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Research Paper

Cheating and Doping in Chess – A Survey among 1,924 German Club Players using the Randomized Response Technique☆

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ABSTRACT

Purpose: This study aimed to investigate the estimated 12-month prevalence of cheating behaviors (i.e., prohibited chess computer engine use or cognitive doping) among German club chess players.
Methods: An online questionnaire was completed by 1924 German club chess players. Self-reported cheating behavior was examined using game mode specific (i.e., Over the board (OTB) and/or online chess) questions on prohibited actions via randomized response technique (RRT), as well as the specific methods of cheating via direct questioning. Estimated 12-month prevalences are presented descriptively. Potential associations between skill level, age, and game mode with cheating behaviors were analyzed using the chi-square test.
Results: The study revealed estimated 12-month prevalences of 5.1 % (95 % CI: 2.5 – 7.8 %) for cognitive doping in both formats (OTB and/or online chess), 7.1 % (95 % CI: 4.3 – 9.8 %) for cheating in OTB chess, and 6.2 % (95 % CI: 3.1 – 9.3 %) for cheating in online chess. Cheating prevalence is potentially influenced by factors such as skill level, age, and game mode.
Conclusion: The study highlights the presence of cheating in the German club chess community. This highlights the need for targeted anti-cheating measures and policies by chess governing bodies and chess platforms to address this issue and secure the integrity of the sport.

1. Introduction

„I believe that cheating in chess is a big deal and an existential threat to the game. I also believe that chess organizers and all those who care about sanctity of the game we love should seriously consider increasing security measures and methods of cheat detection […]“, complained five-time world chess champion Magnus Carlsen via social media (Carlsen, 2022). He accused his opponent Hans Niemann of cheating during their match at the Julius Baer Generation Cup, which once again brought the issue of "cheating" into the spotlight in the chess world (ChessBase, 2022; Zaksaitė, 2020). According to the Anti-Cheating regulations of the International Chess Federation (FIDE) (FIDE, 2022a), cheating is defined as the deliberate use of electronic devices or other sources of information or advice during a game or the manipulation of chess competitions such as, including but not limited to, result manipulation, sandbagging, match-fixing, rating fraud, false identity, and deliberate participation in fictitious tournaments or games (FIDE 2022a; FIDE 2023). The "deliberate use of electronic devices" on which a so-called "engine" is installed is particularly dangerous as advances in Artificial Intelligence (AI) technologies have provided new opportunities for game analysis (Duca Iliescu, 2020; Moravčík et al., 2017). Over the last three decades, computer programs using AI, outperformed experienced human players in many games, such as backgammon (Tesauro, 1995), checkers (Schaeffer et al., 1996), Atari video games (Mnih et al., 2015), Go (Silver et al., 2016) and chess (Campbell et al., 2002). With Garri Kasparov's defeat by chess computer Deep Blue in 1997 (Heßler, 2018), the chess performance of engines have surpassed that of human players. Since engines can calculate a large number of possible moves for each position, any player who gains unauthorized access to them during a game (e.g., via smartphone) can potentially secure a significant advantage over their opponent. Thus, identifying engine cheating has become a critical issue in the chess community

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(Barnes & Hernandez-Castro, 2015).

In chess, a distinction is made between "over-the-board" (OTB) chess, i.e. playing on a physical chessboard, and "online chess", i.e. playing a digital game on an electronic device (e.g. computer or smartphone). Depending on the chess format, anti-cheating prevention measures and potential methods of cheating also differ. For cheating detection, FIDE uses the "FIDE Game Screening Tool" in official high-profile tournaments, which uses advanced algorithms to analyze chess games for patterns indicative of engine use (FIDE, 2020a). Nevertheless, players may naturally make moves similar to those recommended by engines, potentially resulting in "false positive" accusations (Barnes & Hernandez-Castro, 2015; Duca Iliescu, 2020; Guid & Bratko, 2011). Moreover, these tools do not consider the context of moves, the game phase (e.g., opening, middle game, or endgame) or the player's overall strategy (Guid & Bratko, 2011; Haugen et al., 2023). In OTB chess, anti-cheating protection measures such as entry checks, monitoring by arbiters, and other infrastructural arrangements outlined by the responsible chess governing bodies (DSB 2021b, 2023a, 2023b; FIDE 2018a, 2021, 2022a) seek to further reduce cheating. Regarding online chess, FIDE collaborates with established online platforms such as Chess.com, also using automated game screening tools for cheating detection. Confirmed cheating leads to account bans and annulled games, with over 900 daily bans (Chess.com, 2022). In high-level tournaments, players must verify their identities and remain on camera, allowing arbiters to monitor for unauthorized software through screen sharing and Task Manager checks (FIDE, 2022b). Chat functions may be disabled, and video recordings are kept for post-game review if necessary. While there is a significant lack of reliable data on the prevalence of cheating in OTB chess, aside from numerous cases investigated by the FIDE Ethics and Disciplinary Committee (FIDE, 2024a), some data on cheating in online chess already exists. The Chess.com Fair Play Report (Chess.com, 2024) revealed that 62 % of all Titled Tuesday events (i.e. online tournaments open to titled players such as grandmasters) played between November 2020 and March 2024 ($N = 282$) showed overperformances indicative of cheating. However, it should be noted that this is a so-called blitz tournament (3 min per player), and time control (i.e. how much time each player has to complete a game) may affect cheating prevalence. Additionally, algorithm-based detection methods that rely only on unexpected outcomes have methodological limitations.

