



Youth Participation and Injury Risk in Martial Arts

Rebecca A. Demorest, MD, FAAP, Chris Koutures, MD, FAAP, COUNCIL ON SPORTS MEDICINE AND FITNESS

The martial arts can provide children and adolescents with vigorous levels of physical exercise that can improve overall physical fitness. The various types of martial arts encompass noncontact basic forms and techniques that may have a lower relative risk of injury. Contact-based sparring with competitive training and bouts have a higher risk of injury. This clinical report describes important techniques and movement patterns in several types of martial arts and reviews frequently reported injuries encountered in each discipline, with focused discussions of higher risk activities. Some of these higher risk activities include blows to the head and choking or submission movements that may cause concussions or significant head injuries. The roles of rule changes, documented benefits of protective equipment, and changes in training recommendations in attempts to reduce injury are critically assessed. This information is intended to help pediatric health care providers counsel patients and families in encouraging safe participation in martial arts.

abstract

FREE

This document is copyrighted and is property of the American Academy of Pediatrics and its Board of Directors. All authors have filed conflict of interest statements with the American Academy of Pediatrics. Any conflicts have been resolved through a process approved by the Board of Directors. The American Academy of Pediatrics has neither solicited nor accepted any commercial involvement in the development of the content of this publication.

Clinical reports from the American Academy of Pediatrics benefit from expertise and resources of liaisons and internal (AAP) and external reviewers. However, clinical reports from the American Academy of Pediatrics may not reflect the views of the liaisons or the organizations or government agencies that they represent.

The guidance in this report does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

All clinical reports from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

DOI: 10.1542/peds.2016-3022

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2016 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: Dr Koutures is a consultant to Neural Analytics for their clinical trials. Dr Koutures also receives royalties from SLACK Publications. Dr Demorest indicated she has no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

To cite: Demorest RA, Koutures C, AAP THE COUNCIL ON SPORTS MEDICINE AND FITNESS. Youth Participation and Injury Risk in Martial Arts. *Pediatrics*. 2016;138(6):e20163022

INTRODUCTION

The term martial arts is derived from the “arts of Mars” (Roman god of war)¹ and presently encompasses formal combat traditions that can be practiced for self-defense, competition, physical fitness, motor development, and emotional growth. More than 6.5 million children participate in some form of martial arts in the United States.² Martial arts can be effective tools for building muscle strength and balance and enhancing flexibility in children and adolescents,^{3,4} as well as positive interventions and activities in which to help build cognitive function, self-esteem, self-respect, and self-awareness.⁵⁻⁷

Various types of martial art disciplines can be categorized as striking (using blocks, kicks, punches, knees, and elbows to defend oneself while on one’s feet⁸), grappling (taking an opponent to the ground to achieve a dominant position or use a submission hold to end a fight), weapon-based, or low-impact/meditative style with overriding philosophies that are oriented toward combat, health, or spirituality. Mixed martial arts

(MMA) involves the combination of different types of martial arts in a competitive venue.

The practice of a particular martial art or MMA involves both training and possibly competitive activities. All martial artists execute forms, which are individualized repetitive practice of movements, striking/blocking techniques, and potential use of weapons without any contact with objects or other performers. Not all martial arts practitioners progress to combat practice or competition.

For those martial arts disciplines that involve combat elements, a common training practice involves sparring. Sparring is defined as actual combat or fighting between 2 individuals that uses particular techniques of blocking, kicking, striking, and takedowns (throws from the standing position⁸), as taught by each style of martial arts and overseen by instructors. Sparring may begin at any age, as directed by the martial arts instructor, and often after learning basic movements/forms. Martial arts students are often categorized according to age and belt color, with advanced belt designations earned after proper execution of forms often combined with sparring.

Some martial arts styles require participants to use soft gear intended for head and body protection. Martial arts competitions are formal and ritualized time-measured events with referees often awarding points and supervising conduct of the performers.

EPIDEMIOLOGY OF PEDIATRIC AND ADOLESCENT MARTIAL ARTS INJURIES

Pediatric and adolescent martial arts injuries and injury risk are very difficult to quantify, stratify, and extrapolate because of:

- lack of pediatric and adolescent study populations;

- variations in injury definitions (eg, cessation of match, observed injury, reported injury, time loss injury);
- differences in study methods (competition injuries [more commonly studied] versus training injuries [less commonly studied]);
- accounting mostly for acute but not chronic injury;
- lack of consistency across studies in use of protective equipment; and
- lack of detailed, accurate, complete, or any reporting (recall bias, retrospective self-reporting, postmatch video recall).^{9,10}

Most studies to date of martial arts comprise data largely from the adult population; however, when pediatric data were available, they were evaluated and are noted in this report.

