Loot boxes: A scoping review on primary studies of prevalence and association with problematic gaming and gambling

Short title: A scoping review on loot boxes prevalence and association with problematic gaming/gambling

Irene Montiel^{1¶}, Aránzazu Basterra-González^{1¶}, Juan M. Machimbarrena², Jessica Ortega-Barón¹, Joaquín González-Cabrera^{1*}

¹ Faculty of Education, Universidad Internacional de La Rioja (UNIR), Logroño, La Rioja, Spain

² Faculty of Psychology, Universidad del País Vasco (UPV/EHU), Donostia, Basque Country, Spain

*Corresponding Author:

E-mail: joaquin.gonzalez@unir.net

¶ These authors contributed equally to this work.

Abstract

Background: Loot boxes are a type of random microtransactions that are increasingly common in videogames, so there is some concern about its true extent and entailed risks. Although many papers have been published recently about this topic, the actual prevalence of loot boxes use is uncertain and there is still controversy over the nature of its relationship with problematic gaming and gambling. **Objectives:** The aims of this scoping review are to summarize the characteristics and findings of published primary research studies about the prevalence of loot boxes and/or its relationship with problematic gaming and gambling, taking into account the operationalization of loot boxes use in these studies. **Methods:** The Joanna Briggs Institute Guidance for conducting a systematic scoping reviews and the systematic reviews and meta-analysis extension for scoping reviews (PRISMA-ScR) are followed. Searches in three academic databases provided 299 articles. **Results:** Sixteen primary studies met the inclusion criteria for this review. All the studies were cross-sectional, only four used samples of adolescents and males were overrepresented in ten of the samples. The annual purchase prevalence rate in gamers is higher in adults than in adolescents (22.7 - 44.2% and 20 - 33.9%, respectively), but in general samples (gamers and non-gamers) it is just the opposite (from 24.9% among 13-14 to 7.8% in adults). Prevalence rates are also higher in the samples made up of gamers and gamblers and in studies that measured monthly or lifetime prevalence. In general, studies suggest a positive and significant relationship between loot boxes and problematic gaming and gambling. **Conclusions:** The overrepresentation of male adults with gaming and/or gambling problems in study samples do not allow to generalize their results. An enhanced standardization in measurements and methods for future research in this field is recommended. Also, further longitudinal research is needed to improve the understanding of these problems.

Introduction

Almost 40% of the world's population plays videogames. The number of gamers has increased an average of 6% per year over the past five years, reaching 2.7 billion users by 2020 [1]. This powerful industry has managed to launch products that are consumed by millions of users worldwide. The videogame industry billed \$120.1 billion in 2019 and about \$159.3 billion in 2020, an annual increase of more than 9% [1]. One of the components of this success lies in the incorporation of elements such as in-game purchases, which represent an important source of revenue for this industry [2,3].

Within a videogame, there are several objects (usually different in each videogame) that allow obtaining improvements and advantages in the game and quickly achieve the game's objectives. Graphic elements that modify the external appearance of the characters by changing their aesthetics, their clothes, or their weapons (so-called *skins*) are also frequent. These advantages are usually purchased through microtransactions, that is, a stipulated price for a specific and known advantage or skin is paid [4]. A specific type of microtransaction is loot boxes, also called crates, gachas, cases or chests, in which a random virtual item is purchased [5,6]. Loot boxes can be purchased for real or virtual in-game money, with players' most desired items being those with a lower occurrence ratio [7,8].

The most established games in the world rankings include loot boxes within their mechanics, such as, for example, Overwatch, FIFA, Battlefield, Call of Duty, Fornite or League of Legends. Their presence in desktop videogames has increased by 67% in the last nine years [9] and more than 58% of Google Play and iPhone games contain loot boxes [10]. Among people who play video games, 78% of adults [11] and 40.5% of adolescents between 16 and 18 years

old [9] have purchased some loot box, but the first data is about lifetime prevalence and the last refers to the last month, being incomparable. One of the most worrisome aspects is that 56% of mobile games containing loot boxes are considered suitable for children as of seven years of age, and 93% for children as of twelve years of age [10]. There is some evidence about the increasing use of loot boxes among general population who play video games but the real extent of the phenomenon and the risks this could entail for both adults and adolescents is still uncertain.

Some authors claim that loot boxes are introducing gambling elements into gaming and argue that they may be the gateway to problem gambling or aggravating gambling or gaming-related harm [5–7,12]. Whether excessive use of loot boxes is best conceptualized under the theoretical framework of problem gambling or problem/excessive gaming is also under debate [4,12,13]. In this sense, a recent meta-analysis found that there is a small but potentially clinically relevant relationship between gambling symptomatology and loot box spending, and that this association is at least as large as that found with excessive gaming symptoms, suggesting the need for further research [13]. Some longitudinal studies also point out that problematic gaming appears to be an entry behavior to problematic gambling [14], but a recent review found little convincing evidence in support of this “gateway hypothesis”, suggesting that further longitudinal research is needed to better understanding of the links between video gaming and gambling [12].

Based on all the above and, with the main purpose of protecting children and adolescents, a legislative debate has been initiated about whether loot boxes should be considered a bet as such. Some authors emphasize its virtual, uncertain and random nature, pointing to a relationship with the reward systems present in gambling [15,16]. In the same line, others claim that loot boxes are a clear hybrid between slot machines and collectible card packs [17] and have

similarities with bets [18]. Nielsen and Grabarczyk [19] argue that loot boxes are a particular application of a more general phenomenon called the Random Reinforcement Mechanism (RRM), which has been implemented in videogames for decades [16]. These reward mechanisms are also present in slot machines and their components are the condition of eligibility (a requirement that the player must meet to activate the reward, such as reaching a certain number of points), randomness (e.g., shuffling or throwing dices) and reward (e.g., a new weapon) [19]. However, these authors argue that only those that are embedded in the broader economy (that is that offer randomized rewards that can both be sold and purchased) can be said structurally similar to gambling, while Drummond et al. [20] have shown that virtual items have real-world monetary value to users irrespective of whether they can be cashed out, and therefore could be regulated under existing gambling legislation.

