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A preliminary study on the prevalence of mental health symptoms in current and former elite kickboxers and their possible association with severe musculoskeletal injuries and concussions

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Abstract

Aim(s) This study aimed to explore the prevalence of mental health symptoms in current and former elite kickboxers and to establish whether these mental health symptoms were associated with severe musculoskeletal injuries and/or concussions.

Methods A cross-sectional study was conducted by utilizing an electronic questionnaire among current and former elite kickboxers from the highest and second highest international level. Validated screening questionnaires from the International Olympic Committee Sport Mental Health Assessment Tool 1 (SMHAT-1) were used to asses mental health symptoms.

Results The most prevalent mental health symptoms among current elite kickboxers ($N=45$) were psychological distress (57%) and disordered eating (63%). Among former elite kickboxers ($N=29$), the most prevalent mental health symptoms were 36% for psychological distress and 43% for alcohol misuse. Additionally, no statistically significant associations were found between mental health symptoms and severe musculoskeletal injuries and/or concussions among current and former elite kickboxers.

Conclusions The substantial prevalence rates of mental health symptoms among current and former elite kickboxers emphasize the need for increased attention in this area. No associations were found between the potential contributing factors and mental health symptoms among current and former elite kickboxers. While further research is needed, raising awareness as well as developing preventive and supportive measures to assist elite kickboxers with personal and career development should be prioritized, both inside and outside the ring.

Keywords Elite athletes, Kickboxing, Mental health, Concussions, Injuries

1 Introduction

Kickboxing is a modern combat sport where athletes are exposed to high levels of psychophysiological and physical fitness demands [1]. Kickboxing medalists compete in five to seven matches during international competitions, where each match has an 8-minute time limit, consisting of three rounds, each lasting 2 min, with a 1-minute rest interval between rounds [2, 3]. As reported by the World Association of Kickboxing Organizations (WAKO), kickboxing was granted full recognition by the International Olympic Committee (IOC) in 2021 and has become one of the pre-Olympic sports [4]. There are more than 100.000 kickboxers worldwide, and the sport is represented in 135 nations across 5 continents [4]. An injury incidence rate of 1097 injuries per 1000 athlete-exposures (AEs) among elite kickboxers participating in Australian competitions has been observed [5]. Recent meta-analyses and other studies indicate that the prevalence rates of mental health symptoms among elite athletes are either equal to or higher than those observed in non-athletes [6, 7]. These studies observed that contributing factors such as severe injuries, surgeries and life events have an association with the occurrence of mental health symptoms in elite athletes [8, 9]. Injuries in these studies were often categorized by severity, with severe injuries defined as those resulting in 28 or more days of absence from training or competition [10]. By contrast, minor injuries defined as injuries causing one to three days of absence are also common among elite athletes [10]. Even more, former elite athletes also face various challenges after their retirement such as career dissatisfaction, loss of athletic identity and chronic pain [9–12]. Kickboxing is associated with chronic repetitive head trauma that can result in brain injuries, which is found to be the second most common injury in professional kickboxers [5, 11]. Lately, there has been a growing initiative to address mental health symptoms and/or surveillance of post-concussion injury in elite sports [12–14]. At present, while few anecdotical reports have raised some concerns about their mental health, it remains unknown whether elite kickboxing athletes report mental health symptoms at similar rates than those from other sport disciplines. Therefore, the aim of our study was to explore the prevalence of mental health symptoms in current and former elite kickboxers and to establish whether these mental health symptoms were associated with severe musculoskeletal injuries and/or concussions.

2 Methods

2.1 Design

This was a cross-sectional preliminary study, reported according to the cross-sectional guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [15]. Ethical approval was provided by the Medical Ethics Review Committee of the Amsterdam University Medical Centers location University of Amsterdam (W21_526#21.582; Amsterdam, The Netherlands).

2.2 Participants

Participants eligible for this study were current and former elite kickboxers registered at the fight sport authority (VA), which is an associated member of the Netherlands Olympic Committee*Netherlands Sports Confederation (NOC*NSF). The inclusion criteria for the participants were: (i) having a minimum age of 18 years and maximum of 65 years, (ii) being a current or former kickboxer registered at the VA, (iii) fighting or have

fought in the A-class or B-class (highest and second highest international level), and (iv) being able to read and understand fluent Dutch and/ or English. Given the exploratory nature of this preliminary study, a sample size calculation was not conducted and we aimed to enroll a convenient sample.

