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Vaccinations in Athletes

Impfungen im Sport

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Summary

- › **The prevention of infections** is essential to athletes' health and performance. Even mild infections can severely affect athletic performance and the eligibility to train and compete. One of the most effective means of avoiding severe infections are vaccinations. However, like the general population, athletes frequently do not receive the recommended vaccinations.
- › **This shortcoming** is largely based on fear of adverse vaccine reactions, concerns about the efficacy, misinterpretations, negligence, and poor communication. As sports medicine physicians are involved in the regular screening of adolescent, adult, and senior athletes, they are in a unique position to advise on an individual basis about the risks and benefits of an athlete-specific vaccination schedule. Thus, every preparticipation physical examination should be used to check the vaccination status and, if needed, optimize and update the athletes' vaccination profile.
- › **In this clinical review**, recommendations for standard, travel, and specific-indication vaccinations in athletes will be given and their efficacy, timing, and administration in the sports context will be discussed. The review will be completed by recommended literature and useful apps for the sports medicine physician involved in the preparticipation physical examination of athletes.

KEY WORDS:

Standard Vaccinations, Travel Vaccinations, Indication Vaccinations, Tetanus, Diphtheria, Pertussis, Measles, Mumps, Rubella, Hepatitis A/B, SARS-CoV-2, Influenza, Tick-Borne-Encephalitis, Sports

Introduction

Prevention of infections is essential to athletes' health and performance. Even mild infections can severely affect athletic performance and the eligibility to train and compete. Moreover, long-lasting consequences such as post-viral fatigue syndrome or severe complications like myocarditis can occur (16, 18). Exposure prophylaxis, hygiene, and vaccinations are key preventive measures in the infection management of athletes. One of the most effective means of avoiding severe infections are vaccinations. In fact, athletes might benefit even more from vaccinations than the general population due to increased exposure associated with travel requirements and the relevant influence of minor infection on performance (6).

The main objectives of vaccinations are the prevention of infection per se, severe courses of infection, long-term consequences, hospitalization, and

death with varying degrees of vaccine-specific efficacy to be considered. In Germany, the Standing Committee on Vaccination (Germ. "Ständige Impfkommission", STIKO) recommends vaccinations based on a medical-epidemiological risk-benefit analysis using the best available evidence to ensure safety and efficacy, and non-medical considerations like cost effectiveness (3). However, vaccination recommendations for the general population cannot be simply transferred to athletes due to a different risk-benefit profile. Accordingly, athletes are likely to benefit from athlete specific vaccination guidelines.

Like the general population, athletes frequently do not receive the recommended vaccinations (20). This shortcoming is largely based on fear of adverse vaccine reactions, concerns about the efficacy, misinterpretations, negligence, and poor communication (15). As sports medicine physicians are involved in



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the regular screening of adolescent, adult, and senior athletes, they are in a unique position to educate and motivate on an individual basis about the risks and benefits of age-appropriate vaccinations. Thus, every preparticipation physical examination should be used to check the vaccination status and, if needed, optimize, and update the athletes' vaccination profile.

Standard Vaccinations in Athletes

Given the severity and long-term consequences of most vaccine preventable diseases, for maximum protection, basic immunisation should be completed as early as possible, whilst using combination vaccines to minimize the number of injections. Ideally, most standard vaccinations as recommended for the general population will be administered by a paediatrician during early childhood and are therefore not discussed here. These include tetanus, diphtheria, pertussis, haemophilus influenzae type b, hepatitis B, poliomyelitis, pneumococcus, meningococcus type C, measles, mumps, rubella, and varicella. Further information and a downloadable schedule for basic immunisations in infants, toddlers, and children see: www.rki.de. Similarly, specific recommendations for other occupational groups (e.g. clinical, laboratory or military personnel etc.) will not be discussed.

One of the tasks of the sports medicine physician screening adolescent, adult, and senior athletes is to check the vaccination status for completeness and recommend athlete-specific vaccinations as well as age-appropriate catch-up and booster vaccinations. In the case of missing or incomplete immunisation considering the athlete's risk-benefit profile and vaccine-specific time windows of administration, the vaccination profile should be completed as soon as possible and independent of time passed since the previous vaccination. Every shot counts (3). When monovalent vaccines are not available (e.g. measles, tetanus), combination vaccines can be used instead. There is no general risk of over-vaccination (3).