To this day, different countries have echoed the discrepancies in the scientific literature, with conflicting situations. For example, Belgium and the Netherlands have considered loot boxes to be an illegal form of gambling [21], versus the USA, where there is no state legislation in this regard [22], and the United Kingdom has prohibited their use only if the loot box content can be sold outside of the videogame itself [23]. Other countries such as China and South Korea require game developers to include in them the odds of winning the prize [24], and Japan only prohibits some types of loot boxes such as the "kompu gacha" (boxes with rare rewards that can only be unlocked if you first purchase a collection of other loot box items) [25]. Therefore, the need to advance and homogenize scientific-technical criteria that help making such important political and legal decisions is clear.

Due to the emerging nature of this field, scoping review are the best methodological approach to assess and understand our research questions. Scoping reviews are particularly

useful when a body of literature has not yet been comprehensively reviewed, or exhibits a complex, or heterogeneous nature not amenable to a more precise systematic review of the evidence [26]. Moreover, scoping review allow us to identify further areas for subsequent research and clarify whether a systematic review could be conducted to address more specific questions [27].

Therefore, we conduct a scoping review of the primary empirical research studies on loot boxes published to date in a peer-reviewed journals following the follow initial research questions: a) How are loot boxes being measured in the primary research studies; b) What is the prevalence of loot boxes among adults and adolescents and how is it being measured; and c) Is there a clear positive relationship between loot boxes and problematic gaming and/or gambling or it depends on the study characteristics? We then use this information to offer suggestions regarding measurement issues and future research.

Methods

The research and reporting methods of this scoping review were consistent with the preferred reporting items for systematic reviews and meta-analysis extension for scoping reviews (PRISMA-ScR) [28], as outlined in the supporting information (S1 Table). In addition, the Joanna Briggs Institute Guidance for conducting a systematic scoping reviews [26,29], based on earlier work by Arksey and O'Malley [30] and Levac et al. [31], was followed to improve the utility and robustness of the results [26]. The objectives, inclusion criteria and methods of analysis for this review were specified in advance and documented in a protocol adapted from the protocol template of the International prospective register of systematic reviews - PROSPERO- [32] and it will be provided on request from the corresponding author.

Identification of relevant studies

A systematic and comprehensive search was carried out between 22 June and 22 July (both inclusive) of 2020, in the following electronic databases: Google Scholar, Web of Science and Scopus. The search term used was "loot boxes" and "loot box". No limits were placed on the publication dates of the articles, given the scarce literature published in this regard and that it was an emerging topic. Bibliographic references from qualitative or review studies were reviewed and checked to identify research articles not captured by electronic searches in databases. A new search was subsequently carried out in the last week of April, 2021 to detect new publications in this period.

Inclusion and exclusion criteria

The inclusion criteria arise from the formulation of the review questions in the PCC format (population, concept, context)[26]. To be included in the scoping review, the studies had to meet three eligibility criteria: a) to be primary research studies with samples of adults and/or adolescents providing data on the prevalence of loot boxes use in video games and/or data on the relationship between loot boxes and problematic gaming and/or problematic gambling; b) published in English or Spanish; c) published in peer-reviewed journals. Qualitative studies, thesis, reports not published in academic journals, systematic reviews and meta-analysis were excluded. However, their reference lists were reviewed to locate potentially eligible studies. Moreover, authors who had pre-prints were contacted to check the status of the study. One of them provided the published study, which was included in the final selection [15].

Selection of the studies

The Flow Diagram (Fig 1) shows the process of identification, screening, eligibility and inclusion of the studies selected in this review. In the initial search, 292 manuscripts were identified in the three databases consulted. Five manuscripts identified through other sources as reference lists and original authors contacted by email were added to them. All references ($n = 297$) were imported into the Zotero bibliographic manager. From the bibliographic manager itself, the references were ordered and the titles, abstracts and DOIs of all of them were reviewed to detect duplications, which were eliminated. After their elimination, a total of 218 items were transferred to the screening phase. To reduce the possible bias at this stage of the review, two independent researchers (X.X. and Y.Y.) evaluated the titles and abstracts of all of them to preselect the articles that could potentially meet the three eligibility criteria. When the abstract did not allow an assessment of whether a study was or not eligible, the full text was scanned. At this stage, 188 items were removed, which led to a total of 31 pre-selected items. Kappa's match index among the two researchers in the screening and preselection of studies phase was 0.852. After an in-depth reading of the pre-selected articles, 17 of them were discarded for not meeting some of the eligibility criteria. The second researcher reviewed the final selection and potential disagreements on the study's final inclusion were solved with a majority consensus among all the team researchers. In the last search conducted on April, 2021, two articles were added and finally, 16 studies or articles were included in the qualitative synthesis of this scoping review. It is worth noting that two of the studies included two different samples [33,34], as can be seen in the Table 1. This is specified in the narrative synthesis of the results.

Fig 1. PRISMA Diagram of study selection process. *Note.* C1: non-primary empirical studies; C2: studies in a language other than English or Spanish; C3: no peer review.

Data extraction

Table 1 provides a summary of all the information extracted from the 15 articles selected for review. A standardized extraction sheet (Microsoft Excel) was developed containing variables on authors and publication date, country and year of sample study, sample size and age and sex of participants, design and recruitment, objectives, measurement instruments and outcomes of the studies regarding the aims of this scoping review (that is, prevalence rates results, and results concerning the presence or absence of a statistically significant relationship between loot boxes and problematic gaming and/or problematic gambling). Table 2 shows the prevalence ranges by age group (adolescents, adults), time frame and action assessed regarding loot box use (open, purchase or sell) measured in the studies. After piloting the extraction sheet within the review team, data extraction was performed by one team researcher and cross-checked by another team member for accuracy.