2.3 Mental health symptoms

Mental health symptoms in our study were operationalized in 7 constructs according to the International Olympic Committee (IOC) Sport Mental Health Assessment Tool 1 (SMHAT-1), namely distress, anxiety, depression, sleep disturbance, alcohol misuse, drugs misuse and disordered eating [16]. The assessment of these constructs within the IOC SMHAT-1 relies on validated screening questionnaires developed specifically to assess mental health symptoms but not mental health disorders [16].

2.4 Psychological distress

To measure sport related psychological distress among current elite kickboxers, we used the Athlete Psychological Strain Questionnaire (APSQ) [17, 18]. This consisted of 10 questions (e.g., did you worry about life after sport) scored on a 5-point scale that could be answered with 'none of the time' (score of 1) to 'all of the time' (score of 5) [17, 18]. By summing up all 10 questions, a total score ranging between 10 and 50 was calculated, in which a total score between 17 and 50 indicates an elevated or high risk for (athletic) distress [16]. The APSQ has been validated among male and female athletes for indicating signs of distress among athletes (internal consistency: 0.5–0.9; criterion-related validity: Area Under ROC Curve >0.9) [17, 18]. To assess psychological distress among former kickboxers the 10-item Kessler Psychological Distress scale (K10) was used [19]. The K10 consists of 10 items (e.g., during the last 30 days, how often did you feel tired for no good reason) scored on a 5-point-scale from 'none of the time' (score of 1) to 'all of the time' (score of 5) [19]. By summing up all 10 questions, a total score ranging between 10 and 50 was calculated, in which a score of 21 and higher indicates signs of distress [19].

2.4.1 Anxiety

We used the 7-item General anxiety Disorder-7 (GAD-7) to assess the presence of symptoms related to anxiety in the previous four weeks (e.g., do you have trouble relaxing?) scored on a 4-point scale that could be answered with 'not at all'(score of 0) to 'nearly every day' (score of 3) [20, 21]. By summing up all questions, a total score ranging between 0 and 21 was calculated, with a score of 10 or more indicating the presence of moderate anxiety [20, 21]. The GAD-7 is an efficient and valid tool for assessing symptoms of anxiety in several populations and European languages (AUC of 0.91, sensitivity of 94% and specificity of 79%) [20, 21].

2.4.2 Depression

Depression was measured by using the Patient Health Questionnaire-9 (PHQ-9) which consisted of 9 questions (e.g., do you have little interest or pleasure in doing things) scored on a 4-point scale ('not at all' (score of 0) to 'nearly every day' (score of 3)) [22, 23]. By summing up all questions, a total score ranging between 0 and 27 was calculated, where a score of 10 and more indicates signs of depression [22, 23]. The PHQ-9 has been

validated in several populations and European languages (AUC of 0.95, sensitivity of 88%, specificity of 88% and internal consistency: 0.83–0.89) [22, 23].

2.4.3 Sleep disturbance

To measure sleep disturbance we used the Athlete Sleep Screening Questionnaire (ASSQ) that consisted of 5 items (e.g., how often do you have trouble staying asleep?), in which 2 items scored on a 5-point scale and 3 items on a 4-point scale [24, 25]. By summing up the five items, a total score ranging from 1 to 17 was calculated, where a score of 8 and more indicates the presence of moderate sleep disturbance [24, 25]. The ASSQ has been validated in athletes (internal consistency: >0.7; test-retest reliability: >0.8; criterion-related validity: sensitivity >0.8, specificity >0.9) [24, 25].

2.4.4 Alcohol misuse

The validated 3-item Alcohol Use Disorders Identification Test (AUDIT-C) was used to assess the level of alcohol consumption which consisted of 3 questions (e.g., 'how often do you have six or more drinks on one occasion?', which could be answered from 'never' to 'daily' or 'almost daily') scored on a 5-point scale [26]. By summing up all questions, a total score range from 0 to 12 was obtained, where a score of 3 or more (female) and 4 or more (male) indicated the presence of alcohol misuse [26]. The AUDIT-C has been validated in various populations and European languages (test-retest coefficients: 0.6–0.9; criterion-related validity: Area Under ROC Curve 0.70-<1.0) [26].