Besides cheating, doping poses another threat to the game. The World Anti Doping-Agency (WADA) defines doping as the "use of substances from the prohibited classes of substances and the use of prohibited methods" proven by "the presence of a prohibited substance, its metabolites or markers in the body of an athlete" (WADA, 2021, Art. 1–2). FIDE must comply with the requirements of the International Olympic Committee (IOC), such as the Olympic Charter and the World Anti-Doping Code (IOC, 2025; WADA, 2021), as it has been recognized as an International Sports Federation (ARIFS) since 1999. Prohibited substances (i.e. doping), such as Amphetamines, Ephedrine, Methylephedrine, Pseudoephedrine and Modafinil (FIDE 2018a, 2018b; Lanni et al., 2008) are used for cognitive enhancement (CE) and may potentially improve chess performance by enhancing concentration, attention and memory, as well as reducing fatigue and maintaining alertness for longer periods of time (Baranski et al., 2004; Randall et al., 2005; Repantis et al., 2010; Smith & Farah, 2011; Turner et al., 2003).

These medications not only pose a threat to the integrity of chess but also present health risks for athletes. Primary side effects of caffeine, amphetamines (e.g., Ritalin), and methylphenidate (e.g., Modafinil) include tachycardia, hypertension, bronchial dilation, insomnia, nervous agitation, and, at higher doses, an increased risk of psychotic or manic states, alongside potential for misuse and dependence (Dominik et al., 2022). Empirical research on legal CE and (illegal) cognitive doping has predominantly been conducted in contexts other than chess. For instance, studies have found a self-reported use of prescription drugs of approximately 28 % of poker players (Caballero et al., 2016) and 23 % of esports athletes (Schubert et al., 2024). Here, the use of caffeine as a legal CE substance was 71 % in poker and 67 %–78 % in esports (Caballero et al., 2016; Schubert et al., 2024). These numbers should, however, be treated with caution due to small sample sizes and non-representative survey methods. A survey among 2420 chess players by Franke, Dietz et al. (2017) revealed a lifetime prevalence of illicit CE use ranging from 3.5 % to 8.9 %, depending on the questioning technique employed to inquire about prescription and/or illicit drugs. Franke, Gränsmark et al. (2017) showed in another study that the use of Modafinil and Methylphenidate may indeed enhance chess performance. In a double-blind trial with 39 male chess players (mean age 37.0 years, Elo 1677, IQ 127.7), each subject played 20 rapid chess games (i.e., 15 min time limit) against an ELO-matched chess computer (Fritz 12, 6 min time limit) over four separate days. The participants received either Modafinil, Methylphenidate, Caffeine, or a placebo. Chess players under the influence of Methylphenidate, Modafinil, or Caffeine took more time to think and did not win more games compared to placebo controls. However, when analyzing only those 2876 (of 3059 in total) games that were not lost on time, it was shown that the subjects playing under the influence of Methylphenidate and Modafinil, won more games compared to placebo. The researchers, thus, concluded that chess performance could be improved by CE if players are not under time pressure.

In summary, both cheating and doping pose significant threats to the integrity of chess by providing users with unfair advantages over players who do not use such methods. While previous evidence suggests that cognitive doping might be both effective and prevalent (Franke, Gränsmark et al., 2017), the actual prevalence of cheating in OTB and online chess is unknown. Understanding the current prevalence of these behaviors is crucial for developing anti-cheating prevention measures (Zaksaitė, 2022) in both amateur and professional chess. Therefore, the present study aims to assess the 12-month cheating prevalence in organized chess in Germany. An online survey was conducted to investigate different forms of cheating, using a questionnaire that included direct questions as well as the Randomized Response Technique (RRT).

2. Methods

2.1. Ethical approval & survey procedure

The research was conducted using an online questionnaire. All procedures were approved by the local Ethics Commission of the Faculty of Social Sciences, Media and Sport at the Johannes Gutenberg University Mainz. Participation in the study was voluntary and anonymous, and participants were free to withdraw at any point during the completion of the questionnaire. The questionnaire was designed using the online survey tool Unipark by Tivian (V 24.1, Cologne, Germany). Since sensitive data were collected, data protection and anonymity were ensured by strict regulations (ISO 27001, ISO 27018, C5-certified data center). The questionnaire was presented digitally, with participation exclusively via digital devices. The survey was conducted over an eight-week period from April 19, 2024, to June 15, 2024, using a combination of physical and digital outreach strategies. The authors printed posters and flyers with QR-codes, placing them at several chess tournaments in Germany to target engaged participants. Simultaneously, digital graphics were created to promote the survey on social media and other digital platforms. At the outset, the authors engaged key multipliers within the German chess community, including a leading chess magazine and a well-known chess streamer. Additionally, over 120 officials within the DSB and its member associations were contacted on May 8, 2024. These multipliers were provided with the survey link, participation details, and promotional materials, and were asked to distribute the survey within their networks. Several member associations confirmed that they distributed the survey via their websites or newsletters, which led to an increase in the number of participants. A reminder email was sent on June 5, 2024, encouraging further distribution before the survey closed on June 15, 2024.