191 **Table 1. Characteristics of the selected studies (n = 16).**

Author (year)	Year of data collecting , country	Methods				Loot box def.	Outcomes		
		Participants (n, sex, age)	Design and recruitment	Objectives	Measured variables/instruments		Loot Box Prevalence	Problematic Gaming	Problematic Gambling
Brooks & Clark (2019)	2018 North America	(n1) 144 participants ≥ 21 y/o with prior video game play and familiarity with loot boxes; 48.6% ♀; M = 34; SD = 10.	Cross-sectional data from two samples: one collected via Amazon Mechanical Turk (n1) and the other from an online survey (n2). A recompense of 1.50 USD and a course credit were given to the n1 and n2 participants, respectively.	To test the associations between loot box engagement and gambling behaviour, utilizing an exploratory approach.	Use, preferences, virtual item valuation, prioritization of gaming over other activities.	Y	Opening loot box in a game: 88.9% (n1) and 94.8% (n2)	Significant positive association between RLI and IGDS in the two samples.	Significant positive association between scores of RLI and PGSI in the two samples.
		(n2) 113 university students ≥ 19 y/o with prior video game play and familiarity with loot boxes; 12.1% ♀; M = 21; SD = 2.4.			Ever Loot box engagement (use, purchase), beliefs and behaviours, and monthly loot box spending. Risky Loot-box Index (RLI) Internet Gaming Disorder Scale (IGDS) Problem Gambling Severity Index (PGSI)		Buying loot box or key that opens it: 49.3% (n1) and 60.3% (n2) Selling loot box: 27.8% (n1) and 39.7% (n2)		
DeCamp (2021)	2018 / 2019 Delaware (USA)	13042 public school students aged 13-16 y/o; ♀50% ♂50%	Cross-sectional data from the annual Delaware School Survey (DSS), administered by the University of Delaware Center for Drug and Health Studies, with a randomly selected sample.	To examine one dimension of potential similarities between loot boxes/DLC and gambling: risk and protective factors.	Traditional forms of gambling	N	Buy loot box (only 2019 samples)	Does not provide data.	Does not provide data.
		2018: (n1) 4678 (8th Grade), (n2) 3909 (11th Grade)			Digital gaming purchases: Amount of loot boxes purchased and times that other downloable content (DLC) or in-game items has been purchased in the last year.		(n1) 24.9% (33.9% of gamers)		
		2019: (n1) 2126 (8th Grade) (1531 are gamers), (n2) 2329 (11th Grade) (1340 are gamers)			Others (Parental bond, depression/ anxiety, victimization, bullying, substance use, school grades, gender, and race/ethnicity).		(n2) 17% (28.3% of gamers).		
Drummond et al. (2020)	2019 New Zealand, Australia and the USA	1288 respondents (1049 video gamers ≥ 18 y/o)	Cross-sectional data from three national samples recruited through Qualtrics' Survey Targeting Tool.	To examine whether problem gambling and problem gaming symptomology made independent contributions to predicting loot box spending.	Risky Loot Box Index (RLI) Internet Gaming Disorder Scale (IGDS)	N	Does not provide data.	Significant positive association between IGD symptomology, loot box spending and RLI.	Significant positive associations between monthly loot box spending, PGSI and RLI.
		♀63.4% ♂35.5%; M = 40; SD = 15.4. (17% of the sample met PGSI criteria for gambling problems).			Problem Gambling Severity Index (PGSI) Past month spending on loot box. Others (posistive and negative affect, psychological distress).				

Evren et al. (2021)	2019 Turkey	752 video gamers (e-sports players and university students) ≥ 18 y/o. ♀31%, ♂69%	Cross-sectional data from an online survey addressed to members of a database from ESL Turkey Amateur s-sports players and Taleworlds Entertainment, users of gaming forums in Turkish and university student (rewarded with bonus credit).	To evaluate the relationship of loot box engagement to gender, disordered gaming, using massively multiplayer online role-playing games, and motives for online gaming among young adults.	Weekly gaming time Motives for online gaming Internet Gaming Disorder Scale-Short Form (IGDS9-SF) Last year loot box purchase.	N	22.7%	Purchase loot boxes: Significant positive association between loot box purchase and the severity of IGD symptoms.	Does not provide data.
Ide et al. (2021)	2017 Japan	1615 adolescent gamers aged 14 years (born between September 2002 and August 2004). ♀37%, ♂63% (16.2% of gamers exhibited four or more addictive symptoms in online gaming)	Cross-sectional data from the Tokyo Teen Cohort (TTC) study, an ongoing, prospective, and population-based birth cohort study on adolescents and their primary caregivers through a self-reported questionnaire.	To investigate the association between loot box purchasing among adolescents and parents, and problem online gaming in population-based samples.	Loot box purchase (not time frame specified) Gaming Disorder (DSM-5 Internet gaming disorder criteria)	N	Purchase loot boxes: 3.5%	Significant positive association between loot box purchase and problem online gaming.	Does not provide data.
King et al. (2020)	2018 USA, Australia, Canada and UK	428 Fortnite gamers ≥ 18 y/o. ♀6.5% ♂91.8% 57% 18-21 y/o, and 85 % up to 30 y/o (M=23.5 y/o, SD=7.3, median=21). (14% of the sample met DSM-5 criteria for Internet Gaming Disorder).	Cross-sectional data from online forums related to Fortnite (e.g., Epic Games, Reddit forums).	To investigate gaming motivations and behaviors, as well as online social network influences, in relation to microtransaction spending and gaming disorder (GD) symptoms.	Fortnite social play and influence, Fortnite gaming and expenditure: Expenditure on loot Boxes (daily, weekly, monthly and yearly). Gaming Disorder (DSM-5 Internet gaming disorder criteria) Perceptions of Fortnite value (PFV) Others (impulsiveness, gaming-contingent self-worth).	N	Does not provide data.	Not significant association between loot box expenditure (yes/no and amount) and GD symptoms.	Does not provide data.
Kristiansen & Severin (2020)	2018 Denmark	1137 adolescents aged 12-17 y/o who played video games in the last 12 months. ♀50.6% ♂49.5%.	Cross-sectional data from a survey among a representative gross sample of 5000 Danish adolescents (12–16 yrs.) drawn randomly from the Danish Civil Registration System. Web survey sent, mainly	To examine loot box engagement patterns and links with problem gambling severity.	Monetary gambling involvement, simulated gambling involvement, self-evaluated exposure from gambling advertisements, and a subsection on gambling related gaming including loot boxes (past 12 months obtainment, purchase and sale).	N	Total engagement 56.1% (40% earned; 20% purchased; 10.6% sold) Obtained loot box: 44.3% 12-13 y/o; 40.7% 14-15 y/o; 42.4% 16-17 y/o. Buy loot box:	Does not provide data	Significant positive association between loot box purchasing or selling and PG severity (not only obtained), even controlling demographic factors.

