Snooker Science: A Cross-Discipline Scoping Review

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Snooker Science

A Cross-Discipline Scoping Review

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Despite the increase in popularity and professionalism of snooker, the application of scientific support by coaches and athletes to improve snooker performance is limited compared to other closed-skill sports. This study aimed to categorise sports science in snooker through a cross-disciplinary scoping review of the scientific literature. The literature search was conducted in four electronic databases: PubMed, Scopus, SPORTDiscus and Web of Science in September 2024. The search terms were selected based on the sports science disciplines outlined by the Chartered Association of Sport and Exercise Sciences. Initially, the search yielded 261 records, with a total of 14 included in the scoping review, demonstrating a general scarcity of available literature. Three broad themes were identified during data extraction: A) Psychology, B) Biomechanics, and C) Notational Analysis (snooker outcomes). Findings outlined that literature in snooker is monodisciplinary spanning various sport science disciplines. Studies in Theme A investigated: Coaching, Cognition, Decision-making, Mental Toughness, Motivation, and Visual-perceptual skills. Studies in Theme B investigated: Balance, Cue Action, Coaching, and Skills Test (Performance). Studies in Theme C investigated: Statistical Modelling, Complex Networks, and Simulations to understand snooker outcomes. Given the monodisciplinary nature of studies included in this review and the general scarcity of specific sport science research examining snooker, future interdisciplinary snooker science research should align with the three broad stages of the applied research model for sports sciences (description, experimentation, implementation), while also drawing on current knowledge in other closed-skill sports to inform performance preparation.

Introduction

Snooker is played in approximately 110 countries by over 120 million people and watched by 500 million worldwide (World Snooker Tour, 2025). Furthermore, the Professional World Snooker Tour is now worth £19m in price money per year and new tournaments have been formed across Europe, China, Australia, India and Saudi Arabia, highlighting its world-wide appeal. Snooker is a cue sport played on an 11-foot 8.5-inch (3.57m) by 5-foot 10-inch (1.78m) table (see WBSPA, 2022, for full rules) where scientific principles, environmental factors (humidity) and even luck can govern performance outcomes (i.e., break building and frame outcome). The execution of the cue action and the spin applied to the cue ball during different shots within a break and frame can be partly explained using physics, geometry and biomechanics (Kong et al., 2021). Additionally, psychological factors may influence break building and frame outcome, such as mental toughness (Welsh et al., 2023), pattern recognition (McMorris et al., 1993) and heuristics. However, despite the growing rise in popularity and professionalism of the game, the use of scientific support by coaches and athletes to improve performance outcomes in snooker is limited compared to other closed-skill sports such as golf (Ehlert, 2020) and gymnastics (Farana et al., 2023). Where there is use of scientific support in snooker, this is primarily directed towards sports psychology aspects, such as developing mental toughness (Welsh et al., 2018, 2023) and motivation (Uphill & Jones, 2007). A notable of examples outlined in popular media is the role of Dr. Steve Peters in Ronnie O'Sullivan's psychological preparation for competitive snooker performances (Hammer, 2022).

Snooker requires a blend of mental and physical skill, focusing on precision, strategy, and psychological intensity. Unlike many sports, snooker requires relativity little physical exertion meaning it is accessible to varying physical abilities but demands significant mental focus and strategy. For example, the 2025 winner of the World Championship won a total 111 frames across a 3-week period in the tournament, meaning that performance is reliant on a prolonged and varying exposure to physical and psychological demands. Furthermore, during break building, the layout of the red balls is also unpredictable meaning that the snooker player cannot initially forward plan their shots prior to the initial break. The snooker player also must be adaptive in the execution of skill but also psychologically resilient, as the outcome of a frame is also inversely dictated by the performance of the competitor. For example, regardless of how well a snooker player is playing, the opponent could build a frame winning score following the break off and execute successful snookers due to the configurations of balls on the table or by chance, changing the momentum of the match. This gives snooker some unique characteristics which may influence how sport science practitioners can aid in players development and performance preparation.

To date, the limited scientific research on snooker has examined aspects of snooker under different sports science disciplines (as outlined by CASES, 2024) in isolation of each other (e.g., psychology, and biomechanics), which gives a monodisciplinary and fragmented understanding of how to prepare for and play snooker (Rothwell et al., 2020). The Chartered Association of Sport and Exercise Science (CASES, 2024), advocate a transition towards interdisciplinarity working where, from the outset, sports scientists seek to contribute to the body of knowledge or solve real-world problems by aligning theoretical principles with practical delivery in two or more disciplines (e.g., biomechanics, physiology, psychology) in an integrated way. The value of developing an interdisciplinarity understanding of a sport for athlete development and performance has been studied in sports science and coaching science research (see Piggott et al., 2019, 2020). However, acquiring an interdisciplinarity understanding of sports where scientific support is not traditionally utilised is often difficult, given the limited opportunities to collect data using techniques that are representative of the performance environment.