In a cumulative epidemiologic study of pediatric martial arts, overall reported injury rates varied from 41 to 133 injuries per 1000 athletic exposures.¹¹ In a 2006 study, an estimated 128 400 children aged ≤ 17 years (mean age, 12.1 years; 73% male) were treated in US emergency departments for martial arts-related injuries from 1990 to 2003, with most injuries attributable to karate (79.5%).² Generally, martial arts injuries are not life-threatening (abrasions, contusion, sprains, and strains); however, fractures, neck injuries, dental injuries, and concussions do occur.^{2,11} Overall fracture rates of 10% and higher of all documented martial arts injuries have been described in multiple articles.^{2,11-13} Most reported pediatric martial arts injuries are acute.¹¹ Free sparring during tournaments seems to cause many overall injuries in martial arts.¹⁴ The nature of the martial art (kicking, sparring, grappling, and takedowns) dictates the injury risk and rate. Very few catastrophic injuries are reported.¹¹

Risk stratification in studies of martial arts does not show consistent results. Results are inconsistent as to whether age (younger versus older) and level (beginner versus professional/advanced) place an individual at increased or decreased risk for injury.^{11,14-20} A 2005 study spanning 5 martial arts disciplines (Shotokan karate, Aikido, taekwondo, kung fu, and tai chi) found that people 18 years or older were 4 times more likely to sustain an injury compared with those younger than 18 years and that competitors with at least 3 years of experience were 2 times more likely to sustain injury compared with less experienced competitors.¹⁴ Participants younger than 18 years doubled their risk of injury with every 2 additional hours of training per week after the first 3 hours, and those training for more than 3 hours per week had an overall increased injury risk.^{14,15} One study of children and adults participating in martial arts found that those younger than 10 years had an overall lower injury rate per 1000 athletic exposures compared with all other age groups; however, when adjusting for exposure time, the 10- to 14-year-old age group had a higher injury risk per minute exposed compared with the open division.¹⁸ To what degree skill and age may help or harm athletes continues to be researched.

Sex stratification in studies also yields inconsistent results.^{2,10,11,14,15,17,21} Without significant participation of female subjects in many of these studies, more research is needed.

Injuries specific to different martial art forms are detailed in the following sections. Not all disciplines are covered, because not all disciplines have been studied in detail, especially with children and adolescents. Of note, despite kicks to the head and takedowns naturally increasing the risk of head injury, concussion rates are not well accounted for in most martial arts studies. Using

mostly tournament medical reports (no postinjury data or follow-up) and retrospective information, current studies may not accurately capture concussion injury rates. Many studies do not count technical knockouts (TKOs) as concussive head injuries. More research with better epidemiologic data and methods is necessary in this field.

KARATE

Definition

Karate is a stand-up and striking martial art that started in Okinawa, Japan. The basic goal is self-defense by using punches, kicks, knees, elbows, and open hands to block an opponent's strikes and then to disable the opponent with quick strikes.⁸ When takedowns are executed, they tend to be used to set up finishing strikes. Weapons are used in most styles of karate.

Injury Risk

Because much karate practiced in the United States is noncontact in nature, injury rates are lower and usually less severe than in other martial art forms. In a study of karate participants younger than 18 years, a reported injury risk over a 12-month time period of 5.6 per 100 athletes was identified.¹⁵ One study reported a 30% rate of injury during 1 year of regular noncontact karate training. Karate focusing on technique just short of contact has been shown to have a lower injury risk compared with the contact kicks of taekwondo.¹⁴

The most common injuries sustained in karate include sprains/strains, contusions/abrasions, and fractures.^{1,11,12,15} Karate injuries occur from being kicked (contusions), from falling (fractures), and from kicking (sprains).^{2,15} Karate injuries commonly occur to the lower extremities from being kicked. Kicking injuries in less experienced individuals may occur

when landing on bony prominences as a result of punches and kicks that miss their target.² Free-style sparring (more common in younger athletes) accounts for fewer injuries than prearranged sparring.¹⁵ The head and face sustain injury resulting from kicking and punching, including epistaxis.¹¹ Simultaneous executed punches are associated with karate injuries.

Other reported karate injuries to adolescents and adults include a blinding choroidal rupture,²² a unilateral adrenal gland hematoma,²³ a femoral osteochondral fracture,²⁴ and a traumatic pseudoaneurysm of the femoral artery.²⁵

TAEKWONDO

Definition

Taekwondo is a martial art and combat sport originating in Korea. The name taekwondo loosely translates into "the way of the hand and fist" and involves 80% kicks and 20% hand techniques.⁸ Training involves a system of blocks, punches, and open-hand strikes and may include various takedowns or sweeps, throws, and joint locks, although it does not emphasize grappling. Sparring allows kicks to the head and requires use of soft head and body gear.