		43.7% 12-13 y/o; 41% 14-15 y/o; 15.4% 16 y/o.	digitally, to a selected parent of the participant,		South Oaks Gambling Screen-Revised for Adolescents (SOGS-RA).		20.5% 12-13 y/o; 17.8% 14-15 y/o; 23.5% 16-17 y/o.		
Li et al. (2019)	2018 Unknown	618 video gamers ≥ 18 y/o. ♂ 63.7%; M= 27 y/o; SD =8.9 (20.06% of the sample met DSM-5 criteria for Internet Gaming Disorder). (48.55% of the gamers-gamblers sample met PGSI criteria for gambling problems).	Cross-sectional data from an online survey advertised to the general public via an Internet-based research panel (FindParticipants.com), gaming and research forums (e.g., Reddit) and university students who were members of eSports and video game organizations in a large public university.	To explore the relationships of loot box purchases to both problem video gaming and problem gambling behaviors.	Past 12 months expenditure on loot boxes , video games used and gaming experience. Video gaming and online gambling engagement (frequency) Problem Video Gaming (DSM-5 IGD criteria) Problem Gambling Severity Index (PGSI) Others (mental distress)	N	Buy loot boxes: 44.2% of gamers (66.54% bought daily, 26.84% once a week). 66.1% of gamblers	Significant positive association between loot box purchase and PVG severity, after controlling gaming engagement. 39.34% of loot box buyers classified as IGD.	Significant positive association between loot box purchase and PG severity. 66.04% of loot box buyers classified as PG.
Macey & Hamari (2019)	2018 USA, UK, Finland, Canada and 58 other nationalities	582 video game players who have watched ESports, bet or bought a loot box in the last 12 months. 91.9% ♂ 5.5% ♀; 1.9% ≤ 14 y/o, 25.1% 15 - 17 y/o; 31.3% 18 - 21 y/o; 16.5% 22-25 y/o and 23.4% ≥ 26 y/o. (4.5% of the sample met PGSI criteria for gambling problems).	Cross-sectional. A link to an online survey was posted on social media sites, such as Facebook and Reddit, on eSports discussion forums and on the social media pages of various national eSports associations (only English-language sites). Respondents had the chance to enter a raffle to win a US\$50 gift card .	To assess participation rates and demographic characteristics of eSports spectators who gamble and to determine the prevalence of problematic gambling behaviors.	Consumption habits for eSports and gambling behavior (online and offline) (overall engagement). Purchasing loot boxes (frequency, average weekly hours spent and average monthly spend were combined to calculate overall engagement in the past year). Problem Gambling Severity Index (PGSI)	N	Buy loot boxes: 46.2% of those who participate in gambling or gambling-like experiences.	Does not provide data.	Significant positive association between buying loot box and PGSI.
von Meduna et al. (2020)	2018 Germany	6000 Internet users ≥ 18 y/o that have participated in online gambling or Pay2Win gaming. (1508 Pay2Win users: ♂51.3%).	Cross-sectional. Part of the larger e-GAMES (Electronic Gam(bling): Multinational Empirical Surveys) with a representative sample of the German population of Internet users.	To explore the overlap between gaming and gambling, as well as similarities and differences between the countries from a large number of respondents.	Problem Gambling Severity Index (PGSI) Adapted version of PGSI for Pay2Win gaming Past year purchasing loot boxes (yes/no) and frequency of loot box purchasing.	N	Buy loot box: 38.9% of Pay2Win users 9.8% of all people completing the survey (including non-Pay2Win users)	68.9% of loot boxes purchasers are problem gamers but there are mixed results in the regression models.	Significant positive association between loot box participation, purchasing frequency and PGSI, but with mixed results. 45.9% of loot boxes purchasers are problem gamblers
Wardle & Zendle (2021)		3549 participants aged 16-24 y/o that had not taken part in any other YouGov study on gambling in the past year.	Cross-sectional. Participants were drawn from YouGov's online panel of over 1 million people living in Britain.	To examine the relationship between the purchase of loot boxes, gambling	Problem Gambling Severity Index (PGSI)	N	Total loot boxes purchase: 12.1%: 38.9% (16-18 y/o), 29.4% (19-21 y/o), 31.8% (22-24 y/o)	Does not provide data.	Significant positive association between loot box purchase and PG, after controlling other