Where available scientific literature is limited, scoping reviews provide a 'reconnaissance' tool to evaluate a body of literature that is mainly heterogeneous and not amenable to a systematic approach (Peters et al., 2015). Scoping reviews are a flexible method of mapping out broad narratives within a limited literature base, permitting researchers to not only examine existing evidence but to also identify gaps in the literature that can be explored in future research (Munn et al., 2018). Given that the snooker literature in scientific disciplines is limited, a scoping review was selected as an appropriate tool for synthesising available snooker research across the disciplinary landscape. It offers a robust and transparent approach to exploring multiple themes and identifying areas for future research. In characterising the profile of snooker science through an extensive, cross-disciplinary scientific literature, it is anticipated that findings from this scoping review will outline avenues for future interdisciplinary research. Therefore, a population, concept, and context framework was used to develop the research question: What is known about sports science in snooker?

Such lines of scientific inquiry will develop understanding on the snooker science outlined in this review and identify current gaps in the literature where sport science support may be useful. These future studies may be applied to models such as the Applied Research Model for Sport Sciences (ARMSS) due to its flexible an iterative nature and acknowledgement of specific barriers for areas that are unresearched (Bishop, 2008). ARMSS is appropriate for structuring future snooker science research as its flexible and iterative nature and acknowledgement of specific barriers to research within the context of a particular (often under-researched) area before and during the implementation of further research. Doing so will advance new understanding on the technical, tactical, psychological and physical demands of the sport, which could then afford the development of practice tasks that target developments in relevant snooker skills and capabilities.

Methods

Protocol and Registration

The scoping review protocol was developed using guidelines from the Joanna Briggs Institute (Peters et al., 2015), PRIMSA-ScR (Tricco et al., 2018), the methodological framework proposed by Arksey & O'Malley (2005), and recommendations from Levac et al. (2010). Ethical approval for this study was granted by the authors university research ethics committee (ID: ER70218770). The scoping review was managed using Covidence software (Melbourne, Australia).

Eligibility Criteria and Definitions

Research was not limited by year or geographical location and was incorporated into the scoping review if it included: 1) peer reviewed data on snooker or snooker alongside other sports, including quantitative/qualitative research designs, mixed method research or case reports in sport science disciplines/sub disciplines outlined by CASES (https://www.cases.org.uk/), 2) human participants of either sex, and age or skill level (e.g., expert or novice snooker player) and 3) the full text was in the English-language with a Digital Object Identifier (DOI) and International Standard Serial Number (ISSN).

The scoping review excluded professional publications, conference proceedings, and posters due to a lack of screening in reporting quality/duplication of findings and the absence of peer review. Systematic reviews, scoping reviews, narrative reviews and meta-analysis were also excluded (Levac et al., 2010). Studies that used snooker as a vehicle to validate modelling techniques and algorithms (i.e., the focus was not on snooker outcomes) were also excluded as this scoping review is related to snooker outcomes, specifically what is known about sports science in snooker.

Information Sources and Search Strategy

The literature search was conducted in four electronic databases: PubMed, Scopus, SPORTDiscus and Web of Science in September 2024. In consultation with a CASES accredited sports scientist and an expert information scientist these databases were selected by the research team as similar combinations have been used in published cross-discipline sport science scoping reviews.

The following Boolean operations were used: Snooker AND (Biomechanics OR "Motor Behaviour" OR "Physical Activity" OR Health OR Physiology OR Nutrition OR Psychology OR Sport OR Performance OR Exercise OR Analytics OR "Skill Acquisition" OR "Performance Analysis" OR Coaching). The search terms were selected based on the sport science disciplines outlined by CASES (https://www.cases.org.uk/). The title, abstracts, keywords and data sources were searched, and relevant articles were entered for full paper review. The screening of titles and abstracts, as well as full-text reviews, was conducted by the first and second author working independently. Upon completion, the authors investigated additional citations from each reference list. No additional studies were included.

Data Charting and Synthesis

Data charting was undertaken by the first and second author using Covidence software (Melbourne, VIC, Australia). A data charting tool was developed and independently assessed by the research team to determined robustness in capturing key information. Participant characteristics (age, stature, body mass, skill level and snooker experience) and article characteristics (data type; primary/secondary, publication date, geographical location, study design, study aim(s), protocol, measures and findings) were extracted during data charting using templated headings. Where studies used secondary data, the resource/database from where the data set was exported was extracted, alongside details such as the tournament, match sample and season. The outputs from data charting were downloaded from Covidence in a comma separated values (.CSV) file and imported in Microsoft Excel to calculate the frequency of included studies by data type (primary/secondary) and publication date. Table S1 (Supplementary Materials) outlines the studies included for data extraction.

Results

Selection of Sources of Evidence

The initial search yielded 261 studies. After 60 duplicates were removed, 201 studies were taken forward for title and abstract screening. Subsequently, 181 studies were excluded as irrelevant, with 20 full-text taken forward for full-text review. Six studies were excluded at the full-text review stage for the following reasons: 1 did not have the full-text available and 5 studies had a study design which did not meet this review's inclusion criteria (3 used snooker to examine computer modelling techniques, while 2 used snooker to examine image processing techniques). This resulted in fourteen studies being included in the scoping review (see Figure 1).