2.2. Sample & inclusion criteria

The survey in German language addressed active German chess players, i.e., persons who have played in a German chess club governed by the DSB within the last 12 months prior to the study. The DSB, one of FIDE's 201 national chess federations, has around 90,000 members in 2300 clubs, making it one of the largest globally (DSB, 2023b; FIDE, 2020b). As a national sports federation, the DSB complies with the competition and doping regulations of FIDE and WADA (DSB 2021b, 2023c).

Participants were required to be at least 16 years old and possess a chess rating from classical chess (either Elo or “Deutsche Wertungszahl (DWZ)”, both of which represent objective numbers for chess performance). Ratings from online chess platforms (e.g., Chess.com) were not sufficient to participate in the study. Additionally, participants were required to have not taken any pharmacologic cognitive enhancers for medical reasons within the previous 12 months to ensure that only those players using prescription drugs to illegally boost chess performance via CE were included in the present study.

2.3. Questionnaire structure

The questionnaire was designed to be completed in <10 min in order to minimize the drop-out rate (Hoerger, 2010) and comprised a total of 35 questions. Prior to the official survey start, 10 club chess player participated in a pre-test (Kelley et al., 2003), which resulted in minor adaptations of the questionnaire according to their feedback. The survey distinguishes between OTB chess and online chess. Since not every chess player necessarily plays both formats, only those participants who have played both OTB and online chess were eligible to answer all questions. Participants who have only played OTB chess answered a total of 21 questions, while those subjects who have only played online chess during the past 12 months answered a total of 24 questions (see Appendix).

Prior to the questionnaire, participants were informed about exclusion criteria, the procedure and objectives of the survey. Participants had to confirm that they had read and accepted the terms and conditions. At the beginning, demographic data such as gender, age, Elo rating and league affiliation were collected. To ensure anonymity, participants' age, playing level, and Elo rating were collected in ranges to prevent the identification of individual players based on these criteria. Afterwards, the participant's player type is determined by specifying how many OTB games and how many online games he or she has played in the past 12 months approximately. This question determined which and how many questions had to be answered in the subsequent sections (see Appendix). Furthermore, the most played game mode (i.e., bullet/blitz, rapid or standard chess) is queried to assess a possible association between the game mode and potential cheating behaviors.

After collecting the demographic data, the questionnaire continued with a question regarding the respondents' basic attitude towards engine use in chess and its potential threat to the integrity of the game, offering insight into their ethical views on using external assistance. Participants were then asked whether they have taken legal CE substances such as coffee or energy drinks in the last 12 months during an OTB game and/or during an online game. This was followed by an attention check item to further strengthen data quality (Shamon & Berning, 2020). Then, game mode-specific (OTB and/or online chess) direct questions on permitted and prohibited actions in chess were asked to identify the specific methods of cheating. As the prevention measures differ depending on the format, the questions regarding permitted and prohibited actions differ minimally between OTB chess (questions 12–20) and online chess (questions 21–32). The prohibited actions were derived from the official anti-cheating documents of FIDE, in detail: *Art. 11.3 of the Laws of Chess* (FIDE, 2023), *Section 3 of the Anti-Cheating Protection Measures* (FIDE, 2020a), *the Anti-Cheating Regulations* (FIDE, 2022a), *the Anti-Cheating Guidelines for Arbiters* (FIDE, 2021), *the Anti-Doping Policy* (FIDE, 2018a) and *the Anti-Doping-Rules* (FIDE, 2018b), which the DSB has recognized and implemented in its national competition rules (DSB 2021a, 2023b, 2023c). In order to avoid a simple sequence of prohibited actions, permitted actions were mixed in here to ensure a higher level of attention from the participants and consequently a higher quality of answers.

The questionnaire concluded with three "Randomized Response Technique" (RRT) questions. RRT, first introduced by Warner in 1965 (Warner, 1965), is a survey method designed to gather sensitive information without linking individual respondents to specific answers. By ensuring that respondents do not disclose their personal situations, RRT eliminates the potential for embarrassment or stigma, thereby reducing the primary incentives for dishonesty or non-response. A review of the literature reveals that RRT methods provide higher estimates for sensitive characteristics than anonymous questionnaires, while also achieving lower refusal rates (Dietz et al., 2013a; Scheers & Dayton, 1987). In the present survey, the first RRT question (question 33) asked about the use of prohibited substances, i.e. cognitive doping, during an OTB and/or online chess game. The second RRT-question (question 34) asked about the software/engine use or another unauthorized source of information during an OTB game. The third RRT-question (question 35) dealt with such use during an online game.

2.4. Statistical analyses

Statistical analyses were conducted using SPSS (V 27, SPSS, Chicago, IL) for Windows. The authors began by conducting a descriptive statistical analysis to obtain general information about the sample, such as the distribution of gender, age, and skill level. To estimate the external validity of the data set used in our study, an exploratory comparison was undertaken with the DSB player data set, filtering for player status (active), year of birth (> 2008) and FIDE country (GER) (DSB, 2024).

The analysis of the three RRT questions followed a uniform pattern. Participants were first asked to consider a specific birthday in order to answer either a non-sensitive or sensitive question regarding cheating behavior in chess. Since there is only one response option (yes or no) for both the sensitive as well as the non-sensitive question, the authors cannot determine which question each participant was responding to, thus preserving anonymity. Consequently, a probability calculation must be performed to estimate the 12-month cheating prevalence. An example, inspired by Dietz et al. (2013b), (translated into English language), is provided in Table 1.