	2019 Great Britain	♂51.3% ♀48.7%; 33.4% 16 - 18y/o; 31% 19 - 21 y/o; 35.6% 22 - 24 y/o. (42.5% had gambled on any activity in the past year and 3.7% experienced problem gambling)	Email invites to participate were sent by YouGov to a random selection of their panel members, stratified by region.	behavior, and problem gambling among young people ages 16–24	A suite of questions adapted from the UK Gambling Commission's Youth Gambling Survey asked whether participants played video games in the last year Last year use of their own money to open loot boxes. Other measures (impulsivity, ethnicity, age, employee).			variables. 16.9% of loot box purchasers was problem gambler.
Zendle & Cairns (2018)	2018 USA, UK, Canada	7422 gamers ≥ 18 y/o ♀9% ♂88%. 48% 18 - 24 y/o; 27.8% 25-29 y/o; 14.3% 30-34 y/o; 6% 35-39 y/o, 3.5% (> 45 y/o).	Cross-sectional data form an online survey with a self-selected sample through reddit and subreddits (online bulletin board).	To measure both how much these individuals spent on loot boxes, and the links between purchasing loot boxes and problem gambling.	Problem Gambling Severity Index (PGSI) Ever loot boxes purchase (Y/N) Monthly loot box expenditure Other in-game microtransaction spend	N	Buy loot box: 78% Does not provide data.	Significant positive association between PGSI and monthly loot box spending.
Zendle & Cairns (2019)	2018 USA	1172 regular gamers of any of these ten games (≥ 18 y/o): Player Unknown's Battlegrounds, League of Legends, Hearthstone, Overwatch, Counter-Strike: GO, FIFA 18, Rocket League, DOTA 2, Team Fortress 2, and Rainbow Six Siege of Tom Clancy. ♀31% ♂64%. 20% 18-24 y/o; 29% 25-29 y/o; 12% 35-39 y/o; 12% > 40 y/o.	Cross-sectional data from an online survey through Amazon Mechanical Turk. The recruitment message specifically did not mention loot boxes.	To measure problem gambling and loot box spending in a sample of gamers from the USA.	Problem Gambling Severity Index (PGSI) Past month loot box expenditure Other spending habits	N	Does not provide data.	Significant positive association between PGSI and past month loot box spending.
Zendle et al. (2019)	2018 UK, Canada, Australia, New Zealand and some European countries	1155 adolescents gamers aged 16-18 y/o. 9%♀ 88%♂. 26.4% 16 y/o; 26.6% 17 y/o and 47% 18 y/o.	Cross-sectional. Online survey through reddit and subreddits (online bulletin board) or specialist interest bulletin boards for games that featured loot boxes.	To measure the relationship between loot box spending and problem gambling.	Canadian Adolescent Gambling Inventory's (CAGI) Problem Gambling subscale. Past month loot boxes opening and purchase (Y/N) Monthly loot box expenditure Features of loot boxes (in-game currency, contents, etc.) and motivation. Other in-game microtransaction spend.	N	Pay for a loot box: 40.5% Does not provide data.	Significant positive association between monthly loot box spending and PG.
Zendle (2020)	2019 UK	1081 participants ≥ 18 y/o 549♀ 526♂. 190 (18-27 y/o), 176 (28-37 y/o), 203 (38-47 y/o), 184 (48-57 y/o) y 328 (> 58 y/o).	Cross-sectional. Online survey by quota sampling to represent the UK population in terms of sex, age, and ethnicity. Sample recruited by Prolific Academic, an online panel provider that remunerate the participants.	To estimate the prevalence of loot box spending, esports betting, real.money gaming, watching videos,etc., and their links with problem gambling and disordered gaming.	Frequency of engagement in eleven traditional forms of gambling, gaming-related forms of gambling and gambling-like behaviours in the past 12 months (esports betting, loot box spending, frequency of loot box purchase , watching loot box openings online, etc.). Problem Gambling Severity Index (PGSI) Internet Gaming Disorder Scale (IGDS)	Y	Engaged in loot box spending: 7.8%	Significant positive association between purchasing frequency and IGDS. Significant positive association between purchasing frequency and PGSI.

		1200 participants ≥ 18 y/o players			Problem Gambling Severity Index (PGSI)		Pay to open loot box:		Significant positive association between PGSI and loot boxes spending and between paying for loot boxes and PGSI (higher than free loot boxes), even when cashing-out is not possible.
Zendle et al. (2020)	2018 Unknown	♀ 37.1% ♂ 60.8%. 19.8% 18-24 y/o; 27.3% 25-29 y/o; 25.2% 30-34 y/o; 13.3% 35-39 y/o and 14.4% > 40 y/o. (17.7% of the sample met PGSI criteria for gambling problems).	Cross-sectional data from an online survey through Amazon Mechanical Turk workers without mentioning loot boxes.	To determine if loot boxes features strengthen the link between loot box spending and problem gambling.	Past month loot box purchasing Past month expenditure in loot boxes Past month earnings selling loot boxes Others (near-misses, in-game currency, crate and key mechanisms, exclusive items).	N	62.4%	Does not provide data.	

192 *Note.* Y/o = years; ♂ = boys; ♀ = girls; Y = Yes; N = No; IGD = Internet Gaming Disorder; PGSI = Problem Gambling Severity

193 Index; RLI = Risky Loot Box Index; GD = Gaming Disorder; PG = Problem Gambling; PVG = Problem Video Gaming; DG =

194 Disordered Gaming.

Results

Characteristics of the studies

Of the 16 selected studies (Table 1), nine were carried out with samples from a single place of origin. In four of these studies, the sample was limited to Europe: two to the United Kingdom [35,36], one to Denmark [2] and one to Germany [15]. In three studies, the sample was from the USA [6,33,34] and in two from Asia [37,38]. In two studies, the sample was collected through the Internet, and the origin of the participants was unknown [3,39]. The other five studies obtained samples from several countries [5,9,11,40,41], among which the study of Macey et al. [41] is noteworthy for its diversity, as it includes a sample from 61 countries. All studies were carried out between 2017 and 2019 with a cross-sectional design and were published between 2018 and 2021 in peer reviewed journals.

The sample sizes are very heterogeneous and vary from 113 participants of Brooks and Clark [33] to 13042 of De Camp [34]. The age of samples ranges from 12 years [2] up to 58 or older [36]. Of the 16 studies selected, only four of them have samples of only adolescents between 12 and 18 years old [9,34,38,42] and ten have a sample made up of only adults over 18 years of age [3,5,6,11,15,33,36,37,39,40]. The remaining two studies have a mixed sample composed of an adolescents and adults [41,43]. Regarding participants' sex, ten study samples overrepresented male respondents compared to females [6,9,11,33,37–40,40,41,43], while one overrepresented female respondents [5] and in another study this information was not indicated [15]. Males and females were equally represented only in four samples: two of the four adolescent samples [2,44], one of the adult samples [36] and one of the mixed sample (adolescents and adults) [43]. It is noteworthy that in three of the adult samples [3,5,44] and one of the mixed samples [41], there is an overrepresentation of people with gambling problems.

Participants from some studies were recruited through various platforms such as Reddit [9,11,41], Amazon Mechanical Turk [6,33,39] or Findparticipants.com [3]. In four cases, an economic or academic reward was given to the participants [33,36,37,41] and two of the studies blind the aims of the research and do not mention loot boxes in the recruitment message [6,44]. The majority of the studies included certain criteria such as being video gamers [2,3,5,6,9,11,33,37,38], players of Fortnite [40], video gamers who have watched eSports, bet or buy loot boxes [41], gamblers or Pay2Win users [15] or gamers of specific videogames [6]. Only four studies did not include any participation criteria: two among adolescent samples [38,45], one among the adult samples [36] and one among the mixed samples [41]. Four of the sixteen studies had representative samples of the population: two among adult samples [15,36] and two among adolescent samples [2,45].

Operationalization of loot boxes

The definitions of all the studies are homogeneous in the characteristics of the construct, such as virtuality, randomness and monetary payment. Some authors nuance the definitions, supplementing them with features such as "digital reward", "bet", "uncertain value" or "in-game or real-world currency" [3,5,15,35,36,41]. Only two studies provide a specific definition of loot boxes before asking about their use [36,46].