2.4.5 Drug(s) misuse

Drug(s) misuse in the previous three months was assessed using the cutting down, annoyance by criticism, guilty feeling, and eye openers adapted to include drugs questionnaire (CAGE-AID) [27]. This consisted of 4 items (e.g., in the last three months, have you been waking up wanting to use drugs?) scored on a 2-point scale that can be answered with yes (score of 1) or no (score of 0) [27]. By summing up all questions, a total score ranging between 0 and 4 was calculated, where a score of 2 or more indicates substance misuse [27]. The CAGE-AID has been validated for screening substance misuse in several populations and European languages (reliability: >0.9; sensitivity: >79%; specificity: >97%) [27].

2.4.6 Disordered eating

To assess the presence of disordered eating among current elite kickboxers, The Brief Eating Disorder in Athletes Questionnaire (BEDA-Q) was used, consisting of nine items (e.g., 'I feel extremely guilty after overeating') scored on a 4-point scale [28]. By summing up the answers on the first six items a score ranging between 0 and 18 was calculated, with a score of 2 or more indicating the presence of disordered eating [28]. The BEDA-Q is a validated questionnaire to assess disordered eating in athletes (internal consistency: >0.8; criterion-related validity: sensitivity >0.8, specificity >0.8, Area Under ROC Curve >0.7) [28]. To assess disordered eating among former elite kickboxers, we used the Eating disorder Screen for Primary care (ESP) [29]. This consisted of 5 items (e.g., are you satisfied with your eating patterns?) scored on a 2-point scale which can be answered with yes (score of 1) or no (score of 0) [29]. By summing up all items, a score ranging between 0 and 5 was calculated, in which a score of 2 or higher indicated the presence of

disordered eating [29]. The ESP is a validated questionnaire to assess disordered eating in several languages (criterion-related validity: sensitivity 100%, specificity 0.71) [29].

2.4.7 Severe musculoskeletal injuries and concussions

The presence of severe musculoskeletal injuries and concussion was explored with two single questions that could be answered with 'yes' or 'no' (e.g., Do you currently have a severe musculoskeletal injury?). Furthermore, history of severe musculoskeletal injuries and concussion during their kickboxing career was also explored with two single questions which could be answered with 'yes' or 'no' (e.g., How many concussions did you get during your kickboxing career?) If 'yes' was answered for the aforementioned questions, subsequent questions were submitted in order to get an insight about the injury (e.g., number, location, nature). In our study, severe musculoskeletal injuries were defined as sports-related tissue damage or other impairment of normal physical function caused by the rapid or repetitive transfer of kinetic energy with a duration of 28 time-loss days that the athlete was unable to participate in training or competitions [10]. In our study, sport related concussion was defined as a traumatic brain injury caused by a direct blow to the head, neck or body resulting in an impulsive force being transmitted to the brain that occurs in sports and exercise-related activities [30]. Symptoms and signs may present immediately, or evolve over minutes or hours, and commonly resolve within days, but may be prolonged [30]. Both definitions were clearly provided to the participants, while participants were asked to consult with their medical doctor and/or medical record to answer all questions.

2.5 Procedures

Two electronic anonymous questionnaires available in Dutch and English were compiled separately for current and former kickboxers, including all dependent and independent variables from our study (LimeSurvey GmbH, Hamburg, Germany). Additionally, the following demographic and sport characteristic variables were also included in the questionnaires: gender, age, height, weight, education level, employment status, duration of sport career, level of kickboxing (A-class or B-class), duration of retirement (if applicable), and involuntary or voluntary retirement (if applicable). The VA recruited athletes through e-mail contact with elite kickboxers registered at the VA, kickboxing gyms, and social media advertisements. Interested participants who were eligible for this study received an e-mail from the VA or could click on the electronic link in the social media advertisement, which contained information about the study and a request for their electronic informed consent. Subsequently, they were given access to the questionnaire. The participants were asked to complete their questionnaire within two weeks. After two weeks, a reminder e-mail was sent if the questionnaire was not completed. Within the questionnaires, no personal identifiable questions were included to guarantee strict anonymity and the questionnaires were only accessed by the allocated researcher at Amsterdam UMC location University of Amsterdam. The data was collected from April 2023 to June 2023.