In the respective RRT question, the probability of being asked the non-sensitive question 1 was 32.9 % (120/365.25), while the probability of receiving the sensitive question 2 was 67.1 % (245.25/365.25). The proportion of “yes” responses to the sensitive question (i.e., $\hat{\pi}_S$, the estimated 12-month prevalence) is calculated from the proportion a of total 'yes' responses in the sample using the formula:

$$\hat{\pi}_S = [a - (1 - p) * \pi_n]/p$$

p represents the probability of receiving the sensitive question (i.e., *p*

Table 1
RRT-question Example (question 1).

Please consider a particular individual (for example, your mother or grandmother) and her or his date of birth. If the individual in question has a birthday within the initial third of the month (1st to 10th), kindly respond to question 1. If not (in the event that the birthday falls within the period between the 11th and the 31st), kindly proceed to question 2.
Question 1: Is the person's birthday in the first half of the year (January to June)?
Question 2: Have you taken any prohibited substances from the WADA doping list such as amphetamines (e.g. Adderall), Ritalin, Modafinil, Ephedrine, Methylephedrine or Pseudoephedrine in the past 12 months before or during a rated chess game (OTB and/or online chess)?
Yes No

= 67.1 %). The probability of answering the neutral question with 'yes' is π_n = 49.6 % (181.25 /365.25). The 95 % confidence interval (95 % CI) for the unknown prevalence is obtained from the sampling variance (Var) calculated via the following formula:

$$\mathrm{Var}(\widehat{\pi}_S) = [a * (1 - a)] / (n * p^2)$$

In addition to the three primary RRT calculations conducted on the entire sample (cognitive doping, cheating in OTB chess, and cheating in online chess), the sample was divided into distinct groups to identify factors influencing cheating behavior. Seven potential influencing factors (age, skill level, league level, OTB game frequency, online game frequency, most played game mode, and basic attitude), each with two dimensions (e.g., young vs. old), were applied to each of the three RRT questions resulting in a total of 45 RRT calculations. In order to obtain reliable RRT estimates, it is essential that each subgroup reaches a minimum sample size, determined through a statistical power analysis (Ulrich et al., 2012). As the null hypothesis of this power analysis assumes a true prevalence of zero ($\pi_S = 0$), the required sample size for the total sample as well as for each subgroup should be at least 650 participants in order to detect an overall prevalence of at least 6 % (Franke, Dietz et al., 2017) with a statistical power of approximately 0.85 (Dietz et al., 2013b).

Further statistical analysis explored the specific methods of cheating used by players. Exploratory analysis was conducted to determine associations between age, skill level, league level, OTB game frequency, online game frequency, most played game mode, and basic attitude with cheating behaviors. Chi-square tests and effect sizes using Cramér's V were used to evaluate the strength and significance of these associations. Alpha level of significance was set to $p < 0.05$. Effect sizes of Cramér's V > 0.2 are reported.

3. Results

3.1. Data cleansing

Of 4,276 people that clicked on the survey, 2,243 participants started the questionnaire by agreeing to the terms and conditions. In a first step, cases were removed in which participants discontinued the questionnaire (*N* = 288). Secondly, 27 cases were removed where the participant neither played OTB nor online chess during the last 12 months. Furthermore, 3 participants were excluded because they completed the questionnaire in <2 min, suggesting that the questions were not read correctly, and the answers were chosen randomly. Finally, one participant was removed from the data set by failing to answer the attention check question correctly (*"Please select the answer option 'Queen' in this question"*). Thus, the final dataset consists of 1924 cases resulting in a dropout rate of 14.2 % (1924/2243).

3.2. Demographic data

Table 2 outlines the demographic data. With 4276 people, 4.5 % of the total number of club chess players in Germany (*N* = 94,811) clicked on the survey, while the final dataset (*N* = 1924) represents 2 % of the total number of German club players (DSB, 2024). Among respondents, 94.5 % identified as male and 4.8 % as female, which is roughly consistent with the gender distribution among members of the DSB in 2024, where 90.5 % of players are male (*N* = 85,821), as well as reflecting the gender distribution of the global chess landscape (Dilmaghani, 2021). The age distribution in the dataset is skewed towards older participants, with 29.4 % of respondents in the 51–60 years age group and 20.1 % in the 61–70 years group, as players had to be at least 16 years old to participate in the study. Regarding chess rating, the majority (29.7 %) had Elo ratings between 1,800 and 1,999, with a proportion of 22.9 % between 1,600 and 1,799, and 19.6 % between 2, 000 and 2,200. In comparison to the DSB player database, the sample underrepresents lower-rated players (Elo below 1,400), while players with an Elo from 1,600 to 2,200 are overrepresented. Playing levels (league) were predominantly at the local (46.7 %) and regional levels (41.2 %), while 2.9 % of the participants played in the two highest leagues ("1. or 2. Bundesliga") in Germany. This aligns with the pyramid structure of the sports system, whereby the majority of leagues are local, followed by regional, with the most talented players competing in a limited number of national leagues and competitions.

Table 2
Demographic data.