Injury Risk

Taekwondo uses contact aspects of punching and kicking, which is reflected in injury rates. Because of the various study methods, ages of study participants, and methods of reporting, as highlighted previously, reported injury rates for all ages range from 0.4 to 139.5 injuries per 1000 athletic exposures, including light- and full-contact tournaments.^{2,11,16} spotlighting some of the variability, validation issues, and potential unreliability of various martial arts research. In 1 study, 32% of taekwondo injuries (pediatric and adult) resulted in more than 1

week of time lost from training.¹⁸ Another study showed a threefold increased risk of injury and a higher risk of multiple injuries in taekwondo compared with karate.¹³ Of 5 martial arts disciplines (Shotokan karate, Aikido, taekwondo, kung fu, and tai chi), taekwondo had the highest number of injuries requiring time off from training (59%).¹⁴

Taekwondo has a high relative incidence of lower extremity injury compared with upper extremity injury because 80% of its competitive moves involve powerful, fast kicks.¹³ Mechanisms for injury include being kicked, falling, and kicking.² Kicks to the head and face are legal and serve as point-scoring techniques in full-contact taekwondo.^{10,18} Some protective equipment is used but not always hand or foot padding. Being kicked, specifically by roundhouse kicks, may cause the largest number of injuries.^{2,11,18}

Common injuries sustained in taekwondo include sprains/strains, fractures, and contusions/abrasions.^{2,11,18,26} Lower extremity injuries, especially of the foot, occur frequently.^{2,11-13,18,27} Taekwondo participants had higher rates of bruising and soft tissue injury compared with karate athletes in 1 study.¹³ Head injuries are commonly seen.^{11,26} One adult study found that 82% of training injuries sustained in the preceding 12 months were mostly soft tissue injuries to the lower leg or foot; however, 1 in 20 injuries were to the head,¹⁰ whereas another adult study supported the idea that more than 50% of adult injuries sustained in tournaments occurred to the head and neck area.²⁶ Although less frequent in overall number, upper extremity injuries in taekwondo may be more severe compared with lower extremity injuries.²⁷

The incidence of concussion in adult taekwondo ranges from 4.6 to 50.2 per 1000 athletic exposures, potentially up to 4 times higher than

that in American football.^{27,28} One study of adult Olympic taekwondo kicks, measured by a simulated head target, reported that the most common kick impacts used in taekwondo had acceleration and recorded impacts equivalent to or greater than documented concussive injuries in American football.²⁸ Taekwondo rule changes have awarded more points for kicks aimed at the head, which may increase the risk of concussion.²⁷ Ineffective blocking skills may be related to risk of severe head injuries.

Other reported taekwondo injuries include bilateral radial head fractures.²⁹ Catastrophic taekwondo injuries have been reported, including deaths from kicks, cardiac issues, and unknown causes.²⁷

JUDO

Definition

Judo originated in Japan with an emphasis on throwing or taking opponents down by using their energy against them.⁸ Although striking is allowed in form work, it is not allowed in sparring. Judo starts with a standing phase and then moves after a throw or takedown to the ground phase, in which opponents are immobilized and submission holds may be used.

Injury Risk

Judo uses takedowns, throws, and flips, which use more of the upper extremities than other martial arts, such as karate and taekwondo. Strains/sprains, contusions, and fractures are the most common injury.^{2,11,16} Upper extremity injuries to the shoulder, hand, wrist, and fingers are common.^{2,11} Upper extremity injuries are more common in judo versus the lower extremity injuries seen more commonly in taekwondo and karate.² Hyperextension injury to joints may occur.¹¹ Youth judo athletes

sustained a higher proportion of shoulder/upper-arm injuries^{2,13} and neck injuries compared with karate or taekwondo athletes.² Pediatric concussions were more prevalent in judo than karate.² Judo choking techniques can cause loss of consciousness.³⁰

In judo, athletes are more likely to be injured while being thrown or flipped versus karate and taekwondo, in which most injuries are sustained by being kicked.^{2,16} Improperly executed throws can injure both the attacker (if he or she drops the competitor onto himself or herself) or the defender (if he or she lands incorrectly).² Falling is a common pediatric mechanism for injury leading to fractures. Joint-locking techniques, in which joints are locked in full extension and thus are less able to absorb stress during falls (raising the risk of dislocations, subluxation, and fractures), can cause injury.³⁰ Other reported injuries sustained in judo include vertebral artery dissection,³¹ embolic stroke,³² and Paget-Schroetter syndrome (effort thrombosis of upper extremity).³³

MUAY THAI KICKBOXING

Definition

Muay Thai kickboxing originated in Thailand and is a close combat style of martial arts that uses kicking, punching (with boxing gloves), sparring, and kick blocks.² Knee blows to the head or to the genital area are allowed in regular Muay Thai kickboxing, but modified competitive bouts prohibit any knee blows to the head.

Injury Risk

Muay Thai kickboxing, performed with different levels of protective equipment depending on the level, allows punches and kicks with knees and elbows specific for this discipline.²⁰ Limited studies exist of this discipline. Injury rates tend

to be higher in beginners compared with professionals (13.5 vs 2.79 injuries per 1000 participants).¹⁹ However, another study reported higher injury rates in heavier weight classes (except super heavyweight).²⁰ Commonly reported adult injuries include soft tissue trauma, fractures (higher in more experienced athletes), and sprains and strains (higher in less experienced athletes).¹⁹ Epistaxis (a nonprotected area) was the most frequent injury in 17- to 26-year-old competitors in 1 study.²⁰ Vertebral artery dissection was reported in 1 kickboxer.³⁴