In relation to the search terms, three higher order themes (biomechanics, psychology, notational analysis (snooker outcomes) and twelve lower order themes were identified during data extraction synthesis to guide the organisation and presentation of the data and afford coherency in reporting and publicising the results (Gale et al., 2013) (see Figure 2). Higher order themes were developed a priori and agreed by the authorship: Higher Order Theme A: Psychology (43% total, 6/14); Higher Order Theme B: Biomechanics (21% total, 3/14); Higher Order Theme C: Notational Analysis (Snooker Outcomes) (36% total, 5/14).

The labelling of the twelve lower order themes was decided collectively by the authorship using specific wording included in key sections of the relevant paper (e.g., title, abstract, aim, rationale). To maintain analytical rigour the authorship met to give voice to categorisation of higher and lower order themes via critical verbal dialogue (Tracey, 2010). Without changing the meaning of the named CASES disciplines, where appropriate, higher order themes were named using language that is appropriate to communicate findings to groups with a varied exposure to sport and exercise sciences. For example, notational analysis (snooker outcomes) encompasses the CASES sub-disciplines analytics and performance analysis.

Synthesis of Results

In total, 64% (9/14 total) of studies reported primary data, which corresponds to the total number of studies in Theme A (6/14 total) and Theme B (3/14 total), whereas 36% (5/14 total) of total studies reported secondary data which corresponds to the total number of studies in Theme C.

In Theme A, the research designs used were comparative, cross-sectional (33%, 2/6), experimental (33%, 2/6), and qualitative (33%, 2/6). In Theme B, the research designs used were a case study (33%, 1/3), pre-post intervention (33%, 1/3) and a user study (33%, 1/3). In Theme C, the research designs used were statistical modelling (80%, 4/5) and simulation (20%, 1/5).

All studies included in the review specified the skill level of the participant group or secondary data set. In Theme A, 17% of studies (1/6) investigated only professional players, whereas 83% (5/6) used groups of different skill levels. In Theme B, 33% of studies (1/3) examined only professional players and 67% of studies (2/3) used groups of varying skill levels. In studies that used primary data, there was an inconsistency with how skill levels are defined (see later discussed for further details). In Theme C, all studies (100%, 5/5) used secondary data sets from professional snooker events. In the majority of studies, the first authors were based at an academic institution in the United Kingdom 64% (9/14 total),

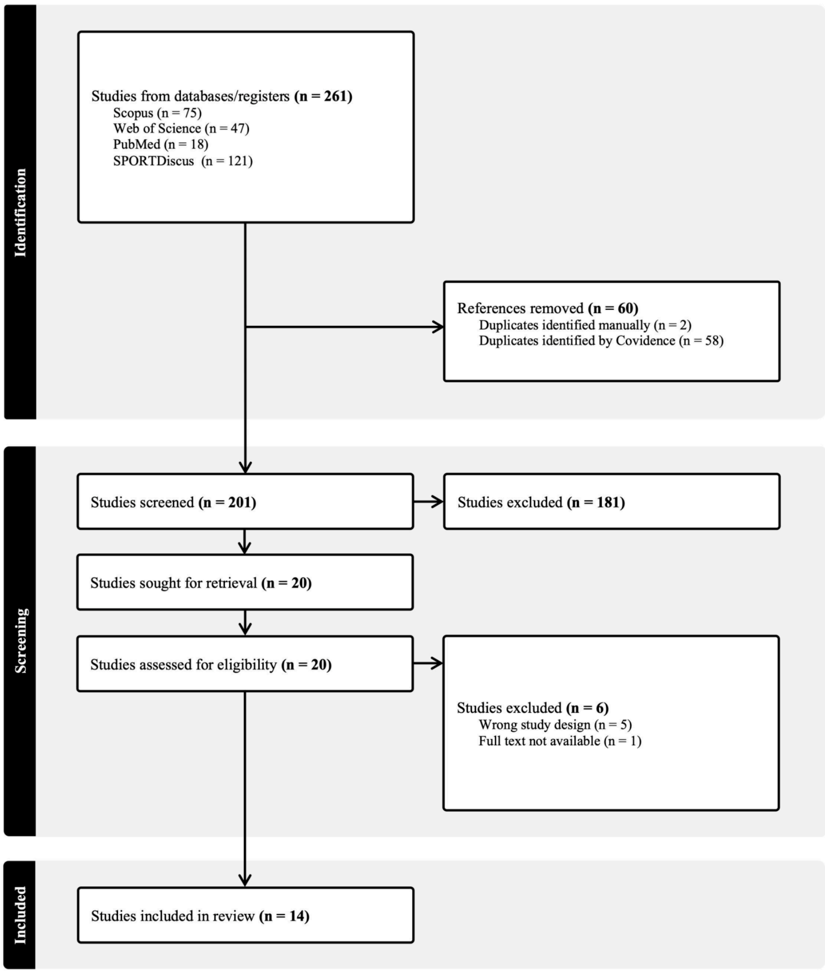

Figure 1. PRISMA-ScR Flow chart of extracted, included and excluded studies.

with the remaining first authors from academic institution in Australia 14% (2/14 total), Iran 7% (1/14 total), Ireland 7% (1/14 total) and Singapore 7% (1/14 total).

