Research Square

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Knowledge and confidence about concussion among medical students: a repeated cross-sectional study

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Abstract

Background

Concussion is a common form of brain injury and doctors have an important role in its diagnosis and management. However, most medical schools do not provide concussion teaching about concussion, and as a result, doctors lack knowledge and confidence on the subject. To inform medical student concussion education, we assessed concussion knowledge and confidence among students at a UK medical school.

Methods

We conducted a repeated cross-sectional online survey of penultimate-year medical students at the University of Oxford over four academic years (2022–2026). Knowledge was assessed using six multiple-choice questions with dichotomous and partial-credit scoring, and confidence using three Likert-scale questions concerning perceived ability to recognise and manage concussion. Associations were assessed using non-parametric tests and multivariable linear regression.

Results

384 students out of 700 eligible participants completed the survey (55.0%). The average knowledge score was 68.8%. Knowledge of concussion symptoms (93.5%), signs (85.7%), and 'red flags' (90.9%) was high, while knowledge of the proportion of concussions involving loss of consciousness (55.7%), risk factors for prolonged recovery (56.6%), and expected symptom duration (30.5%) was lower. Knowledge increased across participants in non-contact (66.5%), contact (71.0%), and collision (76.2%) sports ($p < 0.001$). Regular participation in contact and collision sport was associated with 4.7 (95% CI 1.6–7.8, $p = 0.003$) and 9.5 (95% CI 5.3–14.2, $p < 0.001$) percentage-point higher knowledge scores, respectively, compared with non-contact sports after adjustment for age, gender, medical programme, and frequency of sporting activity. Students expressed low confidence about concussion. Only one in four felt able to recognise concussion (25.0%) or 'red flags' (22.9%), and one in eight felt able to recognise persistent post-concussion symptoms (12.5%). Regular participation in collision sports was associated with greater confidence about concussion after adjustment (+ 0.41, 95% 0.11–0.70, $p = 0.007$). Concussion knowledge and confidence were weakly positively correlated ($\rho = 0.175$, $p < 0.001$).

Conclusions

Medical students demonstrated variable concussion knowledge and low confidence in recognising and managing concussion. Contact and collision sport participation was associated with greater knowledge, while collision sport participation was also associated with greater confidence. Concussion education

should build on existing knowledge, correct misconceptions, and prioritise translating knowledge into clinical decision-making.

Background

Concussion is a common form of brain injury (1–4). Sports-related concussion, in particular, now garners a high level of attention, thanks in part to successful public awareness campaigns and publication of national guidelines, as well as frequent media coverage and widespread discussion across social media (5, 6). Concussion recognition training has been embraced by sporting communities and concussion assessment tools are now available for use by the public (7). In this new context, doctors and allied healthcare professionals are set to play an increasingly important role in the diagnosis and management of concussion, as well discussions about how to weigh potential long-term risks against the benefits of physical exercise and participation in sports (8–11).

Currently, most medical schools do not provide teaching about concussion (12, 13). A recent survey found that four out of five medical students in the US feel that the teaching they received was not sufficient to prepare them to manage concussion, and the same proportion expressed a need for formal concussion training (13). A survey of Scottish medical students found similar results, with only 15% learning about concussion in medical school and 93% interested in receiving concussion training (14). Studies into concussion teaching at medical school have shown that, when provided, it is usually as a didactic lecture, with limited focus on clinical skills, and minimal evidence of impact (12, 15).

Consequently, doctors lack knowledge and confidence about concussion, including those who practise in settings where the condition is most often encountered, including emergency medicine, family medicine, and neurology (14, 16–20). In contrast, allied healthcare professionals generally demonstrate good knowledge about concussion (21–24), with postgraduate education associated with greater knowledge among physiotherapists, and clinical experience and concussion-specific training associated with greater confidence among speech and language therapists (21, 24). Although concussion knowledge among speech and language therapists has improved over time, confidence remains low (25). Online resources for concussion continuing medical education are available, but limited awareness and time are significant barriers to uptake among practising doctors (26).

Improving concussion training in medical school is an important step towards meeting the changing needs and expectations of people affected by concussion. To address this gap, we assessed the knowledge and confidence about concussion among students at a medical school in the UK.