MIXED MARTIAL ARTS

Definition

MMA incorporates a variety of martial arts styles, from stand-up fighting, ground fighting, and throwing or takedowns, in which an opponent is forced from an upright or standing position into a grounded or more vulnerable position. Competitive bouts involve 3 to 5 rounds of fighting, each lasting 3 to 5 minutes. Contestants usually wear small gloves with exposed fingers and are barefoot. The goal of an MMA contestant is to defeat an opponent by:

- submission hold (joint lock or chokehold designed to make an opponent give up or risk injury/become unconscious);
- frank submission, in which an opponent gives up either by tapping out (tapping hand or other body part on ground to signal intent not to continue) or verbal indication (opponent unable to continue or declares stoppage of match);
- knockout or TKO (referee stops match, judging that an opponent is unable to logically or safely defend himself or herself^{35,36}); or

- judge's decision at the end of the match.³⁶

Injury Risk

With no reported pediatric injury studies in the literature regarding MMA, all documented injury information is from professional adult matches. Overall risk of injury has been reported as 85.1 to 228.7 per 1000 athletic exposures,³⁷⁻³⁹ much higher than that reported in other contact sports, such as collegiate football (8.1 per 1000 athletic exposures).⁴⁰ In a 5-year review of sanctioned adult MMA fights, the injury risk over the reported 5 years was 23.6 per 100 fight participants.³⁸

Lacerations, abrasions, and altered mental state are reported as the most common injuries,²¹ but another study reported lacerations and upper-limb injuries (likely resulting from striking) as the most common injuries.³⁸ One study reported injuries, in decreasing frequency, as head injuries, lacerations, fractures, and concussion.³⁷

Because of the nature of MMA, head and neck injury is a concern. Many athletes who experience TKOs receive subsequent injuries from striking the floor with their head.³⁶ Definitions of what constitutes a concussion vary, and studies often miss trackable injuries, making extrapolation difficult.³⁶

A recent study found that head injuries accounted for 67% to 78% of total injuries in MMA.³⁷ In 1 study, the severe concussion rate was reported as 15.4 per 1000 athletic exposures (3% of all matches); however, only official ringside injuries documented by the ringside physician were reported, with no follow-up evaluations provided.³⁸ In this study, 33.7% of matches ended by TKO, despite the small number of concussions reported. Blunt force to the head resulted in the highest number of match stoppages,

suggesting a concussion rate of 48.3 per 1000 athletic exposures in 1 study.³⁶ Video analysis reported that the rate of match-ending head trauma was 15.9 per 100 athletic exposures (31.9% of matches).⁴¹ All knockouts were attributable to direct head trauma, with 53.9% being strikes to the mandibular region. In the 30 seconds before match stoppage, losers sustained an average of 18.5 strikes, with 92.3% of them to the head. Cervical injury biomechanics from 4 common MMA takedown moves revealed biomechanics similar to being involved in a rear-end motor vehicle impact causing cervical spine injury.⁴²

Age, weight, and fight experience did not statistically increase the injury risk in 1 study,³⁸ but the rate of injury was 2 times higher in amateurs than professional fighters in another study.²¹ A losing fighter was 2.53 times more likely to be injured than a winning fighter.³⁸

Omothyoid muscle syndrome (insidious lateral neck protrusion)⁴³ and vertebral artery dissection⁴⁴ have been reported in athletes participating in MMA.

OTHER MARTIAL ARTS FORMS

Kung Fu

Developed in China, kung fu is primarily a striking form of martial arts that uses low stances and powerful blocks⁸ with both open and closed fists to defend against attackers. Some styles may allow throws and joint locks. Kung fu has both "hard" (meeting force with force) and "soft" (using an aggressor's strength against him or her) techniques. Kung fu is widely known for its beautiful and flowing forms.

Brazilian Jiu-Jitsu

Brazilian jiu-jitsu is a martial art based on a unique form of ground fighting in which participants are

taught to fight from the supine position. Jiu-jitsu fighters look to take their opponents to the ground and then attempt to place submission holds, often using arm bars, throws, joint locks, and takedowns.⁸

Pankration

Pankration has origins in the ancient Olympic Games, and modern versions emphasize grappling as well as limited-contact and full-contact competitions. Class C (or grappling) competition can be performed by all age groups with takedowns, ground control, and submissions allowed, but matches cannot be won by brutality or deliberate intent to cause injury. Class B (or limited-contact) competition also can be performed by all age groups and allows takedowns, ground control, submissions, and body strikes; strikes above the collarbone are not allowed. Participants wear soft gloves, helmets, and mouthguards. Head strikes are allowed in class A (full-contact) competition, which is limited to participants 18 years and older.⁴⁵

INJURY-REDUCTION OR -PREVENTION TECHNIQUES

Headgear and Mouthguards

With many martial arts disciplines having participants deliberately target an opponent's face with strikes and kicks, protective equipment such as mouthguards, eye/face protection, and soft headgear has been used to reduce the risk of head or facial trauma. There is a paucity of studies documenting injury risk reduction in martial arts that use these protective devices.