Regarding the operationalization of the use of loot box, not all authors ask about the same actions or uses. Thirteen evaluate the purchase [2,3,11,15,33–37,37,38,38,39,41,47], two the sale or "cash-out" [2,44] and two also measured the opening of the loot box in general with or without a payment [2,33]. For this purpose, sociodemographic questions designed ad hoc such as "Have you bought a loot box in the last year?"[2] are used. In eleven of the studies, the questions present a dichotomic response of yes/no

[2,11,15,33,35,36,39,41,47], while other ask for the amount of loot boxes purchased [45] and other calculate an overall engagement from different variables such as frequency of purchasing or time spent [41]. On the other hand, in six of the 16 selected studies, participants are asked about the expenditure in loot boxes [5,6,40,44,47,48], with an open answer in five of the studies to indicate the amount spent [5,6,39,40,47], and in the sixth study, a closed answer was provided with a spending bracket ranging from less than 1 dollar to more than 300 dollars in the last month [11].

Regarding the time frame analyzed in the studies, two ask about the lifetime [11,33], nine about the past year [2,15,36,37,41,43,45,48], four about the past month [5,6,44,47], one about different time frames (daily, weekly, monthly and yearly) [40] and the last, do not specified any time frame [38].

On the other hand, Brooks and Clark [33] designed an instrument that evaluates risky behaviors in the use of loot boxes that can become problematic, and which offers a risky usage rate. The “Risky Loot-Box Index” (RLI) consists of 5 items associated with three dimensions: cognitive concern about the use of loot boxes, impulsive use and chasing losses. This instrument has adequate reliability ($\alpha = .864$), although it shows limitations of internal validity.

Prevalence of loot boxes

There is great heterogeneity in the prevalence data of loot box use in the 16 selected studies. These data are presented depending on whether or not loot boxes are purchased (with real or virtual money) or obtained/opened (without specifying payment) or sold, the type of sample evaluated (adolescents or adults over 18 years of age) and the time frame analyzed (lifetime, annual or monthly) (see Table 2).

Table 2. Loot boxes use prevalence range according to different time frames, age groups and action measured.

Time frames	<i>n</i>	Prevalence range				
		Open (%)	<i>n</i>	Purchase (%)	<i>n</i>	Sell (%)
Lifetime (<i>n</i> = 2)						
Adolescents	0	-		-		-
Adults	1	88.9 - 94.8 ¹	2	49.7 ¹ - 78 ¹	1	27.8 - 39.7 ¹
Past year (<i>n</i> = 9)						
Overall (mixed)	0	-	2	12.1 ² - 46.2 ³	0	-
Adolescents	1	40.7 - 44.3 ¹	2	20 ¹ - 33.9 ¹ 24.9 ²	1	10.6 ¹
Adults	0	-	4	22.7 ¹ - 44.2 ¹ 7.8 ² - 9.8 ² 66.1 ³	0	-
Monthly (<i>n</i> = 2)						
Adolescents	0	-	1	40.5 ¹	0	-
Adults	0	-	1	62.4 ¹	0	-

Note: ¹Gamers sample; ²General sample (gamers and non-gamers); ³Gamers-gamblers

sample.

In adolescents

Of the 16 studies analyzed, four use samples exclusively of adolescents (12 to 18 years) [2,38,45,47]. One of them uses two different samples (13-14 years and 16-17 years) of North American gamers to analyze the annual prevalence of loot box purchases, ranging from 28.3% in the sample aged 16-17 to 33.9% in the sample aged 13-14 years (17% and 24.9%, respectively, in the general samples) [45]. In other study, with a sample of Danish adolescents gamers between 12 and 17 years, the annual prevalence rate is 20% [2]. In both cases, the samples are representatives of their countries. The third study of adolescents (aged 16 to 18 years), analyzes the monthly prevalence of loot box purchases, placing it at 40.5%

[47], and the fourth obtain a purchase prevalence of 3.5% in Japanese adolescents gamers aged 14 years, but without specify the time frame analyzed [38].

Regarding obtaining a loot box (with or without paying), there is a higher annual prevalence (40.7%) than for purchasing (20.5%) in a representative sample of Danish adolescents between 12 and 17 years, being the largest difference in the age group of 14 to 15 years, where there is 40.7% of loot box attainment versus 17.8% purchase [2].

In adults

In ten of the 16 studies, adult samples are used [3,5,6,11,15,33,36,37,39,40]. Of these studies, six present an annual prevalence of the purchase of loot boxes, ranging from 7.8% in a general sample of United Kingdom [36] to 44.2% in a gamers sample and 66.1% in a sample of gamers who also gamble [3]. One study analyzes the monthly prevalence of loot box purchases, being 62.4% [44] and two, the lifetime prevalence, which varies between 49.3% [33] and 78% [11], all of them in gamer samples. One study has two different samples of adults gamers and offers the lifetime prevalence of different actions such as: 1) Participating in games containing a loot box, 2) opening a loot box, 3) buying a loot box and 4) selling a loot box [33]. In this case, the prevalence data in the purchase of loot boxes vary between 49.3% in the first sample ($n = 144$) and 60.3% in the second sample ($n = 113$), in the case of opening a loot box, the data vary between 88.9% in the first sample and 94.8% in the second sample, and in the case of selling a loot box, the data vary between 27.8% in the first sample and 39.7% in the second sample. The rest of the studies of adults ($n = 3$) do not provide data about the prevalence of use because they measure only the loot box expenditure [5,6,40].

In mixed samples of adults and adolescents

Two studies use a mixed sample of adults and adolescents [35,41]. One states that 46.2% of those gamers who gamble bought a loot box in the last year [49]. The other study shows an annual prevalence of 12.1% in the purchase of loot boxes in a general sample (gamers and non-gamers) between 16 and 24 years, with younger people being the biggest purchasers (38.9% 16-18 years) [35].