Methods

Study design and setting

We conducted a repeated cross-sectional survey of penultimate-year medical students over four consecutive academic years (September 2022–August 2026). Medical students at the University of

Oxford were recruited by email from the course administrator during their Clinical Neurosciences rotation as part of the development of a new concussion education session. The session was designed and delivered by a multidisciplinary faculty including neurologists, neurosurgeons, psychiatrists, and physiotherapists.

Participants

All students enrolled in either the 6-year undergraduate-entry or 4-year graduate entry medicine programme were eligible and invited to participate. The online survey was hosted by the Joint Information Systems Committee (https://app.onlinesurveys.jisc.ac.uk/login), with participant information and consent presented on the first page (Supplementary Material 2). Incomplete surveys were excluded. Study size was determined by the number of eligible students and response rate.

Variables

Variables included participant characteristics, exposures, and outcomes. Characteristics were age, gender, and programme. Exposures included sporting participation and career intentions, which were identified as variables that may potentially influence outcomes. Sporting participation was assessed in terms of the type and number of sports in which students participated regularly over the previous five years, highest level achieved, and frequency of participation. Sports were categorised as non-contact (e.g. running, cycling), contact sports (e.g. association football [soccer], basketball) or collision sports (e.g. rugby, boxing) and participants were categorised according to the highest level of sporting contact reported. Career intentions were assessed using three five-point Likert scale items measuring interest in a career in neurology, psychiatry, or rehabilitation medicine. For regression analysis, ordinal values were assigned to responses (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). Average interest scores were calculated using mean ordinal values.

The outcomes were knowledge and perceived confidence about concussion. Knowledge was assessed using six multiple-choice questions based on the most recent concussion consensus statement (1); two single-best-answer (SBA) questions (1 and 5) and four select-all-that-apply (SATA) questions (2–4, 6). SBA questions were scored dichotomously (1 point for a correct answer). SATA questions used partial-credit scoring, with 1 point for each correct option selected and 1 point deducted for each incorrect option selected (“rights minus wrongs”). This approach was chosen to assess knowledge rather than mastery and has shown better psychometric performance than dichotomous “exact match” scoring (27–29).

To enable comparison, weighted knowledge scores were calculated for each question by dividing the score achieved by the maximum possible score. Total knowledge scores were calculated by summing weighted scores across all six questions and average knowledge scores were calculated using the mean weighted knowledge score and expressed as a percentage. Confidence was assessed using three five-point Likert scale items measuring perceived ability to recognise and manage concussion. For regression analysis, ordinal values were assigned to responses (1 = strongly disagree, 2 = disagree, 3 =

neutral, 4 = agree, 5 = strongly agree). Average confidence scores were calculated using mean ordinal values.

Statistical analysis

Participant characteristics, sporting participation, career intentions, knowledge, and confidence were summarised using standard descriptive statistics. Exploratory univariable analyses were used to assess associations between characteristics, exposures, and outcomes. The Mann-Whitney U test was used to compare outcomes between binary categorical groups, Spearman's rank correlation was used to assess associations with ordinal and continuous variables, and the Kruskal-Wallis test was used to compare outcomes between non-contact, contact, and collision sport participants. No adjustment was made for multiple comparisons given the exploratory nature of these analyses.

Post hoc multivariable linear regression analyses were performed to examine associations between sporting contact level and outcomes, adjusting for age, gender, medical programme, and frequency of sporting activity. Sporting contact level was entered as a categorical variable, with participation in non-contact sport as the reference category. Participants reporting non-binary gender or preferring not to disclose gender were excluded from this analysis because of small group sizes. Regression coefficients with 95% confidence intervals were reported, and model assumptions were assessed using residual plots and collinearity tests. The relationship between individual knowledge and confidence scores was assessed using Spearman's rank correlation. All analyses were two-tailed, with $p < 0.05$ considered significant. Statistical analyses were performed using SPSS (IBM SPSS, Version 29.0) and graphs were drawn using GraphPad Prism (Version 10.3).

Results

Participants

385 students out of a total 700 eligible participants responded to the survey (response rate 55.0%). The response rate was consistent between cohort years (year 1: n = 104/173, 60.1%; year 2: n = 96/173, 55.5%; year 3: n = 82/184, 44.6%; year 4: n = 103/170, 60.6%). 384 responses were included as one incomplete response was excluded. The median age of respondents was 23.0 years (range: 22–35 years) and 64.8% (249/384) were female (Table 1). 83.1% (319/384) were on the 6-year undergraduate programme, which is representative of the enrolment ratio between undergraduate and graduate-entry medicine programmes.