The use of soft or other protective headgear is intended to prevent or reduce the incidence of head injuries, such as facial/scalp trauma and activity-related concussions. Although the use of padded headgear probably helps to prevent minor abrasions, lacerations, and

contusions,⁴⁶ there is little evidence to support this contention. There is also a lack of data suggesting that the use of padded or other protective headgear can prevent or reduce the consequences of martial arts-related concussions. Sport-related concussions are often the result of acceleration/deceleration and rotational forces placed on the head and neck region.⁴⁷ Although unproven, there is also the potential that protective headgear in other sports may actually confer a higher risk of concussion because of a potentially perceived false sense of security for participants, parents, and instructors.

Mouthguards have been shown to reduce the incidence of dental trauma and other direct oral/facial injuries in other combat sports, such as boxing⁴⁸; however, no solid evidence exists in the martial arts or in any other type of sport or activity that suggests a reduction in concussion incidence or severity with mouthguard use.

At the time of this writing, it cannot be recommended with any level of certainty that use of any type of protective headgear or mouthguard can reduce the risk of concussions during sparring or competitive martial arts participation. In addition, no protective device worn during MMA competitions can mitigate the potentially serious effects of chokeholds leading to near- or full suffocation, which could cause anoxic brain injury, cervical spine damage, or even vertebral artery injury, leading to cerebral vascular accidents. Additional research is needed to determine whether these theoretical concerns are encountered in young MMA participants and, if so, at what rates and levels of severity.

Many martial arts equipment companies manufacture clear plastic face guards or padded metal grilles that integrate into standard sparring headgear and do provide a significant level of eye and face

protection.⁴⁶ Currently, few martial arts participants wear this type of protection, and some may regard the equipment as a nuisance or impairment to their vision or breathing. There are no published studies evaluating the use of eye protection in the martial arts.

Body Padding

Several of the combat-oriented martial arts disciplines use soft padding for arms, chest, abdominal, groin, and leg regions.⁴⁶ The padding worn by taekwondo athletes may offer some protection, but this protection may be of greatest benefit to the athlete executing the kick rather than to the recipient of the technique.¹⁴ Although, in theory, these devices may reduce skin trauma and muscle contusions, there are no data on their efficacy in the practice of martial arts.

Rule Changes

Although some studies have identified predisposing factors for injury that include male sex, exposure to sparring and competition, and less experience, rule changes that limit sparring in the latter group may have the greatest effect on injury reduction.⁴⁹ However, other studies have found lower injury risks among less experienced youths, possibly because of less technical ability, lower body mass and strength, and an inability to generate the same level of force than older, more experienced martial artists.¹⁴ Therefore, the exact role of rule changes limiting sparring remains uncertain.

Appropriate rule creation and enforcement have been shown to reduce injury risk. In 2000, the World Karate Federation adopted new rules regarding prohibited behavior, including excessive force used in dealing blows to permitted areas, to forbidden areas (throat, arms, legs, groin, joints, and instep), and to the face with open-hand techniques as well as dangerous or prohibited

throwing techniques. Implementation of the new rules significantly lowered the relative risk of injury for competitors younger than 18 years (male and female), as well as a significant overall decrease in head injuries; however, an increase in leg injuries was also established.¹⁷

Training Changes

One study involving video analysis of head blows leading to concussion in competitive taekwondo participants found that close proximity between athletes and reception of a single roundhouse kick were common mechanisms of injury.⁵⁰ Another study found that young age and lack of blocking skills were risk factors for concussion in taekwondo.⁵¹ Development of blocking skills, safety education, and rigorous enforcement of the competition rules were among the suggestions made to reduce risk of concussions in competitive taekwondo.^{50,51}

Monitoring the number of martial arts training hours per week may play a role in reducing injuries. One study did not find multiple injuries or injuries requiring time away from activity in martial arts athletes younger than 18 years who trained less than 3 hours per week. Injury risk doubled with each additional 2 hours of training after the first 3 hours, although no major injuries were reported.¹⁴

Concussion Recognition and Safety

Although protective safety equipment may not protect against or prevent concussions, proper recognition, evaluation, management, and return to play of athletes with suspected and documented concussion injuries is important. All head injuries should be evaluated, clearly documented, and managed by a pediatrician or health care provider trained in the evaluation and management of pediatric concussions. Athletes recovering from a concussion should

follow normal return-to-learn and return-to-play guidelines previously established and considered standard for concussion management.^{47,52}

MEDIA INFLUENCE, PERCEPTION, AND RELATION TO YOUTH PARTICIPATION IN MMA

Professional MMA has become a sports culture sensationalized by the media. Primetime, televised showcases promote MMA as spectator events, not unlike some other American sports, with financial incentives for both participants and sponsors. MMA draws attention as entertainment venues for many. Dreams of “making it big,” large paychecks, and future wealth appeal to many parents and children. In emulating what they see in the adult MMA culture, children are at risk for imitating professional MMA moves and techniques seen in mass media (eg, choking out, repetitive head blows to floor), even though these moves may not be sanctioned for their ages. Evidence also shows that exposure to media violence can increase aggressive behavior and desensitization to violence.⁵³ Children may try to perform risky moves learned from mass media exposure in practice or in settings with minimal or no adult supervision. As advocates of young athletes, pediatricians and pediatric health care providers can educate parents, families, coaches, teachers, and community leaders with facts on the increased susceptibility to injury if children are imitating what they see from excessive media exposure of MMA contests.