Frequently lacking in athletes are basic immunisations against influenza, hepatitis A/B, tick-borne encephalitis, human papillomavirus, and meningococcal disease A/B/W/Y in adolescent, booster vaccinations for tetanus, diphtheria, and pertussis as well as influenza in adult, and age-appropriate vaccinations in senior athletes (unpublished observations from our university sports medicine outpatient clinic).

Due to close contact with teammates (e.g. dressing rooms) or opponents and crowded environments, athletes are at an increased risk of acquiring airborne diseases like influenza. This highly contagious virus also affects young and healthy athletes and may cause absence from training and competition for prolonged periods. Thus, even though less effective than other vaccinations the risk-benefit analysis favours influenza vaccination in adolescent and adult athletes with an inactivated, non-adjuvanted, quadrivalent vaccine. If athletes are going to travel to the other hemisphere during the influenza season, the use of a second hemisphere-specific influenza vaccine upon arrival is advised (11).

Hepatitis A can lead to months of reduced physical performance and is easily spread between athletes, especially in sports-typical communal settings for example in trainings camps in less developed countries. Infection is hard to prevent by exposure prophylaxis alone, risk-benefit analysis thus favours vaccination in athletes, especially when travelling to endemic areas spontaneously. A monovalent hepatitis A vaccination is available. A single dose protects for a year and long-lasting immunisation is achieved with a second dose 6-12

months later. Particularly, when a basic immunisation against hepatitis B is lacking, a three-dose regime with a hepatitis A/B vaccine should be considered, though temporary protection is not achieved before 4 weeks after the second dose due to smaller amount of antigen.

Hepatitis B vaccination is strongly recommended because it causes a severe disease (typically several months of no or reduced training and competition eligibility complicated by possible irreversible organ damage) and it is highly contagious to teammates and opponents (6). Catch-up vaccinations should therefore be recommended and administered in all adolescent and adult athletes, especially in contact and collision sports athletes. Two established monovalent and a novel recombinant and adjuvanted vaccine (the latter one available since 05/22) are approved requiring three (0, 1, 6 months) and two doses (0, 1 months), respectively. Especially, when a hepatitis A immunization is lacking, a three-dose combination vaccine with hepatitis A/B is advantageous.

Given the ongoing expansion of risk-areas in Germany and neighbouring European countries, immunisation against tick-borne encephalitis (TBE) is recommended before the start of the tick season, especially for athletes regularly training in forests and open meadows in respective risk-areas. Basic immunisation is achieved after the third dose protecting for 3-5 years. The central European subtype TBE vaccine also protects from the Eastern and Siberian subtypes.

Basic immunisation against human papilloma virus should be completed prior to first sexual contact, and thus take place between the ages 9 and 14 years. There should be at least 5 months between the first and second dose. Beyond the age of 15 years, three doses are required. Catch-up vaccinations should be administered by the age of 17 years. Vaccinations in athletes ≥ 18 years can be administered on an individual basis but may be less effective and costs may not be covered by medical aid.

In all athletes, but particularly, for athletes who are at risk of open wounds and potential contact with contaminated soil (e.g. mountain bike, horse riding, etc.), a rigorous tetanus prophylaxis with immunization and boosters is essential. A second booster vaccination for tetanus, diphtheria, and pertussis is recommended between the ages 9-16 years. From the age of 5 years, a reduced content of diphtheria toxoid and pertussis antigen is used. In adult athletes, booster vaccination should be a trivalent combination vaccine with tetanus, diphtheria, and pertussis.

In Germany, a single vaccination against meningococcal disease serotype C (causing around 15% of meningococcal disease in Germany) is recommended in children but not against serotypes A, B, W, and Y, which, primarily for financial reasons, are restricted to vulnerable groups. Three quadrivalent conjugated vaccines against meningococcus serotypes ACWY and two vaccines against serotype B (causing around 65% of meningococcal disease in Germany) are available, which may be considered to maximize protection and costs are covered by some medical aids.

For athletes born after 1970 with unknown status, no or only one single measles vaccination a single dose of a trivalent live vaccine with measles, mumps, and rubella is recommended. In addition to the already mentioned vaccines, for senior athletes ≥ 60 years of age the following vaccinations are indicated: a single dose with a 20-valent conjugated vaccine against pneumococcus (based on recent recommendations by the American Advisory Committee on Immunization Practices (10) and not yet considered by the German Standing Committee on Vaccination), the adjuvanted herpes zoster inactivated vac- ➤

cine with two doses between 2 and maximal 6 months apart, and the seasonal influenza vaccination with an quadrivalent high-dose vaccine.