Table 1
Participant characteristics (n = 384).

Age – median (IQR)	
Age (years)	23.0 (22.0–23.0)
Gender – n (%)	
Female	249 (64.8)
Male	126 (32.8)
Non-binary	6 (1.6)
Prefer not to say	3 (0.8)
Programme – n (%)	
Undergraduate	319 (83.1)
Graduate-entry	62 (16.1)
Prefer not to say	3 (0.8)

Sporting participation

Most respondents participated in sport 3 to 4 times per week (33.9%), while 11.5% participated daily and 7.6% less than weekly (Table 2). On average, respondents participated regularly in three sports, collectively covering 58 different sports (Fig. 1). Highest participation levels ranged from social or recreational level (24.5%) to local (31.0%), regional (32.6%), and national or international competition (10.4%). One in four respondents participated in contact sports (26.3%) and one in ten participated in collision sports (10.4%, Supplementary Material 1: Supplementary Table 1). The most common contact sports were association football (soccer, 18.5%), field hockey (8.3%), and basketball (4.2%); collision sports were led by rugby union (7.3%), boxing (3.1%), and rugby league (1.8%).

Table 2
Sporting participation (n = 384).

Number of sports – median (IQR)	
Number of sports	3.0 (2.0–5.0)
Participation frequency – n (%)	
Daily	44 (11.5)
5–6 times per week	93 (24.2)
3–4 times per week	130 (33.9)
1–2 times per week	86 (22.4)
Less than weekly	29 (7.6)
Prefer not to say	2 (0.5)
Highest participation level – n (%)	
National or international	40 (10.4)
University or regional	125 (32.6)
College, school, or local club	119 (31.0)
Social or recreational	94 (24.5)
Prefer not to say	6 (1.6)

Career intentions

Interest in pursuing a career was highest for neurology (22.6%), followed by psychiatry (18.7%) and rehabilitation medicine (7.0%) (Supplementary Material 1: Supplementary Table 2).

Knowledge about concussion

Respondents demonstrated variable knowledge about concussion, with an average knowledge score of 68.8% (SD 25.2%) across six questions (Fig. 2A, Supplementary Material 1: Supplementary Table 3). Knowledge of concussion symptoms (93.5%), signs (85.7%), and ‘red flags’ (90.9%) was strongest. In contrast, respondents had more difficulty identifying the proportion of concussions involving loss of consciousness (55.7%) and risk factors for prolonged recovery (56.6%), and most incorrectly identified the expected duration of symptoms (30.5%).

Knowledge differed according to sporting contact level (non-contact: 66.5% [95% CI 64.8–68.2], contact: 71.0% [95% CI 68.3–73.5], collision: 76.2% [95% CI 72.2–80.0]; $H[2] = 18.936$, $p < 0.001$, Fig. 2B). In multivariable linear regression adjusting for age, gender, programme, and frequency of sporting activity, participation in contact sport was associated with a 4.7 percentage-point higher knowledge score (95%

CI 1.6–7.7, p = 0.003), and collision sport participation with a 9.5 percentage-point higher score (95% CI 5.3–13.9, p < 0.001), compared with non-contact sport participation. Sporting frequency alone was not associated with knowledge (p = 0.294).

Knowledge was not associated with age, gender, programme, number of sports played, frequency of sporting activity, level of sporting participation, or interest in neurology, psychiatry, or rehabilitation medicine.

Confidence about concussion

Respondents expressed low confidence in recognising and managing concussion (Fig. 2C, Supplementary Material 1: Supplementary Table 4). Only a minority of respondents felt confident recognising concussion (25.0%), post-concussion red flags (22.9%), or persistent post-concussion symptoms (12.5%).

Confidence differed according to sporting contact level (non-contact: 2.48 [95% CI 2.37–2.59], contact: 2.64 [95% CI 2.49–2.79], collision: 2.86 [95% CI 2.59–3.12]; H[2] = 8.553, p = 0.014, Fig. 2D). In multivariable linear regression adjusting for age, gender, programme, and frequency of sporting activity, participation in collision sports was associated with a higher confidence score (+ 0.41, 95% CI + 0.11–+0.70, p = 0.007), compared with non-contact sports. Participating in contact sports was not associated with significantly more confidence than non-contact sports (+ 0.19, 95% CI -0.01–+0.39, p = 0.067). Sporting frequency alone was not associated with confidence (p = 0.495).

