**SUMMARY**

Probiotic supplementation traditionally focused on gut health. However, recently, the clinical applications of probiotics have broadened to allergic, metabolic, inflammatory, gastrointestinal and respiratory conditions. Gastrointestinal health is important for regulating adaptation to exercise and physical activity. Several researches conducted in athletes or active individuals indicate modest clinical benefits in terms of reduced frequency, severity and/or duration of respiratory and gastrointestinal illness. The likely mechanisms of probiotic’s action include interaction with the gut microbiota, interaction with the mucosal immune system and immune signaling directed to a variety of organs and systems. Although scientific evidence for an ergogenic effect of probiotics is lacking, probiotics may provide athletes with secondary health benefits that could positively affect athletic performance through enhanced recovery from fatigue, improved immune function, and maintenance of healthy gastrointestinal tract function.

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**KEY WORDS:** Probiotics - Immunity - Gastrointestinal microbiome - Dietary supplements.

**RIASSUNTO**

La supplementazione dei probiotici è stata inizialmente utilizzata in ambito gastroenterico. Negli ultimi anni, l’impiego è stato esteso al trattamento di patologie allergiche, metaboliche, infiammatorie e respiratorie. La salute gastrointestinal è condizione essenziale per la regolazione del processo di adattamento all’esercizio e all’attività fisica. Diversi studi condotti su atleti o individui fisicamente attivi hanno indicato modesti benefici clinici in termini di ridotta frequenza, severità, e/o durata di malattie respiratorie e gastrointestinali. I probabili meccanismi d’azione dei probiotici includono la diretta interazione con il microbiota intestinale, l’interazione con il sistema immunitario mucosale e con il complesso network di comunicazione tra organi e sistemi. Sebbene la ricerca scientifica non abbia ancora valutato la complessità dell’effetto ergogenico dei probiotici, questi possono sicuramente migliorare la salute dell’individuo e modificare la performance atletica attraverso un migliore recupero dalla fatica, un miglioramento della risposta immunitaria e il mantenimento della salute del tratto gastrointestinale.

**PAROLE CHIAVE:** Probiotici - Immunità - Microbioma gastrointestinale - Integratori alimentari.

Probiotics rich foods and probiotic supplements contain non-pathogenic bacteria that colonise the intestine and potentially provide numerous health benefits, including a reduced incidence of upper airway disorders and gastrointestinal diseases. Such bacteria occur naturally in fermented food products, such as yogurt, kefir, sauerkraut, cabbage kimchi, and soybean-
Probiotics are comprised of various strains having a specific action: helping digestion, reconstructing the mucous barrier and enhancing the immune function. At least two additional factors having a definite therapeutic effect should be taken into account: 1) the “natural” bacterial flora, the microbiota, always tends to return to its original conditions after each change induced through the “external” administration of “non-autochthonous” strains; and 2) each bacterium has an anatomical niche of its own, for instance, the *Helicobacter pylori* only colonises the gastric mucosa, other strains colonise specific segments of the intestine (such as the bifidobacteria that prefer the small intestine, or the *Lactobacillus rhamnosus* that shows a definite liking for the terminal ileum-colon. Numerous are the health benefits ascribed to probiotic bacteria, including effects on the gastrointestinal tract function, immune response, and allergic conditions, as well as on hyperlipidaemia and hypertension. As a result, there is great interest in the use of probiotics supplements in the general population and in athletes in particular.

Probiotics modulate the immunity of the gastrointestinal tract by interacting with specific receptors present in the intestinal epithelial cells, M cells and dendritic cells; they also interact with the mucosa-related immune system, a complex system establishing mutual correlations between inductive sites, contained in the gastrointestinal tract, and effector sites, contained both in the gastrointestinal tract itself and in other mucosal surfaces, such as the upper respiratory tract and the urogenital tract. Probiotic supplementation may reduce the incidence of disorders affecting the upper airways, and it also seems to play a role in reducing gastrointestinal disorders, a common problem in athletes practising endurance sports. Yet another health benefit attributed to probiotics seems to be a capacity to mitigate the risk of infections in the gastrointestinal tract, a widespread concern when travelling abroad.