Publication dates ranged from 1993 to 2024 (Figure 3). In the 1990s, three studies were published, in the 2000s there were two studies published, in the 2010s there was two studies published, and at the time of review in the 2020s, seven studies have been published to date. Unlike a notable increase in sport science research more broadly (Abt et al., 2022) there has not been a significant increase in publication frequency on snooker science studies, highlighting the need for additional research. An exception is Theme C, which has demonstrated a minor increase in publication frequency since 2021. However, the increase is trivial in comparison to increases in the sports science research more broadly (for an example for sport performance, see Abt et al. (2022)).

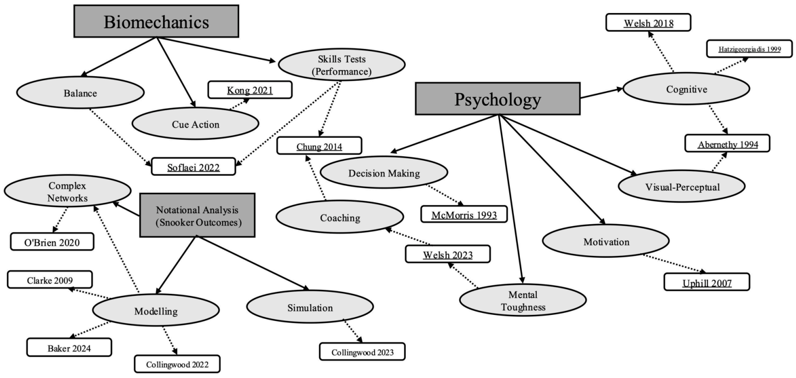

Figure 2. Higher-Order and Lower Order Themes extracted during data charting and synthesis. Note: Author names that are underlined are studies that used primary data, those without used secondary data.

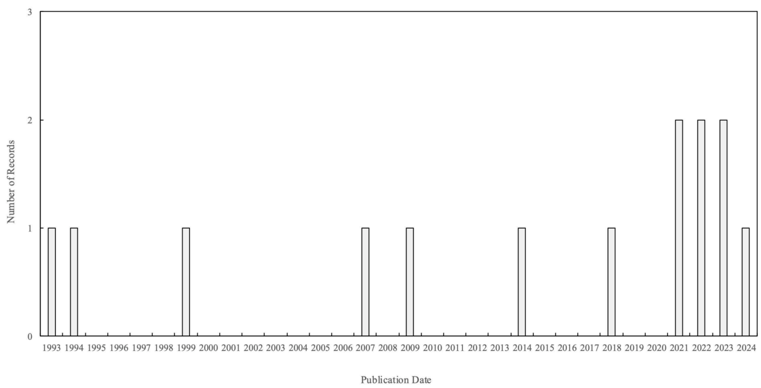

Figure 3. Number of included records by date.

Theme A: Psychology

Cognition

A series of psychological instruments have been used to examine the effects of goal orientation and perceived competence on cognitive interference during tennis and snooker performance (Hatzigeorgiadis & Biddle, 1999). Athletes completed the Thought Occurrence Questionnaire (TOQ) relating to thoughts they might have had during past competitive performances (i.e., during snooker or tennis) as a measure of cognitive interference. Goal orientation was measured using the Task and Orientation in Sport Questionnaire (TEOSQ) and perceptions of competence were measured using an adapted three-item scale from the Intrinsic Motivation Inventory (IMI). Whilst task orientation was negatively associated with 'thoughts of escape' irrespective of perceived competence (low, high), the relationship between ego orientation and 'thoughts of escape' was moderated by perceived competence. Specifically, there was a positive relationship between ego orientation and 'thoughts of escape' in the low perceived competence group, whilst in the high competence group, the association was non-significant. Path analysis revealed a statistically significant mean difference in perceived competence between high and low-competence groups for the tennis and snooker groups. Practically, higher perceived competence should lead to better break building as athletes perceive themselves to be competent and produce skillful action for different shot types in a performance environment. However, given the multifaceted nature of snooker, additional research in representative competitive scenarios (similar to Welsh et al., 2023) is required.

A level 3 think-aloud protocol was used by Welsh et al. (2018) to examine real-time cognitions of professional snooker players (super-elite, elite, lower ranking) during self-assigned solo snooker practice sessions within naturalistic settings. Participants recorded their thoughts before and after shots and were encouraged to describe their thoughts between shots. Super-elite and elite professional snooker players' real-time cognitions were generally directed towards stressors, coping strategies, and snooker-related aspects. Findings from Welsh et al. (2018) provide support for the transactional model of coping (Lazarus, 1991), whereby thought processes change continuously during performance, and in particular, at highly dynamic situation-specific moments. In addition, Welsh et al. (2018) expand on how the exploratory findings further support the knowledge that problem-focused strategies are vital psychological characteristics of experts and optimal performances in general.

Visual-Perceptual

The visual-perceptual and cognitive differences between expert, intermediate, and novice snooker players were examined by Abernethy et al. (1994) using three studies: 1 – clinical examination for uncorrected visual defects, 2 – sport-specific perceptual measures inclusive of a pattern recall and pattern recognition task using images of snooker ball configurations, 3 – sport specific cognitive measures through a think-aloud protocol and evaluation task using recordings of snooker game scenarios. General visual skills do not distinguish between expert and novice snooker players. Instead, expert snooker players demonstrated an ability to accurately evaluate and distinguish the relative strengths and weaknesses in various snooker game situations (decision making) and rapidly encode, recall, and recognise structured perceptual information to plan prospectively six or more shots ahead of the current shot.