		N	%
Questionnaires analyzed		1924	100
Gender	Male	1819	94.5
	Female	93	4.8
	Diverse	11	0.6
	not specified	1	0.1
Age	< 20 years	132	6.9
	20 - 30 years	229	11.9
	31 - 40 years	206	10.7
	41 - 50 years	248	12.9
	51 - 60 years	566	29.4
	61 - 70 years	387	20.1
	> 70 years	156	8.1
Chess Rating (Elo)	< 1,000	28	1.5
	1,000 - 1,199	63	3.3
	1,200 - 1,399	117	6.1
	1,400 - 1,599	208	10.8
	1,600 - 1,799	440	22.9
	1,800 - 1,999	571	29.7
	2,000 - 2,200	377	19.6
	> 2,200	120	6.2
Playing Level (League)	National level (1st & 2nd league)	56	2.9
	Regional level	792	41.2
	Local level	899	46.7
	No games played in last 12 months	177	9.2
OTB games frequency	1 - 10 games	641	33.3
	11 - 20 games	552	28.7
	21 - 30 games	296	15.4
	31 - 50 games	218	11.3
	> 50 games	125	6.5
	I do not know/ not specified	18	0.9
Online games frequency	none	361	18.8
	1 - 20 games	175	9.1
	21 - 100 games	208	10.8
	101 - 250 games	220	11.4
	251 - 500 games	248	12.9
	> 500 games	676	35.1
	I do not know/ not specified	36	1.9
Most played game mode	Bullet or Blitz (< 10 min.)	1002	52.1
	Rapid (10–60 min.)	316	16.4
	Standard	519	27
	No preference	87	4.5
Basic attitude	Disagree	382	19.9
	Rather disagree	440	22.9
	Undecided	334	17.4
	Rather agree	379	19.7
	Agree	387	20.1
	Not specified	2	0.1

Data regarding game frequency showed differences between OTB chess and online chess. 62 % of OTB chess players played <20 OTB chess games in the last 12 months, while a considerable number of online players (35.1 %) played >500 online games in that period. Most played game mode was primarily Bullet or Blitz (52.1 %), with 27 % favoring Standard chess.

Finally, the answers to the participants' basic attitude towards chess engines were quite divided. 39.8 % of participants rather agreed or agreed and 42.8 % rather disagreed or disagreed that chess engines are a threat to the integrity of the game.

3.3. Estimated cheating and doping prevalence assessed via RRT

Table 3 outlines the estimated 12-month prevalence of different

Table 3
Estimated 12-month prevalence for cheating and doping behavior in chess.

Population	N	Yes	No	a	$\hat{\pi}_S$	Var($\hat{\pi}_S$)	95 % CI
Cognitive Doping in OTB and/or online chess							
All players	1,913	378	1,535	19.8	5.1	0.000184	2.5 – 7.8
Low rated players (< 1800 ELO)	852	152	700	17.8	2.3	0.000382	0.0 – 6.1
Older players (> 50 years)	1,101	211	890	19.2	4.3	0.000312	0.8 – 7.7
Cheating via engine or other prohibited sources of information in OTB chess							
All players	1,832	390	1,442	21.3	7.1	0.000203	4.3 – 9.8
Long game players (Rapid & Standard mode)	804	190	614	23.6	10.5	0.000498	6.2 – 14.9
Short game players (Bullet & Blitz mode)	941	182	759	19.3	4.2	0.000368	0.4 – 7.9
Cheating via engine or other prohibited sources of information in online chess							
All players	1,550	331	1,219	21.4	6.2	0.000250	3.1 – 9.3
Younger players (16–50 years)	746	178	568	23.9	10.0	0.000564	5.4 – 14.7
Older players (> 50 years)	804	153	651	19.0	2.7	0.000444	0.0 – 6.8

N: total number of players that answered this question; Yes: total number of 'Yes' answers; No: total number of 'no' answers; a: proportion of total 'yes' responses; $\hat{\pi}_S$: estimated 12-month prevalence; Var($\hat{\pi}_S$): estimated variance; 95 % CI: 95 % confidence interval.

cheating and doping behaviors. The questionnaire revealed estimated 12-month prevalences of 5.1 % (95 % CI: 2.5 – 7.8 %) for cognitive doping in both formats (OTB and/or online chess), 7.1 % (95 % CI: 4.3 – 9.8 %) for cheating in OTB chess, and 6.2 % (95 % CI: 3.1 – 9.3 %) for cheating in online chess.

In comparison to the total sample, the estimated 12-month prevalence for cognitive doping was lower for lower-rated players (2.3 %; 95 % CI: 0 – 6.1) and older players (4.3 %; 95 % CI: 0.8 – 7.7). Regarding cheating in OTB chess, the cheating prevalence among long-game players was higher than in the overall sample (10.5 %; 95 % CI: 6.2 – 14.9), while cheating prevalence among short game players was lower (4.2 %; 95 % CI: 0.4 – 7.9). Cheating in online chess was more prevalent among younger players (10 %; 95 % CI: 5.4 – 14.7) and less prevalent among older players (2.7 %; 95 % CI: 0 – 6.8).