For a professional athlete, gastrointestinal health should be a priority: many studies, in fact, have underscored the important function of the intestine in digestion and the supply of energy substrates for exercise and physical activity. Moreover, as mentioned above, the intestine plays a major role in enhancing the defences against infections and regulating the mucosal homeostasis.
Intense physical exercise causes an increase in gastrointestinal symptoms, such as cramps, diarrhoea, abdominal bloating, nausea and bleeding. These problems have been associated with alterations to intestinal permeability and compromised intestinal barrier function. Increased gastrointestinal permeability, the so-called “leaky gut syndrome,” may lead to endotoxemia, resulting in enhanced susceptibility to infections and autoimmune disorders caused by the passage of harmful microorganisms and toxins into the blood stream. The key components affecting the intestinal barrier function and gastrointestinal permeability consist of cellular junctions, or tight junctions (TJs), i.e., protein complexes situated in the paracellular spaces between the epithelial cells and the intestinal wall. The structural and functional integrity of these junctions depends on complex interactions between the substances produced by resident bacteria, the metabolism of intestinal epithelial cells and the activity of mucosa-associated lymphoid tissue. There is evidence that the administration of probiotics has beneficial effects on the integrity of the intestinal barrier in acute diseases. Alterations to the intestinal barrier following physiological hypoperfusion, especially in the case of prolonged physical stress, may result in changes in nutrient absorption/utilisation levels, immune response and system inflammatory states, with detrimental effects on other organs/apparatus, especially the respiratory and urinary systems, impairing the functions of such systems and decreasing resistance to bacterial and viral infections. While the increase in intestinal permeability is basically due to an alternation of the mucosal barrier at the TJs, the reduction in absorbent/enzymatic capacity is essentially due to the loss of the anatomofunctional integrity of the enterocytes. This is compounded by the “distortion” of the local immune response, causing abnormal lymphocyte stimulation and induction of proinflammatory cytokines, with effects that are local at first and subsequently systemic, resulting in latent systemic inflammatory states, which have no clinical effects but may become clinically manifest if the problem becomes chronic; this is clearly exemplified by autoimmune phenomena in genetically predisposed subjects, and all those eczematous-cutaneous forms associ-
ated with the so-called food intolerances, and even, according to recent studies, the metabolic syndrome and type 2 diabetes, cardiovascular and neurodegenerative diseases. In actual fact, many of these conditions may be correlated to macromolecules, foods, additives and preservatives in general, which end up by behaving as antigens, instead of nutrients, and activate the local immune system, precisely when an impaired barrier lets such elements penetrate into the submucosa, where, in the small intestine, lies the resident immune system.

Besides enhancing cardiovascular performance, physical exercise also increases gastrointestinal permeability through several mechanisms associated with reduced blood flow and intestinal hyperthermia. Pals et al. documented increased gastrointestinal permeability after a run on a treadmill at 80% of the VO$_{2}^\text{max}$ correlated with the increase in internal temperature. 

**Mechanisms and effects of probiotics**

The human gastrointestinal tract is colonised by more than 1000 different bacterial species, which may be macroscopically grouped into two phyla: *Bacteroidetes* and *Firmicutes*. In western society, the main and preeminent species of bacteria are: *Bacteroides*, *Eubacteria*, *Peptostreptococci*, *Bifidobacteria*, *Enterobacteria*, *Streptococci*, *Lactobacilli*, *Clostridia* and *Staphylococci*. The composition of the gut flora of an adult is mostly stable, but it can be greatly affected by a multiplicity of factors: genetics, age, nutritional requirements, immune system conditions, use of antibiotics, alcohol consumption, pH, bowel transit time and presence of material in the intestine.

Probiotics exercise their main activity by modifying the pH, synthesising and releasing various antibacterial compounds, including bacteriocins, organic acids and hydrogen peroxide. As mentioned before, they influence local immunity by interacting with mucosa-related lymphoid tissue, preserving the physiology of the intestinal barrier and systemic immunity, enhancing some aspects of both inborn and acquired immune response. Some probiotic strains, especially some from the lactobacilli and bifidobacteria species, enhance the activity of natural killer cells, the bactericidal capacity of neutrophils and monocytes, modify the production of cytokines, and increase antibody concentrations, with effects that may extend lica and the diabete tipo 2, la malattia cardiovascolare e le malattie neurodegenerative. In effetti, molte di queste situazioni, sono correlabili alle macro-molecole, alimenti, additivi e conservanti in generale, che finiscono per comportarsi non da nutrienti ma da antigeni, attivando il sistema immunitario locale, proprio quando una barriera alterata permette uno sconfinamento degli stessi nello spazio sottomucoso, sede, nel piccolo intestino, del sistema immunitario residente.

L'esercizio fisico aumenta non solo la performance cardiovascolare, ma anche la permeabilità gastrointestinale attraverso molteplici meccanismi correlati al ridotto flusso sanguigno e all'ipertermia intestinale. Pals et al. hanno documentato un'aumentata permeabilità gastrointestinale dopo una corsa sul tapis rotante all'80% della VO$_{2}^\text{max}$ correlata all'aumento della temperatura interna.

**Mechanismi ed effetti dei probiotici**


I probiotici esercitano la loro principale attività modificando il pH, sintetizzando e rilasciando diverse sostanze antibatteriche, incluse le batterio- cine, acidi organici e perossido d'idrogeno. Essi, come accennato, influenzano l'immunità locale, interagendo con il tessuto linfoide associato alle mucose, mantenendo la fisiologia della barriera intestinale e l'immunità sistemica, potenziando alcuni aspetti delle risposte sia dell'immunità innata che acquisita. Alcuni ceppi di probiotici, particolarmente le specie dei lactobacilli o dei bifido- batteri, potenziano l'attività delle cellule natural killer, la capacità microbicida dei neutrofili e dei monociti, modificano la produzione di citochine e aumentano le concentrazioni degli anticorpi, con effetti che possono estendersi dalla sede intestinale ad altre sedi mucosali, incluso il tratto respiratorio.
from the intestine to other mucous membrane lined organs, including the respiratory tract.