Decision Making

A study compared the decision-making of intermediate snooker players (McMorris et al., 1993) against intermediate-level sportsmen engaging in other sports using Group Embedded Figures Test (inclusive of 18 problems with one point allocated for each correct score) (Oltman et al., 1971). The snooker group completed a decision making tasks where the player stated which of the red balls they would 'pot' and specify the follow up in 12 typical snooker situations (two points for a correct decision one point for where a decision would have led to a nonoptimal score in a snooker frame, no points for scenarios that would not have resulted in a score in snooker frame). The snooker group scored significantly higher on the Group Embedded Figures Test than the control group. There was a significant association between scores on field-dependent and snooker decision-making. McMorris et al. (1993) discussed how snooker players may have used mental imagery and pattern recognition skills to plan (decision making) several shots ahead based on pot success balls or distributing the play structure for the opponent via a snooker. This interpretation is partially supported by Abernethy et al. (1994).

Motivation

Semi-structured interviews and hierarchical content analysis have been used to explore associations between specific appraisal components and a range of sport-related emotions experienced by athletes (including snooker) (Uphill & Jones, 2007). Participants were international athletes selected because they competed for their country, and some competed professionally. Sports represented in the sample: snooker (1), archery (1), sailing (1), athletics (2), badminton (2), golf (2), rugby union (3). Concurrent content analyses (inductive and deductive) support the core relational themes in Lazarus (1991) and outline that primary and secondary appraisal components (blame/credit, coping potential, ego-involvement, future expectations, goal congruence, and goal relevance) were associated with the following emotions: anger, anxiety, guilt, happiness, pride, relief, sadness, and shame.

Coaching and Mental Toughness

Regarding snooker coaching, the influence of mental toughness on responses to feedback in snooker has also been examined using two between-subject experiments (Welsh et al., 2023). Experiment 1 examined the effects of feedback on snooker players' break-off performances using a false ranking list. Participants completed 10 break-offs with feedback (20 received positive feedback and 20 received negative feedback) provided after the initial five break-offs. Participants were required to land the cue ball as close to a piece of card (positioned directly behind the green or yellow ball) as possible. A false competitive ranking list was used to investigate the effects of mental toughness in overcoming feedback. Break-off accuracy significantly decreased after feedback in Experiment 1, but there was no interaction with the nature of feedback or Mental Toughness Questionnaire 48 (MTQ48) variables. Experiment 2 examined the influence of mental toughness on feedback (positive and negative) given by a WPBSA coach during real-time break-off performances of snooker players. The negative feedback provided by the coach improved break-off accuracy, whilst positive feedback impaired break-off accuracy. The Life Control subscale of the MTQ48 was also a covariate. Practically, the results from Welsh et al. (2023) suggest that negative feedback provided by a respected figure could provide a vehicle for performance enhancement in snooker moderated by mental toughness.

Theme B: Biomechanics

Cue-Action

One study captured a professional snooker player's cueing action during a snooker task using a three-dimensional motion capture system (with a retro-reflexive marker set) (Kong et al., 2021). The snooker task required the participant to take three pot attempts for each of the five shot types (warm-up, stun, top spin, backspin, stop), with pot rate success calculated as a performance measure. For all shots, the participant stood on two force platforms to measure the cueing action's kinetics. The inter-trial variability was small ($<1°$) for all shot types (i.e., in the overlap in cue stick position between the last practice swing and final stroke). During the cue action, elbow flexion/extension contributed approximately 130° range of motion (ROM) towards the delivery of the cue stick, whilst wrist flexion/extension contributed $<30°$ ROM. The speed of the cue tip at impact was different between the five shot types, although pot rate success was consistent between shot types (1/3). The cue speed at impact was the lowest in the warm-up and highest in the back spin shot. The cue speed of the stop shot was 2.99 ± 0.15 m/s, whereas the stun and spin shots were similar in cue tip speed at impact, 2.57 ± 0.11 m/s and 2.58 ± 0.23 m/s. The ground reaction force profile was similar across all five shot types, with relatively small changes when normalised to body weight. There was a slight lean towards the left foot during the final movements of the cue action (59.6% to 61.7%), although there was no clear difference between the centre of pressure.

Balance (Ability)

A pre-post design was used to examine the effectiveness of a six-week core muscle training (Pilates) on snooker performance, and balance in intermediate snooker players (Soflaei et al., 2022). For the protocol, the stork balance test, snooker lineup break score test and foul test were used as pre-post testing measures. For the intervention, participants undertook training sessions 3 times a week for 6 weeks, depending on the group; this was inclusive of a 5-minute warm-up, 20-25 minutes of either Slow Walking (control group) or core muscle training (Pilates group), 5 minutes of cool down and 1 hour of routine snooker training. A lineup test to record break scores – repeated 3 times at 30-60 second internals, with the best score from the three trials were recorded as the major break score. During the foul number test, a cue ball was placed along the gang, and players were asked to hit the black ball and pot it. This was recorded as a foul if the player failed to sink the target ball with the cue ball. Four cue balls were used, and the test was repeated 3 times with a 30-60 second rest between tests. The minimum number of fouls in the three attempts was recorded as the player's score. Six weeks of core muscle training through Pilates mat exercises improved snooker players' balance, as demonstrated by the scores on the right and left stork tests. Regarding snooker performance, the Pilates group break scores increased more after Pilates exercises than in the control group. However, these exercises did not reduce players' foul counts after six weeks of Pilates training.