2.6 Statistical analysis

For all data analyses, we used the statistical software IBM SPSS Statistics 28.0 for Windows (IBM Corp). Separate data analyses were done for current and former elite

kickboxers. For the demographic and sport characteristics, we conducted descriptive data analyses (e.g., mean, standard deviation, frequency) [31]. For the prevalence of mental health symptoms, we calculated the percentage of participants who reported having a mental health symptom relative to the total number of participants. Hereby, we used the Wald method for 95% confidence intervals [31]. For the potential association with injury and concussion, logistic regression analysis was used [31]. The results were expressed as odds ratio (OR) with corresponding 95% confidence intervals (95%CI).

3 Results

3.1 Participants characteristics

In total, 45 current and 29 former elite kickboxers provided their informed consent and successfully completed their questionnaire. The active elite kickboxers, 83% male in where 55% was competing in the A-class and had a mean age of 28 years (SD = 5.4), and an average career duration of 13.4 years (SD = 10.5). Among the former elite kickboxers, 77% male where 51% had competed in the A-class with a mean age of 40 years (SD = 9.3). They had a mean retirement duration of 8.0 years (SD = 7.0) and had a mean active career duration of 11.5 years (SD = 6.3). All demographic and sport characteristics of the participants are presented in Table 1.

3.2 Prevalence

3.2.1 Current elite kickboxers

The prevalence of mental health symptoms among current elite kickboxers ranged from 57% for psychological distress to 63% for disordered eating. Furthermore, 10% reported symptoms of anxiety, 9% of depression and 19% experienced sleep disturbance. As for

Table 1 Participants characters

Variables	Current male (*n* = 37)	Current female (*n* = 8)	Former male (*n* = 22)	Former female (*n* = 7)
Age (years), mean (SD)	28 (5.4)	27.8 (6.0)	40 (9.3)	35.3 (7.6)
Height (cm), mean (SD)	176.5 (28.5)	167.7(7.7)	178.7 (7.0)	169.5 (6.1)
Body weight (kg), mean (SD)	77.2 (12.3)	62.6 (8.4)	83.4 (12.30	65.3 (5.7)
Duration of kickboxing career (years), mean (SD)	13.4 (10.5)	10.67 (6.31)	11.5 (6.3)	11.6 (6.3)
Duration of retirement (years), mean (SD)	–	–	8.0 (7.0)	6.8 (6.1)
Retirement type, involuntary/voluntary (%)	–	–	14.3/62.9	2.9/20.0
Kickboxing level, A-class/B-class (%)	54.9/27.5	9.8/7.8	51.4/25.7	11.4/11.4
Highest education level, %				
None	0	0	5.7	0
Primary education	19.6	2	8.6	5.7
Secondary education	25.5	7.8	17.1	2.9
Higher professional education	29.4	3.9	31.4	8.6
Research-oriented education	7.8	3.9	14.3	5.7
Currently employed (%)	76.5	11.8	77.1	20.0
Presence of severe injury, yes/no (%)	28.6/50.0	2.4/19.0	17.1/60.0	5.7/17.1
Number of severe injuries, mean (SD)	3.5 (2.02)	2.2 (1.5)	1.8 (2.1)	2.5 (2.1)
Presence of concussion, yes/no (%) (current elite kickboxers)	4.8/73.8	21.4/0.0		
Number of concussions, mean (SD) (over their whole career)	3.06 (4.9)	0.78 (4.6)	1.1(1.7)	0.8 (0.9)

n: number of participants; %: percentage; SD: standard deviation; cm: centimeters; kg: kilograms

substance misuse, the prevalence was 17% for alcohol misuse and 7% for drug misuse. All prevalence rates on mental health symptoms among current elite kickboxers are presented in Table 2.

3.3 Former elite kickboxers

The prevalence of mental health symptoms among former elite kickboxers ranged from 36% for psychological distress to 27% for disordered eating. Additionally, 6% reported symptoms of anxiety, 3% for depression, and 37% experienced sleep disturbance. As for substance misuse, the prevalence rates reached 43% for alcohol misuse and 13% for drug misuse. All prevalence rates on mental health symptoms among former elite kickboxers are presented in Table 2.

3.4 Associations

3.4.1 Current elite kickboxers

We observed no statistically significant associations between mental health symptoms and severe musculoskeletal injuries and/or concussions among current elite kickboxers.

