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# Lifting the lid on American football equipment: understanding current knowledge and safe practise of equipment use in British American Football

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## Abstract

**Purpose** Primary aims of the study were to (i) assess the current equipment usage amongst American football (AF) players in the UK, (ii) evaluate the knowledge, adherence and practise to correct helmet fit guidelines, and (iii) explore AF player attitudes towards the use of protective safety equipment for injury prevention.

**Methods** Cross-sectional study design. One hundred and sixty-eight British AF athletes participated in the online survey. Data were collected on current equipment usage, including practise related to reconditioning of equipment. Questions to assess knowledge, behaviour and perception of importance were designed using the 13-criteria checklist used for helmet fit assessment. Questions related to safety of helmet use and attitude towards equipment were asked on a 5-point scale.

**Results** Knowledge of safe helmet fit was generally good. The most common knowledge question correctly identified by all participants was ‘The helmet should fit the head snugly on all sides’; however, attitude to use of equipment and long-term health was not reflective of this knowledge. Nineteen percent of athletes reported that wearing equipment allowed them to play, whilst injured and 31% of players felt fearless when wearing full AF equipment.

**Conclusion** Despite good knowledge related to helmet safety, attitude to equipment and long-term health was poor. Research shows that the wearing of and choice of equipment is of upmost importance; however, our findings suggest that players attitude to its use could impact its effectiveness. The authors recommend that the national governing body seeks to educate players on equipment use and conditioning to ensure safe play.

**Keywords** Injury · Tackle football · Concussion · Musculoskeletal injury · Protective equipment

## Background

American football (AF) is a sport mainly concentrated in the United States of America (USA); however, there is a competitive league held in the United Kingdom (UK). Based on adult contact memberships published in the annual British American Football Association (BAFA) reports, there has been a 71% increase from 2018/2019 to 2021/2022 (2092 adult contact members) [1].

As part of its 10-year strategic vision, BAFA aims to increase participation within a safe environment [2]. To promote player safety, it is important to first consider the demands and injury patterns within a given sport. At present, there is an absence of large-scale injury data in British AF competitions. However, 4586 head impacts were reported during one playing season in a sample of AF USA collegiate athletes [3]. Furthermore, previous injury surveillance studies have shown that contact sustained to the head region increases the risk of concussion [4]. Indeed, a study by Pelet et al. [5] found concussions to be the most frequent injury type (3.11/1000 athletic exposures) in a sample of North American high school players. The research to date investigating the long-term cumulative effects of sub-concussive head impacts has shown that repetitive head impacts are linked to a short-term decline in reaction time and balance [3] and also increased symptom resolution time [6]. Therefore, strategies to reduce the number and severity of head

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impacts are important for enhancing player safety in AF competitions.

AF is characterised by players use of protective equipment. The primary purpose of wearing equipment is to protect the body from injury during high velocity, impact activities [7]. The importance of such protective equipment was emphasised at the 6th International Conference on Concussion where it was suggested that further research was needed to inform headgear recommendations in collision sports [8]. Specific to AF is the use of helmets (known informally as ‘lids’), which reduce the risk of serious head and facial injuries [9, 10]. Helmet fit is important, as incorrectly fitted helmets can be a risk factor for an increased concussion frequency and symptoms [10]. For example, athletes with a poorly fitted helmet experienced symptoms of concussion for longer than 1 week 6.2% more often than those athletes with a correctly fitted helmet [10]. Both new and reconditioned football helmets offer high school football players the same protection against concussion regardless of the manufacturer or model worn [11].

Helmet design in AF has evolved significantly from simple leather head coverings to modern plastic shells equipped with face-cages and internal padding [12]. These newer models have been found to significantly reduce both translational and rotational accelerations of a makeshift head form more than older helmet models [13]. More recently, exterior soft-padded helmet coverings such as the Guardian Cap have been introduced in the NFL to provide additional head protection [14]. Whilst these advancements in helmet design are intended to further reduce injury risk, their effectiveness depends greatly on a correct fitting for the athlete [15]. Incorrectly fitted helmets have previously been reported to be common within US youth tackle football leagues [16] with possible reasons for this including incorrect fitting by league staff when renting a helmet [16]. Therefore, wearing a correctly fitted helmet in AF is a critical priority due to the high-risk nature of the sport, which involves frequent collisions and impacts. Furthermore, anecdotal evidence suggests that AF players in the UK wear club owned helmets which are pre-used, altered, shared, and often old. For example, individuals are known to modify their helmets by re-painting to match their team colours. Adaptation of a helmet is ill-advised unless conducted by the manufacturer [17]. Therefore, this practise might risk the integrity of the helmet material, putting the wearer at greater risk of injury.