PRACTICAL CONCLUSIONS ON MARTIAL ARTS PARTICIPATION FOR THE PEDIATRIC PROVIDER

1. As a sport or activity, martial arts can provide children and adolescents with vigorous levels of physical exercise that can lead to better overall physical fitness.

2. Children and adolescents should only participate in martial arts classes or competitions supervised by instructors with appropriate training regarding proper teaching of the particular activity and understanding of a child’s limitations based on age, maturity, stature, and experience. Martial arts competition and contact-based training should be delayed until children and adolescents have demonstrated adequate physical and emotional maturity during noncontact preparation and have demonstrated competency with noncontact forms, movements, and techniques.
3. In discussing selection of various disciplines and subtypes of the martial arts, the pediatric health care provider can help to discriminate between noncontact forms, which have a relatively low risk of injury, and sparring or contact forms, which confer a higher risk of injury.
4. For those martial arts disciplines that involve sparring, rigorous enforcement of rules prohibiting excessive force, dangerous movements, or blows to forbidden areas should be encouraged, with safety education promoted for all instructors, officials, and participants. Instructors and officials are encouraged to have an appropriate understanding of the rules and safety qualifications.
5. Although many martial arts disciplines require the use of soft protective headgear, there is no evidence that such devices reduce the risk of concussion. It is encouraged that participants and families also be counseled against engaging in more aggressive activities under the misconception that wearing headgear ensures increased protection against concussion.
6. Pediatric health care providers should encourage the teaching of improved defensive blocking techniques to reduce the risk of dangerous blows to the head.
7. Pediatric health care providers should support the institution of rule changes that eliminate blows to the head and conversely any points awarded for kicks or blows to the head to reduce the risk of concussions in martial arts.
8. Anticipatory guidance regarding injury risks of particular martial arts disciplines, along with proven and unproven benefits of protective equipment, are encouraged as part of a preparticipation evaluation by the pediatric health care provider.
9. Although some evidence exists that training >3 hours per week may increase injury risk, the relation of hours of training per week to particular martial arts injury risk requires more study.
10. The nature of MMA combat fighting, which includes rapid thrusts of the head to the floor and chokeholds to place an opponent into submission, confers a high risk of concussion, asphyxia, or other head and neck injury. As a result, child or adolescent participation in MMA bouts that involve these techniques should be strongly discouraged. As advocates of young athletes, pediatric health care providers can educate parents, families, coaches, teachers, and community leaders with facts on the increased susceptibility to injury if children are imitating what they see from excessive media exposure of MMA contests.

LEAD AUTHORS

Rebecca A. Demorest, MD, FAAP
Chris Koutures, MD, FAAP

COUNCIL ON SPORTS MEDICINE AND FITNESS EXECUTIVE COMMITTEE, 2015–2016

Cynthia R. LaBella, MD, FAAP, Chairperson
Margaret A. Brooks, MD, FAAP
Alex Diamond, DO, FAAP
William Hennrikus, MD, FAAP
Michele LaBotz, MD, FAAP
Kelsey Logan, MD, FAAP
Keith J. Loud, MDCM, MSc, FAAP
Kody A. Moffatt, MD, FAAP
Blaise Nemeth, MD, FAAP
Brooke Pengel, MD, FAAP
Andrew Peterson, MD, FAAP

PAST EXECUTIVE COMMITTEE MEMBERS

Joel S. Brenner, MD, MPH, FAAP
Amanda K. Weiss Kelly, MD, FAAP

LIAISONS

Andrew J.M. Gregory, MD, FAAP—*American College of Sports Medicine*
Mark E. Halstead, MD, FAAP—*American Medical Society for Sports Medicine*