Coaching (Snooker Skills Test)

Chung et al. (2014) developed a systematic skills test to measure snooker player performance, inclusive of a power control test, angles test, top/backspin test, side spin test, and cue alignment test. The user study included six novice, six intermediate, and six expert snooker players and reported data for the power test, angles test, and backspin test. For the angles test, a 1-meter ruler was placed along the corresponding table edge with video footage recording the expected contact point along this cushion. The backspin test was recorded using a high-speed camera (200 fps) with a specialist half-white, half-black ball. Distances were measured in cm using a tape measure. Chung et al. (2014) suggest that this skills test can measure a player's performance, as demonstrated by strong correlations between the different classification bands, with expert players in all skill tests outperforming the participants in the other categories. However, the correlation analysis was not explicitly reported in the user study. The reported data demonstrate shot consistency (interquartile range) improved towards the expert level when examining distances, and scores from the power control test, angles test, and backspin tests demonstrated improvements in median scores in moving from novice to expert. However, differences in the interquartile range between levels were reduced.

The studies in Theme B used objective and quantifiable metrics such as break score and foul score as a determinant of snooker skill level, which may reflect standard norms in the biomechanics discipline and could be a variable included in any future snooker skill level classification.

Theme C: Notational Analysis (Snooker Outcomes)

Statistical Modelling

The effectiveness of different player ranking systems in predicting the results of professional snooker matches has been evaluated (Collingwood et al., 2022) using a ranking position and prize money data earned at the start and end of the season from CueTracker.net and the seeding list of players at each cut off from Snooker.org. These data were then used to identify the prize money ranking of each player at every cut-off in the 2016/2017, 2017/2018 and 2018/2019 seasons. Collingwood et al. (2022) used these data to estimate the probability of one player winning a frame against another based on their relative rating according to four models (i.e., word rankings – based on prize money earned, players win %, along with paired comparison approaches – Bradley-Terry and Elo models). The models were assessed through the ability to predict the result of snooker matches. A subset of matches was also analysed to identify the strengths and weaknesses of the models and potential improvements. Collingwood et al. (2022) identified three areas where there are differences between the models: (1) the modelling of new players, (2) whether they consider the strength of the opposition, and (3) whether they consider the recent form of the players. The performance of 'new' players tended to be underestimated in the models, which is the main limitation of predicting performance using World Rankings (Collingwood et al., 2022). The strength of opposition encountered by the highest-ranked players was important, although this was less true for lower-ranked players (Collingwood et al., 2022). Models based on two years of results outperformed those conducted using results from a single year. However, there was some indication that it may be advantageous to account for recent improvements in snooker performance (Collingwood et al., 2022).

Age-dependent performance has also been estimated in paired competitions in snooker using statistical modelling (R. D. Baker & McHale, 2024). The model estimates players' strengths and allows for those strengths to vary deterministically with time. The model determined that Ronnie O'Sullivan and Stephen Hendry are the greatest ever snooker players with reference to the model parameters. In addition, R. D. Baker & McHale (2024) used estimated strength curves in a random effects model to estimate the relationship between performance and age – with peak snooker performance occurring between the ages of 25 and 30.

Clarke et al. (2009) analysed the annual World Professional Snooker Championship performance to determine how well the criteria for fairness, balance and efficiency are satisfied. Clarke et al. (2009) discussed how a player entering the tournament has about the same probability of winning his first match, whatever the round at which he enters. Clarke et al. (2009) took $154/253 = 0.609$ as an estimate of the probability that a player entering the tournament wins the match. The mean losing score in the 154 matches won by the entering player was 5.63, whilst the mean losing score in the 99 matches lost by the entering player was 6.17. The difference is not surprising, as a losing player would typically be higher up in the rankings to have a higher score than a losing player lower in the rankings. Clarke et al. (2009) concluded that perhaps when faced with an opponent above them in the rankings, players give up hope of winning too quickly.

Complex Networks

When considering a ranking procedure based on the PageRank algorithm incorporating the number of wins a player has over their career and the quality of opponent face in these wins, John Higgins is the highest performing snooker player of all time, with Ronnie O'Sullivan appearing in second place (O'Brien & Gleeson, 2020). Findings demonstrate that before it was revisited, snooker failed to capture the dominance of players through its point-based rank system. The model also outlines how a change in the ranking system to a prize money basis is also inaccurate. The PageRank algorithm can be applied across temporal periods, which may identify each era's strongest player. To improve policy, O'Brien & Gleeson (2020) introduced a rank clock, which offers a novel approach through which policy-makers within the sport of snooker may quantify the success of competitors over the temporal period of their careers.