Research in collision sports suggests that athletes may alter their behaviour when wearing protective equipment [18]. In rugby union, it has been reported that players who wear protective equipment such as shoulder padding may lessen the importance of tackling technique, would continue to play whilst injured, and may also be more aggressive when tackling [7]. As AF involves the heavy use of protective equipment, and with a vast number of BAF players

transitioning from a rugby union background, it could be hypothesised that similar attitudes may be present.

The scientific community has responded to uncertainties in concussion risk by introducing competitive rule changes, policy changes, medical guidance, coaching techniques, and injury prevention exercise strategies [8]. However, in the UK game, the basics of injury prevention, from an equipment use perspective, are yet to be considered. With concussion known to be a problem within the sport [19], and player safety and welfare of considered important [2], it is necessary to understand American football equipment use in the UK.

Therefore, the primary aims of the study were to (i) assess the current equipment usage amongst AF players in the UK, (ii) evaluate the knowledge, adherence and practise to correct helmet fit guidelines, and (iii) explore AF player attitudes towards the use of protective safety equipment for injury prevention.

## Methods

A cross-sectional study design was used to collect data over a 3-month period between the start of September 2022 and middle of November 2022. This falls at the end of the BAFA season and start of the British Universities and Colleges Sport (BUCS) season. All registered members of BAFA who played in the BAFA or BUCS contact leagues were eligible to participate. Participants under the age of 18 years were ineligible to participate. To reduce risk of selection bias, recruitment for the study took place via two methods: (i) email communication was sent to all registered players via central BAFA communication and (ii) email communication was sent to all BAFA registered teams who participated in tackle football and were asked to share the survey link with their members; (iii) participants were invited to participate via communication shared on social media platforms (Instagram and Twitter).

## Ethics

Participants were informed of the purposes and methods of the study and given opportunity to decline participation at the beginning of the online survey. Each survey was anonymous with each individual creating a unique identifiable code which could be stated if they wished to withdraw from the study up until data analysis. All participants were advised that participation was voluntary. Informed consent was gained at the beginning of the questionnaire. All participants had to consent to participate prior to participation in the survey. Ethical approval was granted by Hartpury University Ethics Committee (ETHICS2021-112). Compliance

with General Data Protection Regulation (GDPR) was maintained throughout.

### Questionnaire design

Data were collected via an online survey platform (Qualtrics, Provo, UT). The survey could be completed on a laptop, computer, mobile phone, or tablet, and was written in English.

The survey had a cross-sectional study design. This survey investigated players use of AF equipment, current knowledge, and practise related to correct helmet fit guidelines and players attitude towards the use of AF protective playing equipment. This was the first survey of its kind, and therefore, some questions were designed by the research team, using the previous literature to shape these. The majority of questions ( $n=28$ ) were quantitative, with some open-text questions ( $n=6$ ) allowing for expansion of answers via open-text fields to allow greater insight into the response.

Following the design of the survey, these questions were tested for suitability and tone by eight coaches and players with experience in BAFA leagues. Feedback relating to the framing of questions helped to reshape the questions for the final version. For example, recommendations were made to include options for mouthguards with “integrated lip shields” and “hard shell” chin guards relative to their specific question. The final version of the survey was agreed by the research team. Future work could understand the reliability of the questions.

### Participant demographics

Questions related to demographics included: age, biological sex, gender identity, and level of competition.

### Protective equipment use

Seventeen questions designed by the researchers are related to current equipment use. These related to helmet brand, gum shield, visor and face mask use, and practise related to the reconditioning of equipment. Open text fields were included to allow participants to expand on their answers regarding mouthguards. Boil and bite mouthguards were defined as mouthguards “where a thermoplastic rim is heated in hot water then placed in the mouth and moulded by biting and sucking”. Custom-made mouthguards were defined as being “made in laboratory on a cast taken from an impression supplied by a dentist”. Pre-made mouthguards were defined as “ready to use mouthguards” [18].

### Safety and knowledge of helmet design

Questions to assess knowledge, behaviour, and perception of importance were created using the 13-criteria guideline checklist used for helmet fit assessment by Yeargin et al. [16] and Williams et al. [20] which were designed alongside experts in protective equipment and guidelines on helmet fit (see Table 2). One of the 13-criteria points was removed due to irrelevance within the UK (use of National Operating Committee on Standards for Athletic Equipment sticker within helmet). Participants were asked to state whether these 12 ‘true’ criteria were true or false statements, e.g., ‘helmets should be checked before a game to ensure it appears to be in good condition’ and ‘all padding should be in place in a helmet’. Seven additional statements were designed by the research team to be false distractor statements, e.g., ‘helmet paint should be all one colour’ and ‘missing padding within the helmet is not a problem when training’. Participants were asked to state whether they agreed or disagreed with each 19 statements to demonstrate knowledge of helmet fit assessment.