The number of career concussions among elite kickboxers showed positive non-significant associations with anxiety (OR = 1.3, 95% CI: 1.0–1.6) ,depression (OR = 1.3, 95% CI: 1.0–1.8), and sleep disturbance (OR = 1.3, 95% CI: 1.0–1.8). Similar but non-significant associations were observed for psychological distress (OR = 1.3, 95% CI: 0.9–1.7) and disordered eating (OR = 1.2, 95% CI: 0.9–1.5). In contrast, a weak inverse trend was noted for alcohol misuse (OR = 0.5, 95% CI: 0.2–1.1), while no association was found with drug misuse (OR = 0.9, 95% CI: 0.7–1.1).

Similarly, severe injury history was not significantly associated with any mental health symptoms, though small, non-significant increases in odds were observed for anxiety (OR = 1.6, 95% CI: 0.9–2.8) and depression (OR = 1.6, 95% CI: 0.7–3.7). Several models failed to converge, likely due to low case numbers or/and low prevalence raters of mental health symptoms. All details on the associations between mental health symptoms and severe musculoskeletal injuries and/or concussions are presented in Table 3.

Among former elite kickboxers, the number of career concussions showed a non-significant association with anxiety (OR = 1.6, 95% CI: 0.9–2.7), depression (OR = 1.6, 95% CI: 0.7–3.6), and sleep disturbance (OR = 1.9, 95% CI: 1.0–3.7). No significant associations were observed for distress (OR = 0.6, 95% CI: 0.3–1.4), alcohol misuse (OR = 0.9, 95% CI: 0.4–1.9), or disordered eating (OR = 0.9, 95% CI: 0.4–1.9).

Similarly, the total number of severe injuries over the career period showed no significant association with any mental health symptoms. Non-significant associations were

Table 2 Prevalence of mental health symptoms among current and former elite kickboxers

	Current elite kickboxers *N* = 45			Former elite kickboxers *N* = 29		
	N	**Prevalence (%)**	**(95% CI)**	***N***	**Prevalence (%)**	**(95% CI)**
Psychological distress	29	57.0	(0.42–0.72)	9	25.7	(0.083–0.42)
Anxiety	5	10.2	(0.012–0.19)	2	6.1	(0.51–0.69)
Depression	4	8.7	(0.0029-0.17)	1	3.1	(-0.035-0.095)
Sleep disturbance	8	18.6	(0.068-0.3)	11	36.7	(0.17–0.55)
Alcohol misuse	8	16.7	(0.054–0.28)	15	42.9	(0.23–0.61)
Drug misuse	3	7.0	(–0.0074-0.15)	4	12.9	(–0.0093-0.25)
Disordered eating	27	62.8	(0.48–0.77)	8	26.7	(0.093–0.43)

N: number of participants, CI: confidence interval.

Table 3 Association (odds ratio and 95% CI) between potential contributing factors (concussions and severe injuries) and mental health symptoms among current elite kickboxers and former elite kickboxers

Current elite kickboxers							
	Distress	**Anxiety**	**Depression**	**Sleep disturbance**	**Alcohol misuse**	**Drug misuse**	**Disordered eating**
Concussions (n)	*	*	*	*	*	*	*
Presence of concussion at time of survey completion	1.3 (0.9–1.7)	1.3 (1.0-1.6)	1.3 (1.0-1.8)	1.3 (1.0-1.8)	0.5 (0.2–1.1)	1.2 (0.9–1.5)	0.9(0.7–1.1)
N concussions over whole career							
Severe injuries (n)	1.8 (0.5–7.3)	*	*	0.7 (0.1-4.0)	0.7 (0.1–3.9)	1.1 (0.1–13.7)	2.7 (0.6–11.9)
Presence of severe injury at time of survey completion	1.2 (0.8–1.8)	0.9 (0.5–1.8)	0.9 (0.5–1.8)	1.1 (0.7–1.9)	1.3 (0.8–2.1)	*	1.2 (0.8–1.8)
N severe injuries over whole career							
Former elite kickboxers							
Concussions (n)	0.8 (0.1–4.2)	*	*	1.1 (0.2–5.1)	2.0 (0.5–8.8)	0.3 (0.1–3.4)	0.3 (0.1–3.4)
Presence of concussions during career	0.6 (0.3–1.4)	0.9 (0.3–2.5)	1.6 (0.7–3.6)	1.6 (0.9–2.7)	1.9 (1.0–3.7)	0.9 (0.4–1.9)	0.9 (0.4–1.9)
N concussions over whole career							
Severe injuries (n)	0.9 (0.2–5.9)	3.4 (0.2–62.1)	*	4.4 (0.8–24.6)	1.5 (0.3–7.1)	1.5 (0.9–2.4)	0.8 (0.1–5.7)
Presence of severe injury at time of survey completion	1.1 (0.7–1.5)	1.6 (0.9–2.8)	1.6 (0.7–3.7)	1.2 (0.8–1.7)	1.2 (0.8–1.6)	0.9 (0.9–10.7)	1.2 (0.8–1.8)
N severe injuries over whole career							