Greater confidence also was weakly correlated with playing a higher number of sports (ρ = 0.113, p = 0.027) and with interest in a career in rehabilitation medicine (ρ = 0.108, p = 0.035), but not neurology or psychiatry. Confidence was not associated with age, gender, programme, frequency of sporting activity, or level of sporting participation.

Knowledge and confidence were weakly positively correlated (ρ = 0.175, p < 0.001), indicating that students with greater concussion knowledge tended to report greater confidence.

Discussion

We found that medical students had a strong understanding of the core features of concussion, consistent with previous studies (14). However, important misconceptions were observed, particularly around the prevalence of loss of consciousness and the expected duration of concussion symptoms. Emotional and psychological symptoms of concussion have also been shown to be frequently overlooked (17). Notably, participants in this study had received no formal concussion teaching at medical school, suggesting that their knowledge may have come from other sources.

Concussion knowledge and confidence increased with the level of contact in sporting participation, with the highest levels observed among students playing collision sports. These associations persisted after adjustment for demographic characteristics and frequency of sporting activity, suggesting that they were

not simply explained by greater participation. Students involved in contact or collision sports may be more likely to experience or witness concussion (30), encounter concussion-related media coverage (6), or receive sport-specific concussion training (31). Consistent with this, previous studies have reported relatively high concussion knowledge among college athletes (32). However, most students in our cohort did not regularly participate in contact or collision sports, Together, these findings suggest that without formal training in medical school, future doctors may enter clinical practice with gaps in their knowledge about concussion (6, 31). Therefore, concussion education should build on existing knowledge, account for differences in prior exposure, and address common misconceptions.

Our findings reveal a mismatch between concussion knowledge and confidence. Despite demonstrating relatively good knowledge about the core features of concussion, students reported low confidence in recognising and managing concussion. Although knowledge and confidence were positively correlated, the association was weak, suggesting that knowledge alone is insufficient to build clinical confidence in managing concussion. Concussion education should therefore focus not only on improving knowledge, but also developing confidence in its clinical application. Active learning approaches, such as case-based teaching and simulation, may be particularly valuable, helping students translate knowledge into clinical reasoning and build confidence in a supportive learning environment, more effectively than passive approaches such as lectures (33, 34).

Several limitations should be considered when interpreting our findings. First, despite a relatively high response rate for an online survey (55%), selection bias is possible if students with greater interest, knowledge, or experience of concussion were more likely to participate. Second, the use of non-validated knowledge questions and self-reported sporting participation may have introduced measurement and reporting biases. Third, the cross-sectional design precludes causal inference, and residual confounding may remain despite multivariable adjustment. The exploratory analyses also involved multiple comparisons, warranting cautious interpretation. Finally, while this study included a relatively large sample of students across multiple cohorts, its single-centre design may limit generalisability.

Conclusions

Medical students demonstrated variable concussion knowledge and low confidence in recognising and managing concussion. Participation in contact and collision sports was associated with greater knowledge, while collision sports participation was also associated with greater confidence. Our findings highlight the need for structured concussion education for medical students that builds on existing knowledge, addresses misconceptions, and strengthens students' confidence in applying their knowledge to clinical decision-making.

Abbreviations

SBA = single-best-answer.
SATA = select-all-that-apply

Declarations

Ethics approval and consent to participate

The study was reviewed and approved by the University of Oxford Medical Sciences Interdivisional Research Ethics Committee (R82977/RE001). Informed consent was gained from all participants.

Consent for publication

Not applicable.

Competing Interests

JA: none. GH: none.CN: none.HD: none. GD: has received research funding from the Oxford BRC, MRC(UK), National Health and Medical Research Council (NHMRC), UK MS Society, Department of Defense, Oxford-Quinnipiac-Trinity Health Of New England Partnership, Rosetrees Trust, and the Multiple sclerosis Research, Treatment, and Education (MSTRE); is a panel member of Wellcome Trust Brain and Behavioural Sciences Advisory Group Panel member and Editorial Board member of MSJ, Continuum, Frontiers in Neurology; and has received honoraria for consulting or speaking for Novartis, Merck, the MS Academy, AAN, and the Wellcome Trust.

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Author Contribution

JA: conceptualisation, methodology, investigation, formal analysis, data curation, writing – original draft, visualisation, project administration, funding acquisition. GH: conceptualisation, methodology, writing - review & editing, funding acquisition. CN: conceptualisation, methodology, writing - review & editing, funding acquisition.HD: conceptualisation, methodology, writing - review & editing, funding acquisition.GD: conceptualisation, methodology, writing – review & editing, supervision, funding acquisition. All authors read and approved the final manuscript.