3.4. Methods of cheating and doping assessed via direct questions

Via direct questions, the study examined the 12-month prevalence of permitted CE and cognitive doping in OTB and/or online chess. The results revealed that permitted CE was reported by 47.2 % of OTB chess players and 32.6 % of online players. Regarding cognitive doping, the prevalence was minimal in both contexts, with only 0.4 % of OTB chess players and 0.9 % of online chess players admitting to such practices. The study revealed marked differences in the methods of cheating between OTB chess and online chess. The most frequently reported method of cheating in online chess was participation in fictitious competitions, with 37 % of respondents admitting to this action. Besides that, 9.2 % of participants reported receiving advice from a third person during online games, while there is a notable difference to OTB chess, where the prevalence of such behavior was only 1.4 %. In online chess, 7.7 % admitted to using another player's account, while 7.7 % played with someone else's account during the past 12 months. Deliberately losing a game was reported by 6 % of online players, compared to only 1.4 % in OTB chess. The use of electronic devices during the game was reported by 3.1 % of online players but was much less frequent in OTB chess, where only 0.4 % admitted this behavior. Parallel replay of the game using software/engine (4.1 %), or a second board (4.2 %) occurred in online games, while these actions were nearly nonexistent in OTB chess, with only 0.5 % (software/engine) and 0.3 % (second board) reporting such behaviors. Finally, pre-arranging the match outcome was reported by 4.3 % of OTB chess players, making it the most used method in the OTB setting, compared to only 0.9 % in online chess. In addition to the prohibited behaviors, the study also included 3 permitted actions as a form of attention check, ensuring that participants were not exclusively presented with prohibited scenarios. Table 4 shows prohibited and permitted actions in OTB and online chess with the respective sample size and the distribution of "yes" and "no" answers.

3.5. Further exploratory analyses

Exploratory analyses revealed that younger players (i.e. age < 30 years) are more likely to engage in certain forms of cheating during online games. Specifically, younger players were more inclined to

Table 4
Methods of cheating.

		OTB		Online		Legitimacy
Prohibited/ permitted action		N	%	N	%	
Questionnaires analyzed		**1,850**	**100**	**1,563**	**100**	
Agreed with the opponent on the outcome of the match in advance	Yes	80	4.3	14	0.9	Prohibited
	No	1,757	95.0	1,543	98.7	
	Not specified	13	0.7	6	0.4	
Receive advice on the position from a third person during the game	Yes	25	1.4	144	9.2	Prohibited
	No	1,819	98.3	1,412	90.3	
	Not specified	6	0.3	7	0.4	
Replayed the game in parallel on a second board	Yes	5	0.3	65	4.2	Prohibited
	No	1,840	99.5	1,491	95.4	
	Not specified	5	0.3	7	0.5	
Parallel replay of the game with a software/engine (e.g. during a visit to the toilet)	Yes	10	0.5	64	4.1	Prohibited
	No	1,836	99.2	1,491	95.4	
	Not specified	4	0.2	8	0.5	
Received information via an electronic device during the game (e.g. smartphone)	Yes	8	0.4	49	3.1	Prohibited
	No	1,839	99.4	1,501	96.0	
	Not specified	3	0.2	13	0.8	
Deliberately lost a game	Yes	25	1.4	93	6.0	Prohibited
	No	1,820	98.4	1,461	93.5	
	Not specified	5	0.3	9	0.6	
Played with someone else's account	Yes			121	7.7	Prohibited
	No			1,436	91.9	
	Not specified			6	0.4	
Let someone play with your account	Yes			78	5.0	Prohibited
	No			1,481	94.8	
	Not specified			4	0.3	
Participated in a fictitious competition	Yes			578	37.0	Prohibited
	No			929	59.4	
	Not specified			56	3.6	
Talk to the opponent about the game immediately after the match	Yes	1,753	94.8	340	21.8	Permitted
	No	88	4.8	1,215	77.7	
	Not specified	9	0.5	8	0.5	
Leaving the game board during the game	Yes	1,682	90.9			Permitted
	No	160	8.6			
	Not specified	8	0.4			
Chatted with the opponent during the game	Yes			653	41.8	Permitted
	No			900	57.6	
	Not specified			10	0.6	

receive advice during a game ($p < 0.001$, $V = 0.20$) and to use someone else's account ($p < 0.001$, $V = 0.25$). Other potential influencing factors (i.e. skill level, league level, OTB game frequency, online game frequency, game mode, and basic attitude) had a negligible effect on the methods of cheating ($V = < 0.2$).

4. Discussion

The present study is the first that estimated the prevalence of cheating and cognitive doping among >1,900 German club chess players. Randomized Response technique revealed an estimated 12-month prevalence of 7.1 % (95 % CI: 4.3–9.8 %) for cheating in OTB chess, 6.2 % (95 % CI: 3.1–9.3 %) for cheating in online chess, and 5.1 % (95 % CI: 2.5–7.8 %) for cognitive doping in OTB and/or online chess. In OTB chess, 4.3 % of players prearranged match outcomes. In online chess, 9.2 % admitted to receiving advice during a game, and 7.7 % used someone else's account, with younger players more frequently engaging in these behaviors.

4.1. Cheating in OTB chess

An estimated 7.1 % of players have cheated at least once in an OTB chess game within the last 12 months. Players mostly playing longer games (Rapid & Standard) had a higher estimated 12-month prevalence of 10.5 % than the overall sample, which may be indicative of the greater opportunities for cheating in longer games. The extended time limit (e.g., 2 hours) in Standard chess provides more opportunities to leave the board under various excuses (e.g., visiting the restroom). This extended time frame increases the possibility for players to access external assistance, such as consulting a hidden electronic device or receiving advice from a third party. A recent incident involving a 22-year-old grandmaster, where a cellphone was found in the restroom, underscores this issue (FIDE, 2024b). For players mostly playing shorter games, the authors estimated a lower 12-month cheating prevalence (4.2 %), likely due to the rapid play and minimal breaks in formats like bullet or blitz, which demand continuous focus and limit opportunities for interference or engine use.