*Logistic regression could not converge; N/(n): number of former elite kickboxers

observed in higher odds of anxiety (OR = 1.6, 95% CI: 0.9–2.8) and depression (OR = 1.6, 95% CI: 0.7–3.7). Other mental health symptoms, including sleep disturbance, alcohol misuse, and disordered eating, showed odds ratios close to one. Several models failed to converge, likely due to the limited numbers of prevalence and low number of cases. Overall, No statistically significant associations were found between mental health symptoms and severe musculoskeletal injuries and/or concussions in former elite kickboxers (Table 3).

4 Discussion

The objective(s) of our study was to explore the prevalence of mental health symptoms in current and former elite kickboxers and to establish whether these mental health symptoms were associated with severe musculoskeletal injuries and/or concussions. The most prevalent mental health symptoms among current elite kickboxers ($N = 45$) were psychological distress (57%) and disordered eating (63%). Among former elite kickboxers ($N = 29$), the most prevalent mental health symptoms were 36% for psychological distress and 43% for alcohol misuse. Additionally, no statistically significant associations were found between mental health symptoms and severe musculoskeletal injuries and/or concussions among current and former elite kickboxers.

4.1 Perspective of our findings

To our knowledge this is the first research project to explore mental health symptoms among both current and former elite kickboxers. Therefore, it was not possible to make comparisons within this particular population. A meta-analysis involving current elite athletes from other various sports such as cricket, football, handball, ice hockey, rugby, boxing, judo, gymnastics, rowing, and swimming reported prevalence rates of mental health symptoms reaching 20% for distress, 34% for anxiety/depression, and 19% for alcohol misuse [7]. Our study shows higher prevalence rates for distress (57%), but lower rates for anxiety/depression (10% / 9%) and alcohol misuse (17%). These comparisons need to be interpreted with caution as the population characteristics (e.g., different sport types), study characteristics (e.g., difference in screening questionnaires) and representativeness may differ across these studies. In comparison with studies that used the same questionnaire, current elite kickboxers reported a prevalence rate of 57% for distress which is higher than the prevalence among Canadian elite athletes (40%) and US team athletes (14%) regarding symptoms of distress [32, 33]. Our results regarding disordered eating among current elite kickboxers showed higher prevalence rate in comparison with the US team athletes (63% vs. 10%) [32]. In comparison with a study among combat sport athletes, we found a higher prevalence of alcohol misuse (17% vs. 0%) among current elite kickboxers [34]. The prevalence of 63% found for disordered eating among current elite kickboxers in our study is comparable to the prevalence found in another study among Muay Thai/ kickboxing athletes [35].

Our findings among former elite kickboxers show higher prevalence rates for distress (26% vs. 16%), sleep disturbance (37% vs. 21%), and alcohol misuse (43% vs. 21%), lower rates for anxiety/depression (6%/3% vs. 26%) and similar rates for disordered eating (27%) compared to previous literature among former elite athletes from various sport types [7]. Notably, a previous study indicated that the risk of alcohol-related diseases or deaths is higher in former combat athletes than other sports [36].