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Data Availability

The dataset generated and analysed during this study is available from the corresponding author on reasonable request.

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Figures

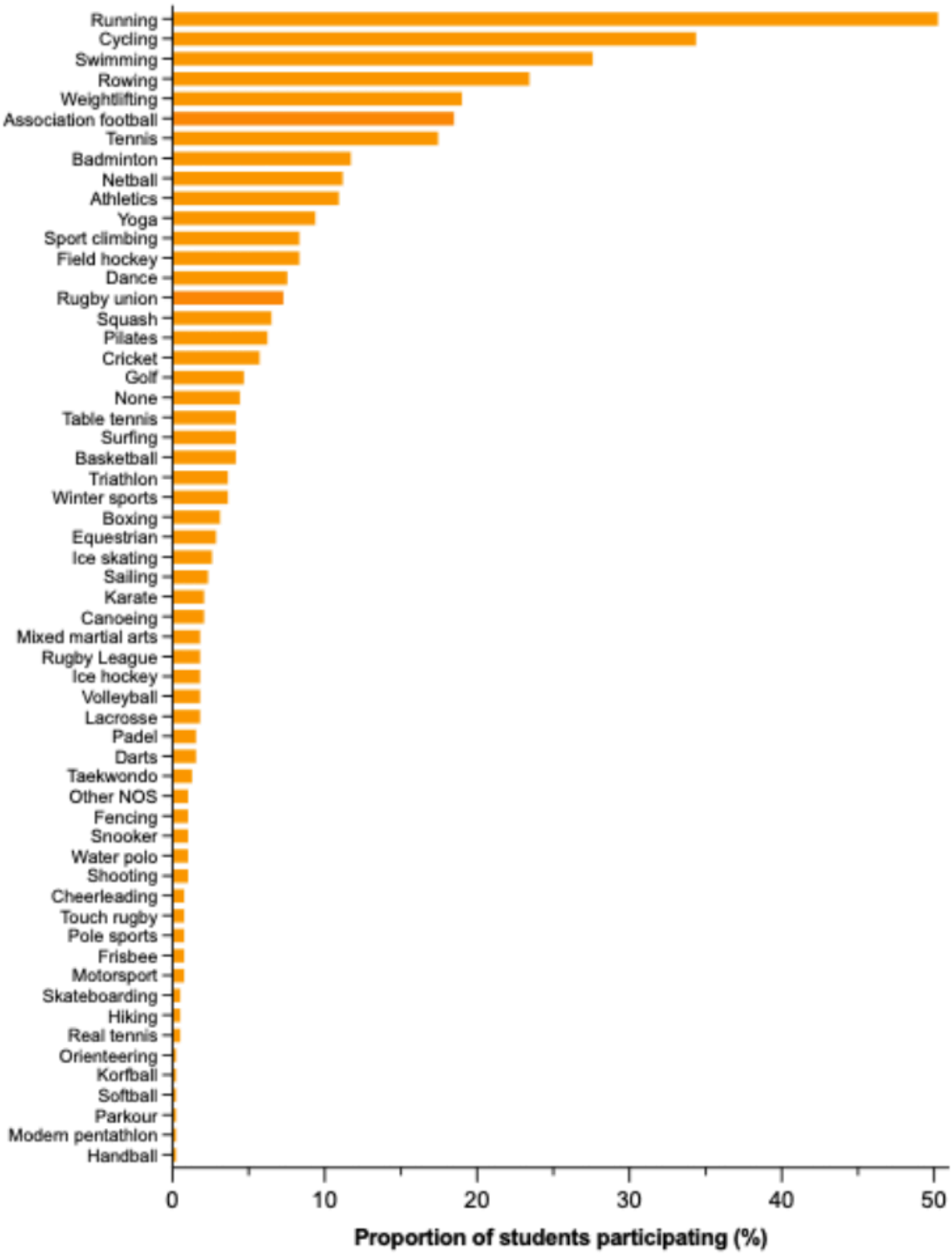


Figure 1

Medical student sporting participation. Proportion of respondents reporting regular participation in each sport during the preceding five years. Participants could report more than one sport.