The lack of prior research on cheating prevalence in OTB chess makes it difficult to contextualize these findings within existing studies. However, we can draw parallels between anti-cheating measures in OTB chess and those used in-person academic examinations, as both settings implement structural and personnel measures like entry checks, monitoring by officials, and other infrastructural arrangements to prevent cheating. Therefore, literature from that field may provide useful insights. For instance, a study by Mortaz Hejri et al. (2013) using the RRT reported that 67 % (83/124) of medical students cheated in examinations during their medical career. While these numbers are much higher than those found in OTB chess in the present study, it is challenging to compare a 12-month prevalence with a lifetime prevalence, given the significant difference in timeframes. In addition, factors such as participant demographics, the time frame (time controls in chess or duration of the examination), and the respective anti-cheating measures in place at the venue or educational institution must be considered. Using direct questions, Watson and Sottile (2010) found that 32.1 % of students cheated in an in-person exam (185/635). With respect to direct questions in the present study, the most used cheating method in OTB chess was "agreeing with the opponent on the outcome of the match in advance" with 4.3 %, which is a form of match-fixing (Moul & Nye, 2009; Zaksaitė, 2020). When comparing these numbers to other sports, Visschers et al. (2020) reported that 23.5 % of football referees had witnessed or suspected match-fixing, while 21 % of Lithuanian basketball players were approached for match-fixing (Transparency International, 2016). However, it needs to be acknowledged that pre-determined draws in chess are a common yet controversial practice and many players see early draws as a legitimate tactic rather than illegal manipulation (Zaksaite, 2013), even though some high-level tournaments do not allow early draws within their competition regulations.

4.2. Cheating in online chess

With respect to online chess, the estimated 12-month cheating prevalence was 6.2 %. Cheating was estimated to be more prevalent among younger players (10 %) and less prevalent among older players (2.7 %). When asked directly about the specific methods of cheating in online chess, 9.2 % of players admitted to receiving advice from third parties during a game, with younger players being significantly more likely to do so. Additionally, 7.7 % confessed to using someone else's account, again with younger players being more inclined. This may be explained by younger players' greater familiarity with digital tools and technologies compared to older individuals, potentially making cheating more accessible to them. Although the most frequently reported prohibited action in online chess was "participation in fictitious competitions" with 37 %. This finding should be interpreted with caution and the authors suspect that the question was misunderstood, despite the fact that this action was derived from the rules in precisely the same way. In this regard, it is possible that some of the participants agreed ("Yes"), as they think that an online game is always fictitious as it is not in-person and physical. Here, again, contextualizing these numbers with existing literature is challenging. However, a comparison to online exams can be drawn from a meta-analysis by Newton and Essex (2024), which reviewed data from 19 studies across 25 samples and found that 44.7 % of participants (2,088 out of 4,672) admitted to engaging in some form of cheating during online exams. Moreover, Watson and Sottile (2010) surveyed 635 students at a medium-sized university and found that 32.7 % of students admitted to cheating in online courses. As in OTB chess and in-person exams, those figures are clearly much higher than the cheating rates found in this study.

4.3. Cognitive doping

47.2 % of OTB chess players and 32.6 % of online players admitted using legal substances to increase cognitive performance (e.g. coffee or energy drinks) in the last 12 months before or during a rated chess game. Those numbers are lower compared to lifetime prevalences reported in poker (71 %) and esports (67–78 %) (Caballero et al., 2016; Schubert et al., 2024). With respect to illegal substances, an estimated 5.1 % of players have engaged in cognitive doping at least once in an OTB and/or online chess game within the last 12 months. The estimated prevalence of cognitive doping was lower (2.3 %) among lower-rated players (Elo < 1,800), possibly due to fewer incentives or motivations to cheat, as they might not be challenged by high stakes and competitive pressures present in high-level tournaments, where even slight performance improvements can be decisive (Dimant & Deutscher, 2015). Older players (> 50 years) showed a lower prevalence (4.3 %), possibly due to stronger ethical convictions or concerns about health risks and medication side effects. A comparable study of Franke, Dietz et al. (2017) using the RRT revealed a lifetime prevalence of 8.9 % among chess players for the use of prescription and illicit drugs. While these findings are roughly comparable to the estimated prevalence of 5.1 % reported in the present study, it is important to highlight that Franke and colleagues assessed the lifetime prevalence. In contrast, the present study reports a 12-month prevalence, focusing only on the use of cognitive doping within the last year. Interestingly, the estimated prevalence of cognitive doping among chess players is lower than in other contexts. For instance, studies using the RRT on cognitive doping among recreational triathletes in Germany showed a 12-month prevalence of 9.4 % (Seifarth et al., 2019) and 15.1 % (Dietz et al., 2013b). Moreover, the estimated 12-month prevalence of cognitive doping in the present study was lower than the lifetime prevalence among poker players (28 %) (Caballero et al., 2016) and esports players (23 %) (Schubert et al., 2024), determined via direct questioning. When comparing these numbers to an examination setting, they are lower than those found in an RRT study by Dietz et al. (2013a), reporting an 12-month prevalence of 20 % for cognitive-enhancing drugs use among German college students. Furthermore, Teter et al. (2006) found an estimated 12-month prevalence of 5.9 % for illicit use of prescription stimulants among 4580 college students (8.3 % lifetime prevalence) via direct questioning. 75.8 % of the 269 past-year illicit users of prescription stimulants ($n = 204$) reported using an amphetamine-dextroamphetamine combination agent (e.g., Adderall) in the past year, while 24.5 % ($n = 66$) used methylphenidate (e.g., Ritalin). Lastly, Ott and Biller-Andorno (2014) found a lifetime prevalence of 6.2 % for the use of substances like Ritalin, Adderall, and Modafinil among students at the University of Zürich. These comparisons suggest that cognitive doping in chess, while present, may be less prevalent than in other sports or academic contexts, but remains a relevant concern that warrants attention.