Lininger et al. [21] found five subscales (stability, snugness, size, integrity and accessory) (see Table 1) within the 13-item checklist [16, 20]. See Table 2. Using these subscales, we assessed behavioural and perception responses to the checklist items (e.g., ‘The helmet should fit the head snugly on all sides’). A Likert scale of 1-Definitely to 5-Definitely not was used to assess behavioural responses and 1-Very important to 5-Unimportant was used to assess perception. A low score was deemed as a positive behavioural or perception score. A high score was deemed as a negative behavioural or perception score.

### Safety of helmet use

Participants were asked questions related to helmet safety on a Likert scale of 1-Definitely to 5-Definitely not (e.g., ‘To what extent do you believe the fit of a helmet determines the likelihood of a concussion’ and ‘How likely is it that you would play with an ‘ill-fitting’ helmet?’) The question ‘How important is it to your safety that you have a good fitting helmet?’ was measured on a Likert scale of 1-Very important to 5-Unimportant. Additionally, three ‘Yes’ or ‘No’ questions related to safety were devised from a helmet manufacturer website [22], e.g., ‘have you ever or do you butt, ram, spear or strike an opponent with your helmet or faceguard?’.

### Impact reducing headwear

To understand players perceptions of impact reducing headwear, a 5-point Likert scale (1-very negative, 5-very positive) was used. Two questions were asked: ‘How likely is it that you would be positive about the introduction of impact

**Table 1** Subscales presented by Lininger et al. [21]

Subscale	Components	Description
Stability	Snug	Helmet fits snugly all sides
	Facemask LR	Facemask does not slip when pulled left to right
	Facemask UD	Facemask does not slip when pulled up and down
Snugness	Neck movement	Helmet does not impinge neck movement
	Padding	All padding is in place
Size	Crown	Crown of helmet is 1–2 fingers above eyebrows
	Skin	Skin on forehead moved with helmet front to back and left to right
Integrity	Eyes	Facemask does not cover eyes when pressing down
	Skull	Helmet covers the base of the skull
	Chinstraps	Chinstraps have equal tensions
	Conditions	The helmet appears in a good condition

**Table 2** Helmet fit assessment criteria

13-criteria checklist used for helmet fit assessment by Yeargin et al. [16]

1. The helmet appears in good condition
2. All padding is in place
3. All snaps and screws are in place
4. NOCSAE football and sticker/logo is visible
5. Helmet fits head snugly on all sides
6. Helmet covers the base of the skull
7. Crown of helmet is 1–2 fingers above the eyebrows
8. Helmet does not impinge neck movement
9. Helmet does not cover eyes when pressing down
10. Chin straps have equal tension
11. Facemask does not slip when pulled left to right
12. Facemask does not slip when pulled up and down
13. Skin on forehead moved with helmet front to back and left to right

reducing headwear in the BAFA football league during training?’ and ‘Please rate how you would feel about the introduction of impact reducing headwear in BAFA league games’. To accompany these questions, two images were used: (1) the guardian soft-shell helmet cap and (2) the Pro-Tech SAFR specialised polyurethane foam helmet cover to provide context for any participants who needed a visual cue.

### Attitude towards equipment

Questions related to attitude towards equipment during playing were adapted from interview themes within the study of protective equipment by Malcolm et al. [7]. Participants were asked to state on a 5-point scale of strongly agree to strongly disagree to what extent they agreed with the following statements ‘wearing equipment makes me tackle harder’, ‘wearing a helmet and pads during games down-grades the

importance of technique’, ‘wearing protective equipment allows me to continue to play while an injury heals’, ‘wearing equipment allows me to avoid “knocks” in games and training’, and ‘I am fearless when I wear full American football equipment’.

### Data analysis

Data were analysed using Microsoft Excel version 2012 and Statistical Package for the Social Sciences (SPSS) for Windows version 28.0.1.1. Descriptive statistics were used to report frequencies related to helmets, visors, mouth guards, equipment reconditioning, damage checks, knowledge, behaviour, and perception questions. Analysis on the subscales related to helmet stability, snugness, size, and integrity were carried out using the criteria outlined in Table 1 and based on the work of Lininger et al. [23]. Thematic analysis [24] was conducted on qualitative open-text field data related to use of mouthguards, damage checks on helmets, and history of reasons behind helmet purchase. Data were thematically coded, and then, themes were identified and confirmed by the research team.