4.2 Potential contributing factors and mental health symptoms

By contrast to previous studies among elite athletes, severe musculoskeletal injuries were not associated with mental health symptoms among current and former elite kickboxers [37–39]. While a limited sample size may be a potential explanation, it is also important to consider that athletes often overlook or minimize signs of mental health symptoms, as such symptoms are frequently perceived as indicators of weakness [40]. This perception can influence not only the manifestation and recognition of symptoms, but also the reporting of mental health symptoms [40]. Furthermore, many combat sport athletes often come from challenging socioeconomic backgrounds and may lack adequate financial, medical and social support. Therefore, further research is necessary, as elite kickboxers may have different potential contributing factors that could lead to the development of mental health symptoms, and may require a tailored approach to support and monitor their mental health. There is a growing concern regarding possible long-term health effects such as mental health problems in former athletes. Two systematic reviews reported an association between exposure to sport-related concussions and increased risk of symptoms of common mental disorders in former elite athletes [41, 42]. In our study, we did not find an association between sport-related concussions and mental health symptoms in (former) elite kickboxers, which is in line with the most

recent publications regarding the potential long-term effects in former elite athletes [30, 43]. Notably, it is important to consider the lack of concussion knowledge and behaviour among combat sports athletes and their coaches, who are often forced to manage concussions due to absence of healthcare professionals during training [44]. This may have impacted the amount of concussion reporting, as the athletes may have failed to recognize concussions [44]. Additionally, mental health symptoms (e.g., anxiety, mood dysregulation, sleep disturbances) may represent manifestations of an undiagnosed concussion, even in the absence of neurological signs [45, 46] This underscores the importance of providing education to kickboxers, coaches and healthcare professionals to recognize these symptoms. The underreporting of concussions in combat sports may also be due to the prevailing culture of toughness, in which concussions are minimized and/or concealed and seeking medical attention is not commonly practiced [30, 44].

4.3 Methodological considerations

Several limitations and strengths of this study should be mentioned. Firstly, the limited sample size, due to the exploratory nature of this preliminary study designed to obtain preliminary data and clarify the resources required to conduct a larger study among elite kickboxers, could potentially affect the generalizability of our results. Furthermore, the true potential sample size and response rate could not be estimated given the recruitment methods. Therefore, caution is warranted when interpreting our findings for (former) elite kickboxers. Notably, mental health symptoms in our study were self-reported and mental health disorders diagnosed by a mental health professional were not included. This may introduce subjectivity, and as with any questionnaire, the reliability and validity of the questionnaires used in our study could be questioned, as suggested in recent literature [32]. This could have potentially led to either an overestimation or underestimation of our results. For instance, some questionnaires used in this study were validated only within the non-athlete population and not specifically among Dutch athletes. Additionally, due to self-reported assessment, recall bias may also have affected our findings. Moreover, our study did not include a reference group consisting of a non-athlete population. Hereby, we were unable to observe potential differences between (former) elite kickboxers and the general population. Furthermore, due to the cross-sectional design of our study, assessing a causal relationship between the prevalence of mental health symptoms and potential contributing factors was not possible. While interpreting our results, it is important to consider that, given the nature of our study, which includes a difficult-to-reach population, we chose to implement a short and efficient questionnaire that did not include other factors that may impact mental health, such as existing pathologies or illnesses, job type, suffering a recent loss, use of medication or caregiving responsibilities. Our study utilized anonymous recruitment, and a non-response analysis could not be conducted. This could potentially introduce selection bias, as it is possible that (former) elite kickboxers with a particular interest in mental health symptoms were more motivated to participate in our study. Also, the prevailing taboo regarding mental health in elite-sports could have resulted in an underestimation of the problem's extent [47].

One of the strengths of our preliminary study is the uniqueness of our topic. The present study is the first to address a gap in literature by exploring mental health symptoms among current and former elite kickboxers. This is a population that is not included in

research about symptoms of mental health disorders among current and former elite athletes [7]. The results of this study provide a foundation for future research in a larger sample and contributes to raising awareness about mental health symptoms in elite kickboxing.

4.4 Practical implications

The substantial prevalence of mental health symptoms among current and former elite kickboxers emphasizes the need for increased attention and awareness in this area. Although statistically significant associations between potential contributing factors and mental health symptoms were not found in our study, addressing and monitoring the occurrence of potential triggering factors and mental health symptoms among elite kickboxers is necessary. This implies embedding sports medicine physicians and/or mental health professionals within the interdisciplinary medical teams of elite kickboxers. Furthermore, as other former elite athletes, former elite kickboxers should receive post-career support and guidance as they transition out of their elite kickboxing careers [48–50]. This approach can contribute in promoting healthy behaviours among former elite kickboxers [48–50].