5. Limitations

It is important to acknowledge certain limitations of the present study. Considering the sample, the age distribution does not fully reflect the DSB's overall membership, particularly as the club chess player population in Germany includes a substantial number of young players in youth and junior categories. The underrepresentation of participants under 20 years old could limit the generalizability of the findings to the broader age spectrum within the DSB, especially as the study results indicate that younger players engage in online cheating more frequently than older players. However, this age group is underrepresented mainly due to ethical considerations. Players had to be at least 16 years old to participate in the study. Additionally, players belonging to a medium to high skill level (Elo 1,600 to 2,200) are over-represented in the sample and the study has shown that chess rating has an influence on the prevalence of cognitive doping. In addition, the proportion of female participants in the sample (4.8 %) was slightly lower than in the overall DSB membership (9.5 %), which may limit the generalizability of the findings to female players.

Besides that, the self-reported nature of the data presents inherent challenges, particularly when participants are asked to disclose behaviors that are illegal or unethical, such as cheating and the use of cognitive doping. Despite the anonymous nature of the study, participants may still be hesitant to admit to such actions due to concerns about potential consequences, such as judgment or shame (Roger Tourangeau & Yan, 2007), which could result in underreporting of cheating. To address this issue, RRT was utilized to enhance the accuracy of responses by providing participants with a mechanism to respond honestly without directly exposing their involvement in prohibited behaviors. Nevertheless, while the RRT can reduce social desirability bias and increase the likelihood of honest reporting, cheaters may still answer "no", when being asked to respond to the sensitive questions, resulting in an underestimation of the true cheating prevalence. In addition, RRT does not provide a precise upper bound, other than 100 % (Schröter et al., 2016) and the probabilistic nature of RRT can result in wider confidence intervals and less precise estimates, thereby making it more challenging to draw definitive conclusions from the data. Equally important, around 13 % ($n = 288$) of the players surveyed did not fully complete the questionnaire, with some participants omitting at least one of the three RRT questions (John et al., 2018). This may introduce selection bias and it is likely that the dropout group includes more cheaters, which could further underestimate the true prevalence (R. Tourangeau et al., 2010). Lastly, online data collection may exclude some groups, especially older individuals who lack digital devices. However, the age distribution within the present sample does not support this concern.

6. Practical applications and future research

This study provides valuable empirical evidence on the prevalence of cheating behaviors in chess and offers a foundation for future research and policy development. Addressing these issues will require a combination of technological innovation, education, and enforcement to safeguard the integrity of chess at all levels. The authors agree with Zaksaitė (2020) on the need for integrated, coherent policies that include both legal and ethical frameworks to effectively address cheating in chess. While this study primarily examined the prevalence of prohibited actions without delving deeply into the underlying motivations or circumstances that lead to such behaviors (Gray & Porreca, 2023; Homer, 2019; Widianingsih, 2013), future studies could provide valuable insights by exploring the psychological and social factors that drive players to cheat or engage in cognitive doping. Moreover, this study focused solely on German club players, and cheating behaviors may vary across different countries and cultural contexts. Future research should compare cheating behavior across cultures. It should also consider gender and game composition, as both may influence cheating. (Dilmaghani & Smerdon, 2024). Additionally, future research should more distinctly differentiate between game modes within each format (OTB and online chess) to draw more targeted conclusions regarding specific anti-cheating prevention measures. Moreover, while the only existing study to date investigating the effects of pharmacological CE on chess performance (Franke, Gränsmark et al., 2017) included only male players, the idea of conducting controlled, randomized trials may seem promising. However, such studies are ethically problematic, particularly when involving healthy individuals. Finally, as technology continues to evolve, new forms of cheating and cognitive doping are likely to emerge. Science should remain vigilant to these developments, ensuring that studies remain relevant and reflective of the current landscape of chess and its associated challenges. Building on this study, the authors presented these findings to the DSB to evaluate its process of developing and implementing anti-cheating policies (Schu et al., 2025). This approach will offer valuable insights into the federation's response to the issue and contribute to a deeper understanding of how national chess organizations can proactively address and reduce the risks of cheating.

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Data statement

The dataset is available from the corresponding author on reasonable request.

CRediT authorship contribution statement

Kim Schu: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Nils Haller:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Generative AI (ChatGPT −4o) was used for language improvement.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.peh.2025.100344.

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