### Results

One hundred and sixty-eight players (age  $27.4 \pm 6.9$ ) completed the survey. Most of these were male ( $n = 144$ ), followed by female ( $n = 22$ ), non-binary ( $n = 1$ ) and one preferred not to state their gender. When asked at what level of the game participants currently played at 42% ( $n = 71$ ) stated premiership, 29% ( $n = 48$ ) division 1, 22% ( $n = 37$ ) division 2, 6% ( $n = 10$ ) other (university game, women’s national football league, under 19s division), and 1% ( $n = 2$ ) associate level.

## Equipment

Eighty-seven percent of respondents claimed their helmet as their own. The top two brands of helmet were Riddell (62%) and Schutt (27%). Of those participants who were able to provide the age of the helmet ( $n = 98$ ), the average age of helmet was 3.6 years ( $\pm 2.7$ ).

Findings related to helmet ownership and purchase are found in Table 3. Themed safety reasons for acquiring a new helmet included: injury in previous helmet, previous ill-fitting helmet, wished for helmet with increased safety rating.

Ninety-eight percent of respondents reported that they wear a mouthguard. The 4 respondents who did not wear a mouthguard cited face mask or speech restrictions as their reasoning. Of the 98% ( $n = 163$ ) who wore a mouthguard, 69% ( $n = 113$ ) wore a design that covers the gum, and 31% ( $n = 50$ ) wore a design with an integrated lip shield. Twenty percent ( $n = 32$ ) of respondents reported that they have never renewed their mouthguard.

Thirty percent ( $n = 50$ ) of respondents wore a visor. The top three primary reasons for wearing a visor were reported as ‘eye injury protection’ (40%,  $n = 20$ ), ‘prevention of being able to be grabbed by the face mask’ (24%,  $n = 12$ ), and ‘increased confidence in appearance’ (20%,  $n = 10$ ); see Fig. 1.

Seventy-nine percent ( $n = 132$ ) of respondents reported that their current helmet was as bought by the manufacturer, i.e., it has not been re-sprayed or wrapped, etc. When asked about equipment reconditioning, 100% of respondents stated that their helmet, chin cup, and face mask had never been returned to the manufacturer for reconditioning.

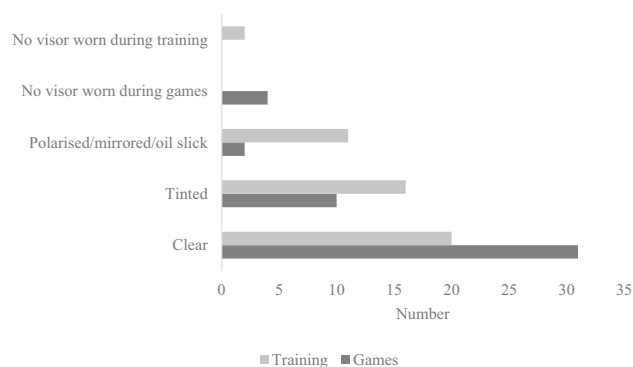


Fig. 1 Visor type worn in training and games

## Safety and knowledge of helmet design

The most common knowledge question correctly identified was: ‘The helmet should fit the head snugly on all sides’ (100%,  $n = 150$ ). The most common misconception identified was: ‘The skin on the forehead should move with the helmet when moved front to back and left to right’ (83.3%,  $n = 125$ ) (see Table 4).

Analysis of the subscales showed perception of helmet snugness to have the highest weighting of importance, followed by stability, size, and integrity. A more positive score was noted for behaviour towards stability and snugness; see Table 5.

## Safety of helmet use

Thirty-six percent ( $n = 60$ ) of respondents stated that they performed damage checks once a week. Of the 13% ( $n = 22$ ) of respondents who selected ‘other’, emerging themes from the open-text field included regular checks

Table 3 Questions related to helmet ownership and purchase

Was your current helmet purchased brand new?	N (%)
Yes	114 (68)
Uses club helmet	19 (11)
No, second-hand helmet purchased	35 (21)
When purchasing your helmet second-hand, did you ask why the helmet was being sold on?	
Yes	22 (63)
No	13 (37)
Have you acquired your current helmet within the last 12 months?	
Yes	59 (35)
No	109 (65)
What was the primary reason for acquiring a new helmet?	
To own their own helmet	30 (51)
Helmet had come to the end of its recommended life, i.e., met its expiry date	8 (14)
For reasons of safety	9 (14)
Other	12 (20)