Simulation

One paper explored the utility of a Monte Carlo simulation model to simulate the progression of a frame of snooker played by professional-level players (Collingwood et al., 2023). The probability of potting a ball for each shot changes as the frame progresses (Collingwood et al., 2023). A player's scoring power (defined as the proportion of successful pots by a player, for instance, a player's break-building capabilities) within the simulation can be adjusted to reflect players with slightly greater / weaker break-building ability. Tactical awareness and safety play were harder to measure.

Discussion

This scoping review aimed to categorise and understand the current sports science research in snooker through a cross-disciplinary review of the scientific literature. This scoping review provides an overview of the understanding of sports science in snooker, highlighting the limitations and potential avenues for future interdisciplinary research aligned with the Applied Research Model for Sport Sciences (Bishop, 2008). The current studies within snooker specific populations align within three sports-science disciplines: Psychology, Biomechanics, and Notational Analysis of snooker outcomes. A summary of the review findings is discussed below to guide what is specifically known about sport science in snooker at the current time, areas for future snooker specific research, and where it might be beneficial to utilise other sport science research from populations outside of snooker to help inform snooker professionals in the preparation and performance of match play.

Studies in the Psychology Theme (A), examined various sub-disciplines across psychology in snooker disciplines, including cognition, visual perception, motivation and mental toughness. Two studies examined motivation (Uphill & Jones, 2007) and mental toughness (Welsh et al., 2023) within snooker populations. These provide a starting point to guide snooker practitioners, however given the apparent psychological challenges players can face (see TNT Sports (2024) for an example) this is an area which requires further investigation. There has been a growing rise in research on mental health and wellbeing across a range of sports (e.g., Pilkington et al. (2024)), using contemporary qualitative methods like longitudinal photo-elicitation to gain insights into underrepresented populations (e.g., Higham et al. (2024)). Practitioners can utilise this current knowledge from other sports to guide practice on mental health and aid in developing future research to explore the unique challenges snooker players may encounter.

The works of Abernethy et al. (1994) and McMorris et al. (1993) demonstrated that snooker could be used to examine expert performance and decision making in sport, following similar seminal studies on pattern recognition in populations such as chess (Chase & Simon, 1973) and basketball (Allard et al., 1980). With the advancements in technology (such as improved mobile eye tracking and motion capture systems) in recent years and the relative ease in comparison to some sports for snooker to be played in representative conditions (see Pinder et al., 2011), while maintaining scientific control of variables, snooker could be a good vehicle to advanced current knowledge within the skill acquisition and motor learning domain of sport science.

An area that should be refined in future studies, especially if examining skill acquisition and learning is the skill level classification of participants which was inconsistent in many of the psychological studies. For example, some studies defined sub-cohorts within the same sample based on their performance relative only to each other (e.g., elite versus non-elite) rather than the sport as a whole. Years of competition experience were also used to determine an intermediate level (McMorris et al., 1993). However, the term 'intermediate level' is inconsistently used to represent 'non-elite', and a consistent definition of a novice is not presented. Elite status is outlined using auxiliary terms such as 'super elite' based on ranking in one paper (Welsh et al., 2018), whilst others do not use 'super elite' to describe the professional participants. Such discrepancies in how skill level is defined limit the external validity of research and make it difficult to draw a conclusion and generalised findings when conducting research synthesis (like in this scoping review of the current review) or translating knowledge to practice (McAuley et al., 2022). Therefore, as outlined in previous research on skill level classification in sports (see McAuley et al., 2022), using standardised terminology related to the participant's skill level (in the case of snooker) is essential to direct future research and shape snooker coaching practices. Future research could use a similar model of sport classification outlined in J. Baker et al. (2015) for classifying skill levels in snooker or adapt the criteria of the participant/sample subsection in McAuley et al. (2022). Although the variables and weighting criteria used in such models must be examined and scrutinised (McAuley et al., 2022), this research would afford opportunities to develop a snooker-specific skill level classification. Here, objective performance measures, such as break scores and fouls, could also be included to afford consistency when describing the samples, allowing readers to determine the sample classification more effectively and facilitating improved research synthesis and practical application.

Studies in the Biomechanics Theme (B) used descriptive designs to provide an exploration of the complexity of snooker and the cueing action (case study, Kong et al., 2021). Given the cuing action is a critical element of snooker performance, it seems logical to build upon the work of Kong et al. (2021), to move beyond a single participant design with a wider range of participants at varying skill levels (noting the point above about defining skill level consistently). Given there seems to be a small amount of movement variability (in this one participant of the study), examining if movement variability exists (see Bernstein, 1967) between varying skills levels, or during the learning of the cuing action could help develop further knowledge on how to most effectively coach the cuing action, similar to the work performed in other target sports like golf (Langdown et al., 2012). Chung et al. (2014) development of a snooker skills test (user study, Chung et al., 2014) is a sound starting point to evaluate current players skill level and could be utilised in future research that transitions towards more traditional experimental designs examining areas such as intervention designs on snooker performance. However, future investigations on snooker must acknowledge the methodological limitations of data collection when using isolated skill tests as identified by studies in Theme B and would benefit from more multidisciplinary research to alleviate such limitations, for example, by combining ideas from psychology (i.e., representative design) and biomechanics (i.e., measuring the cue action).

