects of self-exclusion tend to be limited to the exclusion period, studies have reported positive impacts on psychosocial functioning, family relations, and work performance. The included reviews show that less than half of the empirical research on youth prevention programmes demonstrated positive effects on gambling behaviour or problems. While the respective numbers of primary studies were small, there was some preliminary support for reduced opening hours of gaming machines; smoking bans; personalised feedback interventions; removal of large note acceptors; maximum bets; and removal of ATMs.

The quality of the included systematic reviews was found to be low. As such, conclusions that can be drawn from the systematic review evidence-base are limited both by the volume, and the methodological robustness of evidence for the different intervention strategies. Indeed, it seemed the case that the motivation for a number of the systematic reviews was to highlight the methodological shortcomings of primary research and thus call for the use of more robust experimental designs to evaluate the effectiveness of intervention strategies. As such, many of the reviews were inclusive assessments of the evidence-base and thus included a heterogeneous body of primary research both in terms of intervention types and study designs. The AMSTAR 2 may therefore provide an overly harsh assessment of the systematic review evidence-base in this topic area which is limited by the stage of development of the primary research.

As shown in Fig. 2, the evidence-base is dominated by systematic reviews of harm reduction interventions, and interventions targeting individual behaviour. This finding is typical of the public health literature and is often explained in terms of (i) the 'inverse evidence law' and (ii) political context and public support for more regulatory action. The 'inverse evidence law' highlights the tendency for there to exist the least evidence and research about interventions that are most likely to be effective (Nutbeam, 2004). In the case of gambling, this has resulted in more research for individually focused behaviour change interventions relative to demand and supply reduction interventions. In the context of legalised gambling in the UK, policy responses aim to ensure the right balance between a sector that can grow and contribute to the economy, and one that is socially responsible (Department for Digital Culture Media & Sport, 2018). As such, the dominant philosophy is one of restrictivism (Collins et al., 2015) where the focus is less on reducing gambling activity per se, but rather on efforts to protect consumers. Reith has highlighted the obvious tension inherent in pursuing an agenda of individual self-control and responsibility, while simultaneously supporting liberalisation and the decline of regulatory controls (Reith, 2007). The focus on targeting individuals may also be explained in part by the emphasis placed on a 'pathologised minority' which serves to shift the locus of intervention away from the 'power centres that generate the risk' to the addicted gambler (Young, 2013).

Additionally, the role of research funding has been highlighted as influential in shaping the profile of gambling research. In this study we found that just over half of the reviews reported their funding sources, and none of the reviews systematically assessed the funding sources of primary studies. While a recent report examining the funding sources of responsible gambling initiatives found no significant differences between study characteristics, and their funding sources (Ladouceur, Shaffer, Blaszczynski, & Shaffer, 2018), the role of direct and indirect industry funding has been consistently identified as a challenge for gambling research. In particular, authors have expressed concern in relation to the 'state-industrial gambling complex' (Young & Markham, 2015), whereby governments are involved in legislating and regulating commercial gambling, while also deriving revenue through owning gambling businesses and through taxation (Livingstone & Adams, 2016). Additionally, while gambling research is often supported through charities described as 'independent', authors have questioned the extent to which such organisations fully disclose financial relationships with the gambling industry (Cassidy, 2014). Thus, an important consideration for future empirical research, and evidence

syntheses, is the adequate reporting of all funding sources, and potential conflicts of interest that would allow for greater transparency in this field of research.

Finally, the lack of consideration of equity effects of interventions is an important gap in the evidence-base which has been highlighted in this umbrella review. There is a body of empirical research to support the existence of a social gradient in gambling behaviours and potential harm, along with evidence highlighting the relationship between the proximity and density of gambling opportunities and measures of area-level deprivation (Macdonald, Olsen, Shortt, & Ellaway, 2018; Wardle, Keily, Astbury, & Reith, 2014). Additionally, researchers have highlighted the potential for interventions which target individual behaviour to inadvertently increase inequalities in behaviour (Adams, Mytton, White, & Monsivais, 2016; McGill et al., 2015). These findings will likely have important implications for designing and evaluating prevention and harm reduction interventions in this field of research.

4.2. Implications for research and practice

The conclusions that can be drawn in this umbrella review are limited by the quality and robustness of the primary research evaluating prevention and harm reduction interventions. Additionally, relative to the volume of research for individual level harm reduction interventions, there is paucity of research on supply reduction interventions in particular. Future research should consider the equity effects of intervention strategies to avoid potential widening of inequalities in gambling behaviour and gambling related harm (Bambra, 2018). This could be assisted by employing recent guidance for equity considerations both in experimental research and systematic reviews (Maden et al., 2017; Welch et al., 2016; Welch et al., 2017). Additionally, systematic reporting of funding sources and potential conflicts of interest, both in primary research and evidence syntheses, is needed. It is worth also noting the high degree of overlap across reviews which likely reflects an unnecessary duplication of effort (Pieper, Antoine, Mathes, Neugebauer, & Eikermann, 2014). None of the included reviews had prospectively registered the review protocol, something which will be important both for avoiding duplication of effort (Stewart, Moher, & Shekelle, 2012), and indeed as a measure of the robustness of the systematic review evidence base.

4.3. Strengths and limitations of this review

Umbrella reviews are a relatively new approach to synthesising research evidence, and thus present unique methodological challenges and limitations (Pollock et al., 2016). Some of the challenges encountered in this review included: overlap between reviews; quality of reporting within reviews; and synthesising heterogeneous findings (Pollock, Campbell, Brunton, Hunt, & Estcourt, 2017). Additionally, while we checked all primary studies for their relevance to the umbrella review question, we only extracted data from the systematic reviews (and any relevant supplementary material). Although none of the systematic reviews reported being funded by industry, they also did not report the funding sources of the primary studies. As such, it is possible that some of the primary studies included in this review were directly, or indirectly, supported by industry funding. While a strength of the umbrella review methodology is the ability to efficiently synthesise the highest levels of evidence across a breadth of literature, the review output is invariably limited by the content of the included reviews and a lack of precision due to the level of synthesis produced.

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Contributors

NMcM designed and oversaw the study with CB and EK. NMcM conducted the searches, reviewed articles for inclusion and extracted data. KT checked the searches and extraction forms. NMcM drafted the manuscript with input from CB, EK and KT. All authors have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.addbeh.2018.11.048>.

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