**Table 4** Percentage of correct responses to knowledge of helmet use

	%	<i>n</i>
The helmet should fit the head snugly on all sides (True)	100	150
All snaps and screws should be in place in place (True)	99.3	149
The helmet should not cover eyes when pressing down on the top of the helmet (True)	99.3	149
The chin straps should have equal tension (True)	99.3	149
The facemask should not slip when pulled up and down (True)	93.3	149
All padding should be in place in the helmet (True)	98.7	148
The helmet should not impinge neck movement (True)	98.0	147
The facemask should not slip when pulled left to right (True)	98.0	147
Helmets should be checked before a game to ensure it appears to be in good condition (True)	97.3	146
Missing padding within the helmet is not a problem when training (False)	96.7	145
The primary purpose of a helmet is to identify which team you are on (False)	96.0	144
The helmet should cover the base of the skull (True)	95.3	143
The crown of helmet should be 1–2 fingers above the eyebrows. (True)	93.3	140
Missing a screw within the helmet construction is not a problem when training (False)	92.7	139
Helmets can be stored in warm, dark, moist storage areas (False)	86.7	130
Helmets do not need to be checked for training sessions (False)	86.0	129
The skin on the forehead should move with the helmet when moved front to back and left to right (True)	83.3	125
Helmet paint should be all one colour (False)	54.0	81
Installing an exterior or interior communication device does not damage the structural integrity of the helmet (False)	40.7	61

**Table 5** Average of respondent's responses to behavioural scores and perception scores related to factors of helmet fit

	Average behaviour scores—the likelihood of players to check the following with using a helmet	Perception of helmet check importance score
Stability	1.7 (SD ± 0.9)	1.5 (SD ± 0.5)
Snugness	1.7 (SD ± 0.9)	1.4 (SD ± 0.5)
Size	2.0 (SD ± 0.9)	1.6 (SD ± 0.6)
Integrity	1.9 (SD ± 0.9)	1.6 (SD ± 0.7)

and inconsistent use. Response examples included that they would perform damage checks 'before and after each game or session', 'every time I wear it', and 'following a big collision'. However, one respondent noted their checks were 'inconsistent'; see Table 6.

Thirty-one percent ( $n = 37$ ) reported that they never perform maintenance work on their helmet, with another 31% ( $n = 36$ ) selecting 'other'. Of those who selected 'other', respondents stated that they would perform maintenance work 'as required' or would change items such as a chin strap due to preference. Other responses included 'nothing [needed] to be replaced'. See Table 6.

Eighty-four percent ( $n = 139$ ) stated they definitely or probably agreed that the fit of a helmet determines the likelihood of a concussion. Eighty-three percent ( $n = 138$ ) stated it is 'very important to your safety that you have a good fitting helmet'. Sixty-nine percent ( $n = 115$ ) stated they would probably not or definitely not play with an 'ill-fitting' helmet. See Fig. 2.

Twenty-nine percent ( $n = 44$ ) of respondents reported being very positive about the introduction of impact reducing headwear in BAFA league training; however, only 10% ( $n = 17$ ) reported to feel very positive about the use of impact reducing headwear in BAFA leagues. See Fig. 3.

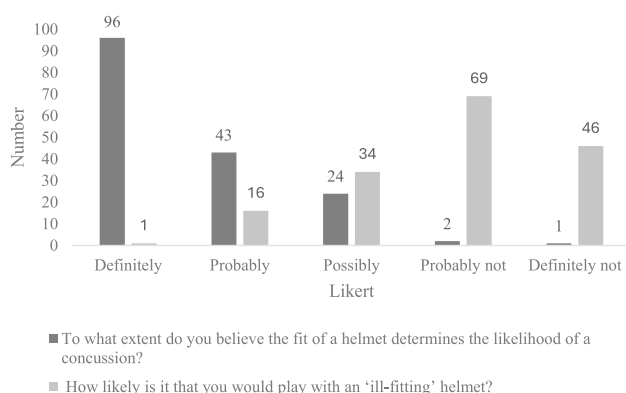
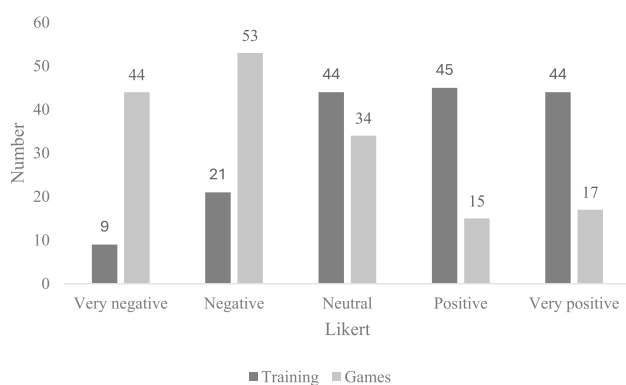
Forty-seven percent ( $n = 78$ ) of respondents reported that they have or do use their helmet or faceguard to butt, ram, spear, or strike an opponent. Thirteen percent ( $n = 22$ ) reported a BAFA coach has previously encouraged them to use their helmet or faceguard to butt, ram, spear, or strike an opponent. Thirty-seven percent ( $n = 61$ ) reported that a fellow teammate has previously encouraged them to butt, ram, spear, or strike an opponent with their helmet or faceguard. See Fig. 4.