Travel Vaccinations

Due to frequent international travel to competitions and training camps in non-industrialised countries, athletes are exposed to an increased risk of endemic diseases that are hard to prevent by exposure prophylaxis alone. The choice of travel vaccinations should be based on an individual risk-benefit analysis taking into consideration, among other factors, the current endemic situation, length of stay, hygienic standards, seasonal exposition risk to vectors, and efficacy of the vaccine (1). Potential vaccinations should be considered well in advance of each international travel (note that normal live vaccine-related responses may only occur after 10–14 days at the peak of replication and more than a single dose may be necessary to achieve protection) and include vector-borne (yellow fever, Japanese encephalitis), food-borne (typhoid fever) illnesses, and others (meningitis type A, poliomyelitis).

Yellow fever vaccination is recommended for endemic areas (see recent outbreak in Kenya 03/22) and compulsory for travel to some countries. For more information see: www.who.int. Previously, a single dose of an attenuated live vaccine was administered, which provides a life-long certificate but not life-long protection. The latest guidelines (08/22) therefore recommend a second dose after 10 years to optimize individual protection. For basic immunisation against Japanese encephalitis (see recent outbreak in Australia 04/22) two doses are required with an inactivated adjuvanted vaccine 4 weeks apart. Given continued exposure further doses may be administered 12–24 months and 10 years later.

Considering the travel habits of athletes and typical hygienic standards of stay, vaccination against typhoid fever will rarely be necessary and the effectiveness of the vaccines are rather low. Monovalent typhoid fever vaccinations with a single dose parenteral inactivated vaccine or a three-dose live vaccine are available, which must be administered at least two weeks or completed ten days prior to travel, respectively. Especially, when hepatitis A immunisation is lacking, a combined vaccine (available from the age of 16 years) may be advantageous.

When travelling to areas where meningococcus type A is endemic, a conjugate vaccine against meningococcus serotypes ACWY is recommended, if not already been used instead of the monovalent meningococcus type C vaccine. Considering competition schedules and sport event locations as well as social and political circumstances in endemic regions, vaccination of athletes against poliomyelitis will rarely be necessary. For basic immunisation of yet unvaccinated athletes against poliomyelitis two doses should be administered 4 weeks apart prior to travel and completed with a third dose 6 months later.

Indication for Vaccinations

For immunocompromised athletes or athletes with certain risk factors (immunodeficiency, asplenia, cochlear implants), pneumococcal vaccination is recommended independent of age. In vaccine-naïve athletes <18 years of age, a sequential vaccination is recommended with the conjugate vaccine PCV-13 followed by the polysaccharide vaccine PPSV-23 6–12 months later (note that PCV-20 is not yet approved for persons <18 years of age; a statement of the STIKO regarding the new

PCV-20 vaccine is expected in due time). In athletes ≥18 years with chronic disorders (asthma, COPD, CVD, etc.) a single dose with a 20-valent conjugated vaccine against pneumococcus is approved and recommended (10). A single haemophilus influenzae type b vaccination is indicated in asplenic athletes with a monovalent vaccine being available through international pharmacies. In athletes with increased health risks due to underlying chronic disease, a herpes zoster vaccination may already be considered from the age of 50 years as well as a seasonal influenza vaccination with a quadrivalent high-dose vaccine.

SARS-CoV-2 Vaccinations

SARS-CoV-2 vaccinations are indication vaccinations within a pandemic and recommendations get regularly updated (2). Due to close contact with teammates or opponents and crowded environments, athletes are at an increased risk of airborne diseases like SARS-CoV-2. This highly contagious infection also affects young and healthy athletes and may cause absence from training and competition for prolonged periods (8). It further may void competition eligibility even in asymptomatic athletes. It is noteworthy that persons under the age of 20 years are 6 times more likely to develop myocarditis from primary COVID-19 infection than those who have received the vaccine (18). Thus, even though less effective than other vaccinations and despite decreasing efficacy against currently circulating SARS-CoV-2 variants, the risk-benefit analysis favours SARS-CoV-2 vaccinations in athletes.