CONSULTANT

David Bernhardt, MD, FAAP
Neeru A. Jayanthi, MD
Jeff Mjaanes, MD, FAAP

STAFF

Anjie Emanuel, MPH

ABBREVIATIONS

MMA: mixed martial arts
TKO: technical knockout

REFERENCES

1. Clements J. A short introduction to historical European martial arts. *Meibukan Magazine*. January 2006;Spec Ed 1:2–4
2. Yard EE, Knox CL, Smith GA, Comstock RD. Pediatric martial arts injuries presenting to emergency departments, United States 1990–2003. *J Sci Med Sport*. 2007;10(4):219–226
3. Padulo J, Chamari K, Chaabène H, et al. The effects of one-week training camp on motor skills in karate kids. *J Sports Med Phys Fitness*. 2014;54(6):715–724
4. Vando S, Filingeri D, Maurino L, et al. Postural adaptations in preadolescent karate athletes due to a one week karate training camp. *J Hum Kinet*. 2013;38:45–52
5. Alesi M, Bianco A, Padulo J, et al. Motor and cognitive development: the role of karate. *Muscles Ligaments Tendons J*. 2014;4(2):114–120
6. Wall RB. Tai chi and mindfulness-based stress reduction in a Boston public middle school. *J Pediatr Health Care*. 2005;19(4):230–237
7. Conant KD, Morgan AK, Muzykewicz D, Clark DC, Thiele EA. A karate program for improving self-concept and quality of life in childhood epilepsy: results of a pilot study. *Epilepsy Behav*. 2008;12(1):61–65
8. About Sports. Styles of martial arts. Available at: <http://martialarts.about.com/od/styles/a/styles.htm>. Accessed February 27, 2016
9. Birrer RB, Birrer CD. Unreported injuries in the martial arts. *Br J Sports Med*. 1983;17(2):131–133
10. Feehan M, Waller AE. Precompetition injury and subsequent tournament performance in full-contact taekwondo. *Br J Sports Med*. 1995;29(4):258–262
11. Pieter W. Martial arts injuries. *Med Sport Sci*. 2005;48:59–73
12. Birrer RB, Halbrook SP. Martial arts injuries. The results of a five year national survey. *Am J Sports Med*. 1988;16(4):408–410
13. Critchley GR, Mannion S, Meredith C. Injury rates in Shotokan karate. *Br J Sports Med*. 1999;33(3):174–177
14. Zetaruk MN, Violán MA, Zurakowski D, Micheli LJ. Injuries in martial arts: a comparison of five styles. *Br J Sports Med*. 2005;39(1):29–33
15. Zetaruk MN, Zurakowski D, Violan MA, Micheli LJ. Safety recommendations in Shotokan karate. *Clin J Sport Med*. 2000;10(2):117–122
16. Pocecco E, Ruedl G, Stankovic N, et al. Injuries in judo: a systematic literature review including suggestions for prevention. *Br J Sports Med*. 2013;47(18):1139–1143
17. Macan J, Bundalo-Vrbanc D, Romić G. Effects of the new karate rules on the incidence and distribution of injuries. *Br J Sports Med*. 2006;40(4):326–330, discussion 330
18. Lystad RP, Graham PL, Poulos RG. Exposure-adjusted incidence rates and severity of competition injuries in Australian amateur taekwondo athletes: a 2-year prospective study. *Br J Sports Med*. 2013;47(7):441–446
19. Gartland S, Malik MH, Lovell ME. Injury and injury rates in Muay Thai kick boxing. *Br J Sports Med*. 2001;35(5):308–313
20. Gartland S, Malik MH, Lovell M. A prospective study of injuries sustained during competitive Muay Thai kickboxing. *Clin J Sport Med*. 2005;15(1):34–36
21. McClain R, Wassermen J, Mayfield C, Berry AC, Grenier G, Suminski RR. Injury profile of mixed martial arts competitors. *Clin J Sport Med*. 2014;24(6):497–501
22. Mars JS, Pimenides D. Blinding choroidal rupture in a karateka. *Br J Sports Med*. 1995;29(4):273–274
23. Ortu M, Vaccarezza M, Trovati S, Galli M, Gervasoni C, Vella A. A martial arts injury: karate induced unilateral haematoma of the adrenal gland. *Br J Sports Med*. 2006;40(8):730–731, discussion 731
24. Mbuabegbu CE, Percy AJ. Femoral osteochondral fracture—a non-contact injury in martial arts? A case report. *Br J Sports Med*. 1994;28(3):203–205
25. Doiz E, Garrido F, Conejero R, García P, Fernández E. Acute pseudoaneurysm of the femoral artery after repeated trauma in full-contact karate practice. *Br J Sports Med*. 2008;42(12):1004–1005
26. Burke DT, Barfoot K, Bryant S, Schneider JC, Kim HJ, Levin G. Effect of implementation of safety measures in tae kwon do competition. *Br J Sports Med*. 2003;37(5):401–404
27. Pieter W, Fife GP, O'Sullivan DM. Competition injuries in taekwondo: a literature review and suggestions for prevention and surveillance. *Br J Sports Med*. 2012;46(7):485–491
28. Fife GP, O'Sullivan DM, Pieter W, Cook DP, Kaminski TW. Effects of Olympic-style taekwondo kicks on an instrumented head-form and resultant injury measures. *Br J Sports Med*. 2013;47(18):1161–1165