### Attitude towards equipment

When asked about how important to their safety a good fitting helmet is, 83% ( $n = 138$ ) of respondents reported 'very important' with the remaining 17% reporting 'important'.

**Table 6** Questions related to equipment checks

	<i>N</i> (%)
How often do you perform damage checks on your helmet? For example, check padding, the shell, etc.	
Once a week	60 (36)
Once a month	40 (24)
Once per year	6 (4)
Once per season	19 (11)
Never	21 (13)
Other	22 (13)
How often do you perform maintenance work on your helmet? For example, fixing chin straps, replacing screws, etc.	
Once a week	15 (13)
Once a month	30 (25)
Once per year	0 (0)
Once per season	0 (0)
Never	37 (31)
Other	36 (31)

**Fig. 2** Responses related to helmet safety**Fig. 3** Question: rate how you feel about the introduction of impact reducing headwear in BAFA league training and games

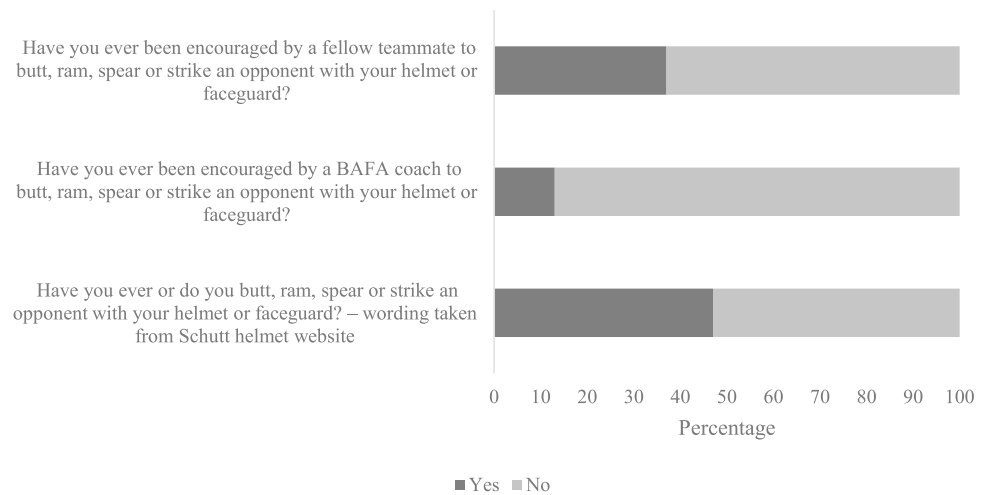
When respondents were asked whether wearing equipment made them tackle 'harder' 63% ( $n = 95$ ) strongly agreed or agreed. See Table 7 for further responses related to attitudes to playing equipment.

## Discussion

This is the first study to investigate the current understanding surrounding equipment use and evaluate knowledge related to correct helmet fit in a sample of BAF athletes. BAF athlete's knowledge of safe helmet fit was good; however, this did not always translate to having a good attitude towards use of equipment in play, as a moderate percentage (19%) suggested that protective equipment allowed them to play whilst injured. This pattern of poor attitude is illustrated by 63% of respondents reporting that wearing AF equipment made them tackle 'harder' and creates conflict between knowledge and practise.