The IOC SMHAT-1 should be used by sports medicine physicians and other licensed/registered health professionals during the pre-competition phase (preferably a few weeks after the start of training) and in response to significant events for kickboxers (such as, major injury/illness, adverse life events, transition out of sports etc.) [16]. This approach aims to support kickboxers at risk for developing mental health symptoms and/or mental health disorders [16]. Hereby, subsequent treatment (if necessary) can be provided, which can improve quality of life and performance among elite kickboxers. Considering the relatively high prevalence rate of symptoms of disordered eating among elite kickboxers, it is important to educate athletes, trainers, coaches, physicians, and other stakeholders in kickboxing about potential risk factors and consequences of disordered eating behaviours [51, 52]. This knowledge is essential for promoting healthy eating habits and preventive measures within the kickboxing community [53]. Education regarding mental health symptoms among elite kickboxers can enhance mental health literacy and reduce the stigma surrounding mental health symptoms in elite sports, which ultimately can serve as facilitator for seeking help [54]. In addition, the management of concussions among kickboxers warrants particular attention. In combat sports, underreporting remains common which may be partly due to the cultural normalization of 'toughness' in which symptoms are overlooked or even concealed. While educational interventions are valuable, they are unlikely to be sufficient on their own to change reporting behavior. Effective concussion management therefore requires a strategy that combines athlete and coach education with the implementation of clear medical protocols and systematic monitoring [30].

Enhancing knowledge and awareness about identifying symptoms of concussions among elite kickboxers and their coaches may improve concussion reporting and reduce the risk of subsequent injuries by referring athletes to medical evaluation on time [44]. Developing and implementing effective anti-stigma intervention programs is crucial to address the ongoing stigma surrounding mental health [55–57]. Stigma associated with mental health challenges, which may portray them as weaknesses, can potentially hinder elite kickboxers from seeking necessary support and/or treatment [55–57]. The

development of preventive and supportive measures should be prioritized to assist elite kickboxers with personal and career development, both inside and outside the ring. This approach will contribute to creating a destigmatizing environment for elite kickboxers, where mental health support and guidance become necessities and forms of self-care in kickboxing.

5 Recommendations for future research

This preliminary study should be repeated in a larger sample and could include other types of combat sports (e.g., Mixed Martial Arts, Boxing and Taekwondo). Additionally, a longitudinal design should be considered to gain a prospective insight on the occurrence of mental health symptoms among elite kickboxers during an entire fight season. Future research should also focus on exploring how different factors (e.g., adverse life events) in kickboxing can relate to the development of mental health symptoms and/or mental health disorders. Furthermore, future research should also screen for other elite-level sport participation, which could help the assessment of potential confounding factors and improve the accuracy of interpreting the impact of elite kickboxing on mental health. These insights could contribute to more tailored recommendations and interventions to support athlete well-being. Importantly, future studies should also consider the co-occurrence of mental health symptoms. For instance, disordered eating, sleep disturbances, and alcohol misuse frequently co-occur with other mental health problems such as mood disorders, anxiety or trauma-related conditions [6, 58].

6 Conclusion

The substantial prevalence rates of mental health symptoms among current and former elite kickboxers emphasize the need for increased attention in this area. No associations were found between the potential contributing factors and mental health symptoms among current and former elite kickboxers. While further research is needed, raising awareness as well as developing preventive and supportive measures to assist elite kickboxers with personal and career development should be prioritized, both inside and outside the ring.

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Author contributions
SB, GK and VG were involved in the design of the study. SB initiated the study and was responsible for data collection. All authors were involved in the data analysis and data interpretation. SB drafted the initial version of the manuscript, with critical review provided by all authors. All authors reviewed and approved the final version of the manuscript for submission.

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Data availability
The data analyzed in this study are available on request from the corresponding author.

Delarations

Ethics approval and consent to participate
Ethical approval was provided by the Medical Ethics Review Committee of the Amsterdam University Medical Centers location University of Amsterdam (W21_526#21.582 and date of approval: 10 December 2021; Amsterdam, The Netherlands). The study was conducted and reported according to the cross-sectional guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. Participants eligible for this study were provided with sufficient information regarding the purpose, significance, and procedures of the study and were given

the option to consent or decline participation prior to data collection. Electronic informed consent was obtained from those who agreed to participate, after which they were granted access to the questionnaire.

Consent to publish
Authors and participants gave their consent to publish the manuscript.

Competing interests
The authors declare no competing interests.

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