29. Deshmukh NV, Shah MS. Bilateral radial head fractures in a martial arts athlete. *Br J Sports Med.* 2003;37(3):270–271, discussion 271
30. STOP Sports Injuries. Preventing martial arts injuries. Available at: http://imis.sportsmed.org/AOSSMIMIS/STOP/STOP/Prevent_Injuries/Martial_Arts_Injury_Prevention.aspx. Accessed February 27, 2016
31. Lannuzel A, Moulin T, Amsallem D, Galmiche J, Rumbach L. Vertebral-artery dissection following a judo session: a case report. *Neuropediatrics.* 1994;25(2):106–108
32. McCarron MO, Patterson J, Duncan R. Stroke without dissection from a neck holding manoeuvre in martial arts. *Br J Sports Med.* 1997;31(4):346–347
33. Zigun JR, Schneider SM. “Effort” thrombosis (Paget-Schroetter’s syndrome) secondary to martial arts training. *Am J Sports Med.* 1988;16(2):189–190
34. Malek AM, Halbach VV, Phatouros CC, Meyers PM, Dowd CF, Higashida RT. Endovascular treatment of a ruptured intracranial dissecting vertebral aneurysm in a kickboxer. *J Trauma.* 2000;48(1):143–145
35. Wong V. Sports lingo, activities, positions and general sports terms. In: Koutures C, Wong V, eds. *Pediatric Sports Medicine: Essentials for Office Evaluation.* Thorofare, NJ: Slack Publications; 2013:9–10
36. Reider B. Battle scars [editorial]. *Am J Sports Med.* 2014;42(6):1287–1289
37. Lystad RP, Gregory K, Wilson J. The epidemiology of injuries in mixed martial arts: a systematic review and meta-analysis. *Orthop J Sports Med.* 2014;2(1):2325967113518492
38. Ngai KM, Levy F, Hsu EB. Injury trends in sanctioned mixed martial arts competition: a 5-year review from 2002 to 2007. *Br J Sports Med.* 2008;42(8):686–689
39. Buse GJ. No holds barred sport fighting: a 10 year review of mixed martial arts competition. *Br J Sports Med.* 2006;40(2):169–172
40. National Collegiate Athletic Association. Football injuries. Available at: https://www.ncaa.org/sites/default/files/NCAA_Football_Injury_WEB.pdf. Accessed February 27, 2016
41. Hutchison MG, Lawrence DW, Cusimano MD, Schweizer TA. Head trauma in mixed martial arts. *Am J Sports Med.* 2014;42(6):1352–1358
42. Kochhar T, Back DL, Mann B, Skinner J. Risk of cervical injuries in mixed martial arts. *Br J Sports Med.* 2005;39(7):444–447
43. Lee AD, Yu A, Young SB, Battaglia PJ, Ho CJ. Omohyoid muscle syndrome in a mixed martial arts athlete: a case report. *Sports Health.* 2015;7(5):458–462
44. Slowey M, Maw G, Furyk J. Case report on vertebral artery dissection in mixed martial arts. *Emerg Med Australas.* 2012;24(2):203–206
45. United States Fight League. Pankration, grappling and mixed martial arts rules. Available at: <http://fightleague.org/Rules.html>. Accessed February 25, 2016
46. Woodward TW. A review of the effects of martial arts practice on health. *WMJ.* 2009;108(1):40–43
47. Halstead ME, Walter KD; Council on Sports Medicine and Fitness. American Academy of Pediatrics. Clinical report—sport-related concussion in children and adolescents. *Pediatrics.* 2010;126(3):597–615
48. Knapik JJ, Marshall SW, Lee RB, et al. Mouthguards in sport activities: history, physical properties and injury prevention effectiveness. *Sports Med.* 2007;37(2):117–144
49. Birrer RB. Trauma epidemiology in the martial arts. The results of an eighteen-year international survey. *Am J Sports Med.* 1996;24(suppl 6):S72–S79
50. Koh JO, Watkinson EJ, Yoon YJ. Video analysis of head blows leading to concussion in competition taekwondo. *Brain Inj.* 2004;18(12):1287–1296
51. Koh JO, Cassidy JD. Incidence study of head blows and concussions in competition taekwondo. *Clin J Sport Med.* 2004;14(2):72–79
52. Halstead ME, McAvoy K, Devore CD, Carl R, Lee M, Logan K; Council on Sports Medicine and Fitness; Council on School Health. Returning to learning following a concussion. *Pediatrics.* 2013;132(5):948–957
53. Council on Communications and Media. Virtual violence. *Pediatrics.* 2016;138(2). Available at: www.pediatrics.org/cgi/content/full/138/2/e20161298

Youth Participation and Injury Risk in Martial Arts
Rebecca A. Demorest, Chris Koutures and COUNCIL ON SPORTS MEDICINE
AND FITNESS
Pediatrics 2016;138;
DOI: 10.1542/peds.2016-3022 originally published online November 28, 2016;

Updated Information & Services

including high resolution figures, can be found at:
<http://pediatrics.aappublications.org/content/138/6/e20163022>

References

This article cites 47 articles, 22 of which you can access for free at:
<http://pediatrics.aappublications.org/content/138/6/e20163022#BIBL>

Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):

Current Policy

http://www.aappublications.org/cgi/collection/current_policy

Council on Sports Medicine and Fitness

http://www.aappublications.org/cgi/collection/council_on_sports_medicine_and_fitness

Sports Medicine/Physical Fitness

http://www.aappublications.org/cgi/collection/sports_medicine:physical_fitness_sub

Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
<http://www.aappublications.org/site/misc/Permissions.xhtml>

Reprints

Information about ordering reprints can be found online:
<http://www.aappublications.org/site/misc/reprints.xhtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Youth Participation and Injury Risk in Martial Arts

Rebecca A. Demorest, Chris Koutures and COUNCIL ON SPORTS MEDICINE
AND FITNESS

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-3022 originally published online November 28, 2016;

The online version of this article, along with updated information and services, is
located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/138/6/e20163022>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2016 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