The knowledge by athletes of safe helmet fit was deemed good (13 true responses were correctly identified by 93% or more), evidencing that they would be able to recognise an ill-fitting helmet and conduct necessary adjustments if required to ensure a better and safer fit. The most common misconception (16.7%) was 'The skin on the forehead should move with the helmet when moved front to back and left to right'. This suggests that if there is no movement, the helmet fit might be too big which could indicate that athletes are playing with helmets too large, risking insufficient full protection of the head. However, 'snugness' of the helmet was noted to have the highest importance [ $1.4$  ( $SD \pm 0.5$ )] on the perception score, showing that participants prefer a correctly fitted helmet but may be unsure of the specifics surrounding this. We found that over 80% ( $n = 138$ ) of participants



**Fig. 4** Questions related to use of helmet as a weapon**Table 7** Questions related to attitudes to American football equipment

	Strongly agree <i>N</i> (%)	Agree <i>N</i> (%)	Undecided <i>N</i> (%)	Disagree <i>N</i> (%)	Strongly disagree <i>N</i> (%)
‘Wearing equipment makes me tackle harder’	42 (28)	53 (35)	13 (9)	39 (26)	3 (2)
‘Wearing a helmet and pads during games down-grades the importance of technique’	5 (3)	15 (10)	13 (9)	66 (44)	51 (34)
‘Wearing protective equipment allows me to continue while an injury heals’	5 (3)	15 (10)	13 (9)	66 (44)	51 (34)
‘Wearing equipment allows me to avoid knocks in games and training’	22 (15)	58 (39)	13 (9)	35 (23)	22 (15)
‘I am fearless when I wear full American Football equipment’	18 (12)	29 (19)	16 (11)	63 (42)	24 (16)

reported a good helmet fit is very important to their safety and 69% ( $n = 115$ ) stated they would definitely or probably not play with an ‘ill-fitting’ helmet. However, 51 participants reported that they would continue to play with an ill-fitting helmet. Motivations for this were not explored, although the previous research suggests that collision athletes will play at any cost to their health [25, 26]. Furthermore, athletes were deemed as good in the practise of performing damage checks on the helmet, with 36% checking their helmet for damages each week or more frequently, such as every time the helmet was worn or as one participant noted ‘following a big collision’. This is not surprising when our findings show that most participants ( $n = 139$ , 84%) believed that helmet fit determines likelihood of a concussion, demonstrating good knowledge about the importance of wearing a helmet in relation to concussive injury.

The Virginia Tech Rating system tests and provides unbiased Summation of Tests for Analysis of Risk (STAR) equation ratings to assess the performance of football helmets [27], working to improve helmet safety. Use of this system provides consumers with a trusted metric to help understand the performance of individual helmet models. Helmets with more stars are seen to provide greater protection against concussion in comparison to helmets with less stars awarded

to them. Positively, when comparing the choice of helmets against the 2022 Helmet Laboratory Testing Performance [28] results, athletes generally used highly/recommended brands and/models, with only 6% reportedly using helmets on the ‘not recommended’ list. These findings demonstrate that athletes are generally wearing helmets which, according to the Virginia Tech Rating system [29], best reduce the risk of concussion. The age of a helmet should also be taken into consideration and warranties on helmet shells range from 3 to 10 years depending on manufacturer [17, 30]. Our findings highlight the average age of the helmet was 3.6 years, indicating that players regularly update their helmet. When asked about the primary reason for acquiring a new helmet in the last 12 months, over half of players reported that this was to allow them to own their own helmet. Just over one quarter report to have purchased a new helmet due to the helmet meeting its recommended manufacturer’s expiry date or due to safety reasons. Themes included helmet fit, suspicion of insufficient protection, previous injury, and athlete safety. These qualitative comments further demonstrate athlete’s good knowledge and practise in relation to helmet fit and selection.

Choice and age of helmet are important; however, the condition of this helmet is what may protect the player

against injury [31]. In the present study, participants suggested that they performed damage checks, yet more thorough conditioning checks is of importance to ensure no deterioration to the helmets material properties which are necessary for reducing risk of concussion [31]. One hundred percent of participants reported that their helmet, chin cup, and facemask had never been reconditioned by the manufacturer, despite recommendations by manufacturers that services should be completed annually to honour the warranty [17]. To not recondition a helmet risks sub-optimal performance of the helmet and may reduce time for resolution of concussive symptoms [10]. Reasons for not reconditioning helmets was not explored within the survey and could be explored in future studies. Twenty-one percent (21%,  $n=36$ ) of participants stated that their helmet was not in its original condition (i.e., re-sprayed or wrapped). The helmet manufacturer Schutt warns that some paints can destroy the helmet shell integrity, putting the athlete at risk of injury [32]. Guidance should be given to players regarding 'home paint jobs' and the importance of seeking helmet painting from an approved helmet manufacturer.

Helmets are not the only line of defence against injury in the game of American Football. Mouthguards have been shown to be effective in preventing oro-facial injury and dental injury [33], and thus, it is positive that 98% of players reported to wear mouthguards at training and in games. However, mouthguards can only be effective if they are in good condition [33]. Mouthguards are proven to deteriorate 6 weeks into football season [34], and 20% ( $n=32$ ) of participants reported to never have renewed this piece of equipment. Player education could advise upon the regular upkeep and renewal of mouthguards for hygiene and injury risk reduction purposes.