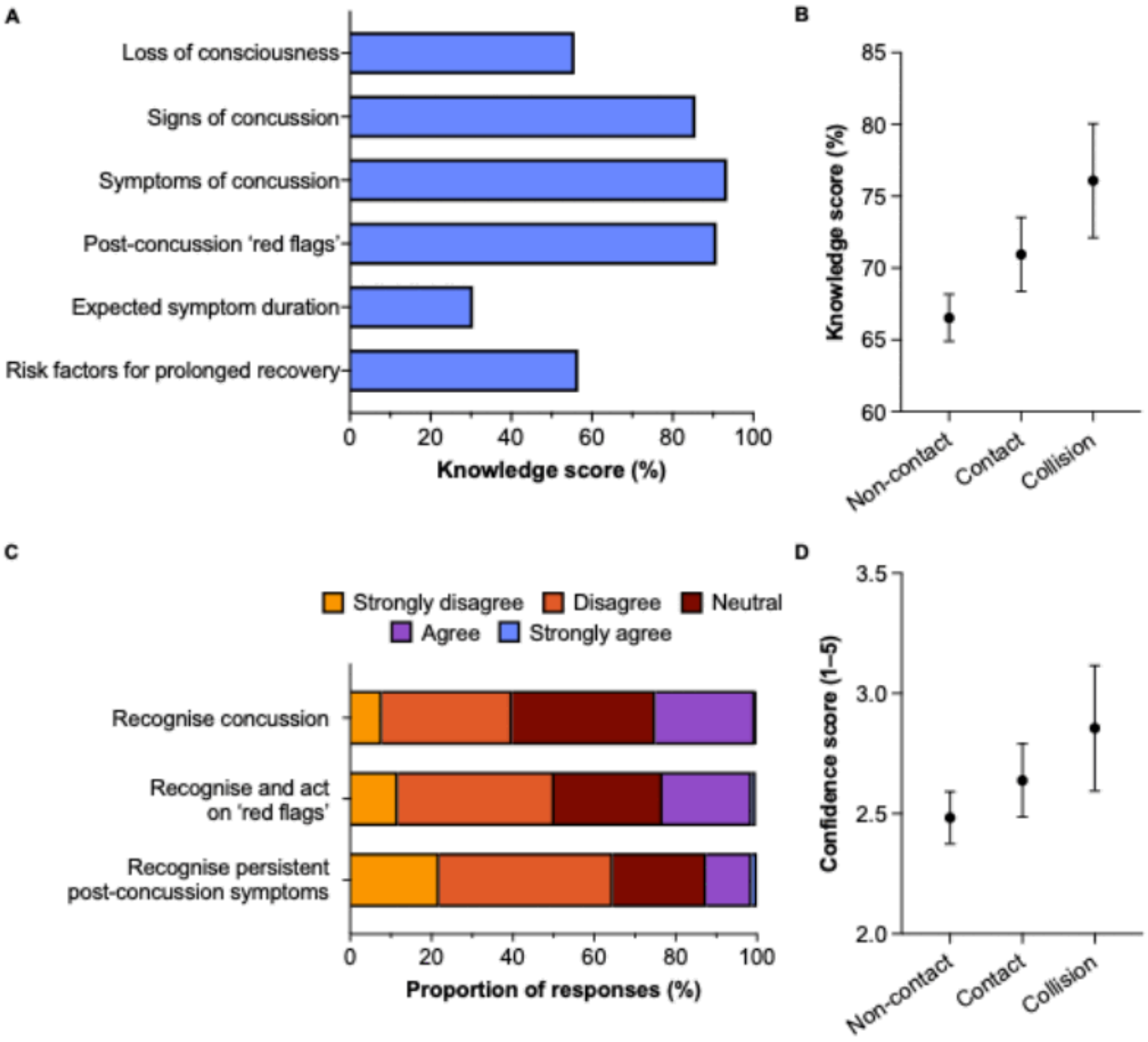


Figure 2

Medical student knowledge and confidence about concussion. A. Mean weighted scores for six concussion knowledge questions. **B.** Mean knowledge scores according to level of sporting contact. **C.** Distribution of responses to three statements assessing perceived confidence in recognising and managing concussion. **D.** Mean confidence scores according to level of sporting contact. **B,D.** Points represent unadjusted means and error bars represent 95% confidence intervals; non-contact (n=233), contact (n=101), collision (n=40).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterial1.pdf
- SupplementaryMaterial2.docx