There were limited studies examining physical development and snooker performance, except for Soflaei et al. (2022) who examined the use of a Pilates intervention on balance and snooker test performance. Results suggest improved balance and some snooker specific skills improved after the intervention, but the implications are limited with the movement skill being reductionist without adequate contextualisation with snooker performance (Rudd et al., 2020, 2021). Given anecdotal evidence of some professional snooker players now having a greater focus on physical fitness (see TNT Sports, 2025) and the large body of current evidence across sports on effective physical preparation (e.g., Wang et al., 2023), snooker coaches and players could harness this knowledge and transfer it when designing physical preparation programmes, given the current lack of population specific evidence.

Studies in the Notational Analysis (Snooker Outcomes) Theme (C) used statistical modelling to explore performance and ranking in snooker with some robust methods presenting contemporary evidence of ranking systems. However, not all the papers directly address the multifactorial aspects of snooker, which is a central limitation of big data in sports science (see Cossich et al., 2023; Cust et al., 2019). Future research using a more integrative approach would aid in addressing not just "what", but "how" these ideas could advance sport science support in snooker (Muir et al., 2015). For example, Goes et al. (2021) recommend that sports scientists and data scientists' collaboration benefits from stronger dialogue where hypotheses are proposed and modelling techniques developed and evaluated by testing the robustness of the model in practice – an area that may be investigated in the future snooker science research.

Given this review has highlighted there is currently limited understanding of sports science in snooker and much of the research has been monodisciplinary in designs, future work could be guided by the three broad stages of the applied research model for sports sciences (ARMSS) (description, experimentation, implementation) (Bishop, 2008). The ARMSS model (Bishop, 2008) proposes that at stage 1 ("defining the problem"), an excellent understanding of the underlying science that relates to the identified research problem must be achieved before progressing to stage 2 ("descriptive research"). The findings here have begun stage 1 with a formal review of the existing literature. However, stage 1 should also include discussions with stakeholders (e.g., athletes, coaches, officials) to identify real world problems that need to be addressed in future research. Without these discussions, future empirical research is likely to be poorly conceived and unable to address questions that will contribute to snooker performance. Consequently, it is recommended that the next stage of research in the domain of snooker sport science should involve formalised stakeholder conversations (e.g., interviews, focus groups and surveys). Such discussions not only assist in better understanding the problems faced by those involved in snooker but would likely go some way to address methodological limitations in future studies (Bishop, 2008). Next, future studies could align with the second stage (experimentation) and third stage (implementation) of the ARMSS model. Studies in this phase could focus on understanding specific training practices in snooker and other factors that might influence optimal sports performance (Bishop, 2008). Additionally, methodological studies could be implemented with a focus on developing interventions/protocols, standardising terminology, or determining factors associated with elucidating predictors of performance. In terms of using research to inform coaching decision-making, previous research on coaching research outside of snooker outlined a key distinction between "what" decisions are made in snooker and "how" these decisions are implemented (Muir et al., 2015). A notable example of this application in this review was the introduction of an expert coach by Welsh et al. (2018). The "what" knowledge outlined via this current scoping review represents snooker's current sports science knowledge landscape. As this area of research develops, it will be important to establish what good practice looks like and, therefore, provide practical evidence on the usefulness of the scoping review findings.

Studies in the third stage of the ARMSS model should not commence until possible solutions to the research problem have been identified using stage one and stage two. Future research in stage three should utilise experimental approaches to examine relationships between predictor variables and snooker performance (see Kirk et al., 2020, for an example in sports science). Replication studies are generally performed in stage three (Bishop, 2008), although novel experimental protocols may need to be developed if no suitable existing interventions exist.

Conclusions

This scoping review categorised sports science in snooker through a cross-disciplinary scoping review of the scientific literature. Findings outlined that whilst there is a general sacristy available, literature in snooker is monodisciplinary, broad and heterogeneous, spanning various disciplines (psychology, biomechanics, and notational analysis (snooker outcomes)). A distinction between studies included in this scoping review was the type of data collected and analysed, with psychology and biomechanics research using primary data collected through quantitative and qualitative designs and notional analysis research using secondary data sampled from online databases. There is some understanding of psychology in snooker in the following areas: Coaching Cognition, Decision-making, Mental Toughness, Motivation, and

Visual-perceptual skills. There is some understanding on biomechanics in snooker in the following areas: Balance, Cue Action, Coaching, and Skills Test (Performance). Statistical modelling and simulations are used to understand snooker outcomes, particularly ranking, age-dependent comparisons, and player rating systems.

In studies that used primary data, the definition of skill levels was inconsistent. It recommended that future research develop a consistent approach to categorising skill levels in snooker science research. Moreover, studies using secondary data and statistical techniques require collaborations between sports scientists and data scientists who benefit from stronger dialogue where a hypothesis is proposed and modelling techniques employed and evaluated by testing the robustness of the model in practice. Moving towards a more integrated interdisciplinary approach, future snooker science research should align with the three broad stages of the applied research model for sports sciences (ARMSS) (description, experimentation, implementation).

Additional Information

Data Accessibility

Not applicable as the study is a scoping review.

Conflict of Interest

The authors declare that they have no competing interests.

Consent to Participate

Not applicable as the study is a scoping review.

Consent to Publish

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