Association between Loot Boxes and problematic gaming and problematic gambling

Half of the 16 studies analyze the relationship between problematic gaming and loot boxes. Seven of them use adult samples [5,15,36,37,40,46,48] and one an adolescent sample [38]. Only one of these eight studies have a similar proportion of men and women in a general and representative sample of gamers and non-gamers [36] and two without data about the sex of the participants [15,37]. In six of them, a positive statistically significant relationship between the two constructs is observed [3,5,33,36–38], whereas one study does not find this relationship [40] and other shows mixed results [15]. Five of these six studies report a positive relationship between the purchase of loot boxes and problematic gaming measured by Internet Gaming Disorder Scale (IGDS; [50]) [36], Internet Gaming Disorder Scale-Short Form (IGDS9-SF; [51]) [37] and the DSM-5 Internet Gaming Disorder criteria (IGD; [52]) [3,36,38], while two studies report a positive relationship between the RLI and problematic gaming measured by IGDS [5,33]. The study of von Meduna et al. [15] indicates that 68.9% of loot boxes purchasers are problem gamers according to an adapted PGSI-score for Pay2Win gaming, but highlights mixed results in the regression models. On another hand, Drummond et al. [5] also observe a positive relationship between loot box spending and disordered gaming, as measured through the IGDS. There is only one study, carried out in a sample of Fortnite adult gamers, that does not find a positive relationship between loot box

expenditure (yes/no and amount) and IGD symptoms measured through the DSM-5 criteria [40].

Furthermore, 12 of the 15 selected studies analyze the relationship between the use of loot boxes and problematic gambling, indicating all of them a positive association between the two constructs [2,3,5,6,11,15,33,35,36,41,44,47]. Two of these 12 studies are carried out with a sample made out of adolescents [2,47], two with mixed samples [43,49] and the remaining eight studies are carried out with adult samples. Two of these 12 studies use general samples (gamers and non-gamers) and three of out 12 studies (one of adolescent samples, one of mixed samples and one of adult samples) have a similar proportion of men and women in their samples. Seven of the 12 studies report a positive relationship between the purchase of loot boxes and problematic gambling measured by Problem Gambling Severity Index (PGSI; [53]) in adults [15,36,43,44,48,49] and by the South Oaks Gambling Screen–Revised for Adolescents (SOGS-RA; [54]) [2] when the sample is of adolescents. Two studies find a positive relationship between the RLI and problematic gambling measured by PGSI [5,33] and five studies find a positive relationship between the loot box expenditure and problem gambling measured by the PGSI in adults [5,6,11,44] and the Canadian Adolescent Gambling Inventory (CAGI; [55]) when the sample is of adolescents [47].

Discussion

In the last years many papers have been published about loot boxes, but primary empirical research is still scarce and provide very heterogeneous data that hinders their comparison and the general understanding of the phenomenon. This scoping review seeks to order, synthesize and underscore the highlights of loot boxes, such as their prevalence rates in the adolescent and adult population and their relationship with problematic gaming and

problematic gambling, taking into account how this construct has been measured in the primary research studies.

First of all, regarding how loot boxes are being measured in the primary research studies, it is important to underline that, in general, we observed a high degree of agreement about the characteristics of loot boxes, such as the virtuality of the objects, randomness, and monetary payment (with real currency or in-game currency earned through gaming time). Nevertheless, very few studies are sufficiently consistent in their methods to be able to compare their results. Regarding to this, we observed that each study measure different aspects of loot boxes such as the opening, the purchase (yes/no), the frequency, the amount of loot boxes and/or loot box expenditure and use varied time frames, making very difficult and inappropriate to compare the results between studies. On the other hand, as far as we know, there is only one validated instrument that evaluates risky behaviors in the use of a loot box, the Risky Loot box Index [33]. However, it would be advisable to carry out more robust analyses of its psychometric properties.

With regard to the second of the research questions of this scoping review, the heterogeneity of the methods used do not allow us to truly know the magnitude of the phenomenon. Taking all the data extracted of the studies without differentiate among time frame or loot box use (purchase, opening, etc.), adolescents prevalence rates vary between 17% [45] and 44.3% [2] and in adults vary between 7.8% [36] and 94.8% [33], but these data are incomparable among them. The annual purchase prevalence among adolescents gamers varies between 20% found in Denmark in underage aged 12-17 years [2] and 33.9% in underage aged 13-14 years in the USA [56], while the monthly prevalence is 40.5% [47]. In youth and adults over the age of 18, the annual prevalence of purchase varies between 22.7% [37] and 44.2% [49] among gamers and between 46.2% [41] and 66% among gamers who also gamble [48]. The monthly prevalence in adult gamers is 62.4% [44] and the lifetime

prevalence varies between 49.3% [46] and 78% [11]. Annual prevalence of loot box purchase seems to be higher in adults than in minors, and this makes sense, considering that adults are not subjected to parental control, enjoy more freedom and in most cases, they have more purchasing power. But these data do not show the full severity of the problem because they only are referred to the samples of gamers. In studies with general samples of gamers and non-gamers, the average annual prevalence decrease with age, being 24.9% among adolescents aged 13-14 years, 17% among adolescents aged 16-17 years [45], 12% among young people aged 16-24 years [43] and 7.8% among adults [36]. Even in the studies with mixed samples, it could be seen that the youngest participants are the most frequent purchasers of loot boxes, in line with the results of Wardle et al. [43]. On the other hand, it is striking that the prevalence rates are higher the shorter the period evaluated, with the monthly prevalence being higher than the annual one. Arguably it is easier to remember the actions taken more recently so participants' responses to the annual or lifetime timeframe may contain biases that must be taken into account when interpreting the results [58]. It is expected that the data will continue growing in the absence of intervention or legal measures that reduce or eliminate the use of loot boxes among adolescents. It would be desirable, however, to observe adolescents' behavior in longitudinal studies, which could provide more information about the construct at different times and analyze its causal relationships with other variables, such as problematic gaming and gambling.

Another possible cause of this heterogeneity in the data may be other measurement issues related to the recruitment process such as the fact that very few studies provide a definition of loot box to the study participants and it could be possible that the construct did not be interpreted in the same way by all the participants. Also, in some cases, the aims of the studies were blinded, and in others, a reward was given to the participants, which could have skewed the results.