Just under 80% of participants disagreed with the belief that wearing equipment down-grades the importance of technique, yet 6 out of 10 participants (63%) reported that wearing equipment makes them tackle harder. These findings indicate that players have good knowledge about the importance of tackling technique, and the use of equipment increases confidence in collisions. Similar findings related to increased confidence whilst wearing protective equipment have also been evidenced in rugby union where athletes reported an increase in confidence when going into contact situations when wearing protective headgear [18].

The current study reported 19% of participants demonstrated the risky behaviour of continuing to play whilst injured if wearing protective equipment, and 31% of players stated that they felt fearless when wearing full AF kit. These findings support previous research that found athletes may act recklessly when wearing protective equipment [35, 36]; however, in the sport of rugby union, this was a stated reason for regularly wearing non-mandatory protective headwear [18]. BAF players have previously demonstrated their belief

that playing through a concussive injury outweighs the risk to health [37], yet no study has sought to understand other injuries BAF players are willing to play through. Future studies could investigate these behavioural traits by studying the type and severity of injuries that athletes are happy to play with and if this is impacted by the equipment they wear as helmet use is known to influence risk-taking behaviour in other sports [34]. Further, research could also explore athletes feeling of being 'fearless' in relation to their attitude to tackling, e.g., whether they weaponise their head more or are open to persuasion by coaches or peers to use their head.

No matter the game-situation, using the helmet to butt, ram, or spear an opponent can be a high-risk factor for cervical spine injury [38]. Spear tackling (referring to forcefully driving a helmet into an opposing player) has been prohibited since 1976 but still evident in the game [38]. It is concerning that almost half of participants in the present study stated that they use or have used their helmet as a weapon, and that this has been encouraged by a coach or fellow player. These findings are greater than those reported in high school athletes from Hawaii who reported under 10% would deliberately use their helmet against an opposing player during a tackle or block [25]. These findings justify the need for continued education of athletes and coaches around the association of using the head as a weapon.

The use of impact reducing headwear was met with a positive reaction with more players ( $n=57$ ) reporting to likely wear this headwear in training than in games. Reasons for this were not explored but could be due to the appearance of the headwear which NFL players have openly criticised for their appearance and added weight [39]. Whilst these are positive findings, the question should be asked as to whether this would act as another barrier for athletes who wish to play through injury and whether players are aware that this additional headwear is not associated with a decreased risk of concussion in practise and games [40].

## Limitations

This is the first study of its kind to explore knowledge and attitudes to equipment in BAF. These findings provide a platform to future investigation into helmet equipment use. It is important to note that this study relied on the respondent's honesty in answering attitude and behaviour questions; thus, findings might be read with caution should respondents have answered in a way which they might have felt was socially acceptable. Additionally, selection bias and the cross-sectional design may impact the results, threatening the generalisability of the results. However, these findings should not be discredited and provide a ground for future investigations in this area and the development of educational strategies to increase player safety. Future studies utilising these questions could look to gain a deeper insight into the

characteristics of participants for example, playing position, the number of years of playing experience, the number of previous concussions, and how this might impact their knowledge and safe practise of equipment use.

## Conclusions

It may be possible that following the recent drive in the UK towards improved concussion education, athletes are better informed about head injuries and risk reduction, including use and fit of equipment. Key findings demonstrate that BAF athlete's knowledge related to safe helmet fit was generally good; however, attitude to the use of equipment and long-term health was not reflective of this knowledge, demonstrating a disconnect. The wearing of and choice of equipment is of upmost importance; however, should the equipment not be in good condition; the protection of the equipment may be less effective. Regardless of the condition of helmets, they should not be used as weapons and a greater understanding of the mechanisms behind this practise should be examined. The authors recommend that continued education related to equipment use and equipment conditioning is required to create a positive change to player behaviour and attitude to equipment use.

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**Data availability** Data are provided within the manuscript.

## Declarations

**Conflict of interest** ET is a member of the British American Football Association (BAFA) Sports Science and Medicine Committee and is employed on a contractual basis as a Sports Therapist with the BAFA National Program.

**Ethics approval** Ethical approval was granted by the lead researchers' previous institution, Hartpury University ethics committee ETH-ICS2021-112. The study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki.

**Informed consent** All participants were required to confirm their informed consent prior to participation in the study.

**Consent to participate** All participants had to consent to participate prior to participation.

**Consent for publication** All participants consented to their data being shared for publication purposes.

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