In Europe, five vaccines have been approved with the following STIKO age recommendations: Comirnaty (mRNA; ≥5 years), Spikevax (mRNA, ≥30 years), Nuvaxovid (adjuvanted protein vaccine; ≥18 years), Vaxzevria (vector-based, ≥60 years), Jcovden (vector-based, ≥60 years). The age recommendations for Spikevax are due to the greater risk of myo- and pericarditis in persons <30 years and for vector-based vaccines due to the greater risk of thromboembolic events in persons <60 years. For basic immunisation against SARS-CoV-2 two doses 3–6 weeks apart are required independent of the vaccine. Under the age of 12 years, one vaccination is recommended in healthy and two vaccinations in children with medical preconditions, preferentially with Comirnaty (10 µg). In adolescent and adult athletes <30 years as well as pregnant women, two doses with Comirnaty (30 µg) are recommended. In athletes ≥30 years, Comirnaty (30 µg) and Spikevax (100 µg) are considered equal. From the age of 18 years, Nuvaxovid (5 µg) can be used as an alternative. In athletes ≥60 years, a vector-based vaccine may be used for a first dose. All athletes with a vector-based vaccine as first dose should receive a heterologous vaccine as second dose.

Independent from the vaccine used for basic immunisation, mRNA vaccines should be used for booster vaccinations 3–6 months later (Nuvaxovid may be recommended at a later stage) and for optimisation of basic immunisation in athletes with a single dose Jcovden vaccine (<30 years Comirnaty (30 µg), ≥30 years Comirnaty (30 µg) or Spikevax (50 µg)). Nuvaxovid (5 µg) can be used in cases of product-specific, medical contraindications against mRNA-vaccines. A second booster dose is currently only recommended for high-risk groups and persons ≥60 years 3–6 months later. However, considering the development of an Omikron-variant adapted vaccine (expected to be available from 10/22) a booster shot is recommended for all athletes, whose previous shot is longer ago than 6 months. To reduce the risk of mRNA vaccine-related myo- and pericarditis a pre-injec-

tion aspiration should be performed to ensure intramuscular application (2, 14).

Efficacy, Timing, and Administration of Vaccinations in the Sports Context

Many athletes are nevertheless concerned about an impaired efficacy of vaccinations after intense training and competition due to an alleged transient or chronically impaired immunity (13). However, there is only limited scientific evidence to support the common assumption that strenuous endurance exercise bouts impair immune competence (4). For a contentious debate see Simpson et al. (2020) (17). Specifically, the available evidence shows no impaired efficacy of vaccinations even after strenuous exercise and during an ongoing training process (5, 12, 19). Thus, high-intensity training and competitions do not seem to challenge the immunological success of vaccination. Regular physical activity and acute exercise of moderate intensity have even been shown to increase antibody response after influenza and SARS-CoV-2 vaccination without increased side effects (7).

Another concern of athletes is the fear of training loss due to adverse vaccine reactions. While training restrictions due to normal vaccine-related responses in athletes do indeed occur after influenza (11) and SARS-CoV-2 (9) vaccinations, they are on average minor, and symptoms resolve after 2-3 days. The most frequent side effect is local pain at the injection site and athletes due to greater body awareness may tend to be more prone to be affected than the general population (9, 12, 19). Intramuscular injections should therefore be administered into the non-dominant deltoid muscle (e.g. in unilateral throwing and racquet sports) or alternatively into the gluteal muscle (e.g. in wheel-chair athletes). In individual athletes, however, systemic vaccine-related responses like fatigue, myalgia, and headache may be considerably stronger and longer lasting. Critically, athletes should not return to training before systemic reactions have subsided. Typical consensus statements to avoid high-intensity training and competitions in the 2-3 days after vaccinations may therefore on average be adequate but fail the individual athlete. Should symptoms persist longer than the usual 2-3 days, athletes should seek medical advice before returning to training and competition. Thus, to minimize interference with training and competition, vaccinations should ideally be administered during the off-season or, if they cannot be planned and are urgently required, shortly after an intensive training cycle or competition to maximize the time to the next competition.

For further information the interested reader is referred to the information box including recommended literature and useful apps for the sports medicine physician involved in the preparticipation physical examination of athletes. ■

Conflict of Interest

The authors have no conflict of interest.

Further Information

Recommended literature and useful apps for the sports medicine physician involved in the preparticipation physical examination of athletes.

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