On the other hand, the differences could be associated with cultural and legal variables specific to each country. For example, the 3.5% in the purchase of loot boxes obtained by Ide et al. [38] in Japan and the 7.8% obtained by Zendle [36] in the UK are very far from the 38.9% shown by von Meduna et al. [15] in Germany. This could be due to differences in the legal status of loot boxes in the two countries. Whereas in Germany, there are legal barriers to regulating loot boxes, presenting a lax legislation [18], in the UK loot boxes are covered by the gambling legislation due to their characteristics, and in Japan some types of loot boxes such as the "kompu gacha" (boxes with rare rewards that can only be unlocked if you first purchase a collection of other loot box items) are prohibited [25]. Regulation in some Western countries revolves around a definition of betting in which virtual items have no value outside of the game itself, so any activity containing virtual items would not be considered gambling [41]. However, in some European countries such as Belgium and the Netherlands, the authorities determined in 2018 that some loot boxes did not comply with the gambling legislation and ordered their withdrawal from videogames [59]. Similarly, in some USA states with stricter laws, the sale to minors of videogames containing loot boxes is prohibited [18]. These controversies and lack of agreement in this regard are reflected in the data shown.

Concerning the last of our research questions, there seems to be a positive relationship between loot boxes and problematic gaming and gambling, but further research is needed. After summarizing the results on the relationship between loot boxes and problematic gaming in the studies, it should be noted that only eight of the studies analyzed this relationship, when the pathway of access to loot boxes occurs precisely through videogames. In general, a positive association between the constructs was observed [5,15,36–38,40,46,48] but mainly in adult samples and in some cases, with an overrepresentation of participants classified as problem gamers [38,48]. It is really striking that this relationship only has been studied in one

adolescent sample, when they are heavy users of video games. Also, it can be argued that the entire population does not play the same games and, therefore, there could be a relationship between the two constructs depending on the type of game used. In fact, the only study which does not find an association between loot box and gaming disorder symptoms is exclusively based in Fortnite [40], while the others do not limit the game played by participants. In addition, the existence of free loot boxes should also be considered and their differentiated effect from those that are paid should be further studied, since the required increase in game time as a way to get loot boxes could suggest a possible link in the development of problematic gaming. For example, Kristiansen and Severin [2] stress that there is only a relationship between loot boxes and problem gambling when looking at buying or selling loot boxes, but not when they are obtained for free, and Zendle et al. [44] observe a higher association between loot boxes and problem gambling when a price is paid than when they are free. Nevertheless, none of them have analyzed whether the same is true for the relationship with gaming problems.

As far as the relationship with gambling is concerned, it seems reasonable to infer that the gambling nuance attached to loot boxes favors the relationship between loot box purchase and problematic gambling [3,15], which has been corroborated by all the existing studies to date in both adult and adolescent samples and in recent secondary analyses of loot box data [60]. However, it is advisable to be cautious because the scientific literature is still scarce and an overrepresentation of male adults with problem gambling has been observed in the samples of some studies included in this scoping review [5,44,48] and in the aforementioned secondary analyses of Close et al. [60], which could be influencing the results and does not allow to generalize them. On the other hand, although very few works analyze the relationship between loot boxes, problematic gaming and problematic gambling simultaneously in the same study, their results point to a statistically significant relationship

between purchase of or expenditure in loot boxes and the two problems, in line with the results of the meta-analysis of Garea et al. [13]. In short, it could be concluded that loot boxes are linked to problems related both to gaming and gambling, but to learn more about these relationships, deeper longitudinal studies and representative samples are necessary, as all the studies in this review are cross-sectional and the most of them of limited representativeness, so they do not allow to establish causal effects between variables nor to generalize its results to the general population.

Recommendations for Research

In view of the results obtained in this scoping review, some recommendations could be made for further research. Firstly, effective policies for preventing problematic gaming and/or gambling must be based on scientific evidence, thus a valid identification of the phenomenon's magnitude is essential for prevention or policy-making. To achieve this, future studies should unify the way to measure the use of loot boxes to establish comparisons between different studies and favor the overall comprehension of the construct and the consciousness of the real magnitude of this phenomenon. For example, providing a settled definition of loot boxes to the participants (with some examples) before asking the questions about usage habits and focalize them in recent behaviors (last month) could be a good practice. Regarding spending, an appropriate option would be to offer a response range like the one used by Zendle & Cairns [11], which ranges from less than \$1 to more than \$300, with some intermediate options. It also seems relevant to carry out investigations in which there is a clear distinction between the opening of "free" loot boxes and the opening of paid loot boxes to analyze its differential effects. On the other hand, samples should include similar proportions of males and females and wider age ranges, providing aggregated and disaggregated data for each subsample and discuss their results with the same subsamples from other studies and being cautious in the interpretation and generalization. Also, it would

be advisable to use of clinical and specific instruments for the online context, such as the Online Gambling Disorder Questionnaire [61], or make it explicit when using the PGSI that this does not assess a clinical problem, but its more social aspects [62]. Finally, more instrumental studies are needed to assess the construct of problematic use of loot boxes that can relate it to gaming and gambling problems, both in general and clinical populations.

It is worth noting that this scoping review presents some limitations that should be mentioned. Firstly, the small number of studies included in the review, which may be due to the novelty of the subject matter and the inclusion criteria chosen. For example, relevant studies not published in peer-reviewed journals have been left out of this review (e.g., thesis, unpublished dissertations or reports). Secondly, the heterogeneity and limited representativeness of the samples has hindered the process of comparison between studies, which could lead to biases in their interpretation. For this reason, we have presented separately the data according to the age of the sample, the time frame and the action analyzed in each study. Finally, all the studies included in this review were cross-sectional, which should be in mind when interpret the results about the relationship between loot boxes and problematic gaming and/or gambling.

Conclusion

In sum, this study contributes to a better understanding of the loot boxes study. First, it could be confirmed that loot boxes use is prevalent among both adults and adolescents. However, the prevalence data are very heterogeneous mainly due to the methods differences such as the operationalization of the loot boxes use, the samples' characteristics and the cultural or legal context, compromising comparability across studies and countries. Second, available data suggest a significant relationship among loot boxes use and gambling and

gaming problems. However, it is advisable to be cautious because the scientific literature is still scarce and, to date, all studies published are cross-sectional and some samples are limited in terms of their representativeness, so they do not allow to establish causal effects or generalize its results. Finally, an enhanced standardization in measurements and methods for future research in this field is needed to draw solid conclusions about the use of loot boxes, their risks and role as a gateway or enhancer of other problems such as problematic gaming and problematic gambling.

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Supporting information

S1 Table. PRISMA-ScR Checklist.