An aspect that has to be taken into due account is the specific role played by the different bacterial strains: *L. rhamnosus* is known for its beneficial effects on epithelial cells, and, besides fostering the production of butyric acid, it modulates the function of dendritic cells to induce a new form of hyporesponse of T cells. Besides balancing the intestinal flora, *L. plantarum* effectively suppresses the growth of gas producing bacteria, clostridia and other methanogenic bacteria, restoring intestinal eubiosis, with remission of the symptoms; several studies have shown that besides improving the microbial flora, lactic ferment *L. fermentum* protects the liver from alcohol and its effects and is able to improve a number of specific functions.

**Indications on health and the potential benefits offered by probiotics**

Probiotics have always been known to have beneficial effects in the prevention and treatment of many illnesses; a recent systematic review of the literature has described how, in lactose-intolerant subjects, the probiotics contained in yogurt helped enhance tolerance to said nutrient, and has revealed that a number of bacterial strains perform an antimicrobial activity through the production of important organic acids, such as lactic acid and acetic acid, hydrogen peroxide, diacetyl, β-hydroxypropionate, aldehyde and other peptides and bacteriostatic and/or bactericidal proteins. Such antimicrobial properties may inhibit the growth of a large number of pathogenic bacteria.

Simenhoff *et al.* have shown that bacteria belonging to the *Lactobacillus acidophilus* species can have favourable effects on pathogen colonisation of the small intestine — an organ which, as is known, is physiologically host to few bacteria —, inhibiting the production of gas such as dimethylamine. The latest systematic review of the literature on the benefits of probiotics on upper respiratory tract infections (URTIs), which considered the results of 12 controlled and randomised trials conducted on 3720 subjects, concluded that probiotics were able to reduce the incidence of upper respiratory tract infections and, at the same time, reduce the number of days with symptoms, which were 2, on average, in an acute episode.

L’aspetto su cui è fondamentale focalizzare l’attenzione è sicuramente il differente ruolo esercitato dai diversi ceppi batterici. *L. rhamnosus* è noto per conferire effetti benefici alle cellule epiteliali, induce la produzione di acido butirrico, modula la funzione delle cellule dendritiche al fine di indurre una nuova forma di iporisposta delle cellule T. *L. plantarum*, oltre a riequilibrare la flora batterica intestinale, contrasta efficacemente i batteri gasogeni, i clostridi e altri metanogeni, ristabilendo l’eubiosi intestinale con remissione della sintomatologia; diversi studi hanno dimostrato come il fermento lattico (*L. fermentum*) oltre ad aiutare la flora microbica, è in grado di proteggere il fegato dall’alcol e dai suoi effetti; e di migliorare alcune funzioni specifiche.

**Indicazioni sulla salute e potenziali benefici derivanti dall’assunzione di probiotici**

Da sempre associati agli effetti benefici nella prevenzione e trattamento di diverse condizioni mediche, una recente revisione sistematica della letteratura ha descritto come, in soggetti affetti da intolleranza al lattosio, i probiotici presenti nello yogurt si sono dimostrati validi alleati per potenziare la tolleranza allo stesso e che alcuni ceppi batterici esibiscono un’attività antimicrobica attraverso la produzione di alcuni importanti acidi organici, come acido lattico e acido acetico, peroressido d’idrogeno, diacetile, β-idrossipropionato, aldeide e altri peptidi e proteine batteriostatiche e/o battericidi. Tali proprietà antimicrobiche possono inibire la crescita di un grande numero di batteri patogeni.

Simenhoff *et al.* hanno dimostrato come batteri della specie *Lactobacillus acidophilus* fossero in grado di influenzare positivamente la colonizzazione patogenetica del piccolo intestino che, com’è noto, fisiologicamente è sede di pochi batteri, intibendo la produzione batterica di gas come la dimetilamina. La più recente revisione sistematica della letteratura sui benefici dei probiotici per le infezioni alle alte vie respiratorie (upper respiratory tract infections, URTI), elaborata sui dati di 12 studi randomizzati e controllati che hanno coinvolto 3720 partecipanti, ha concluso che i probiotici erano in grado di ridurre l’incidenza di infezioni del tratto respiratorio superiore e, allo stesso tempo, di ridurre i giorni dei sintomi che per un episodio acuto erano in media 2.

Tuttavia, sebbene la maggior parte delle evidenze sia a favore di effetti positivi sulla salute in generale (Figura 1), ulteriori studi sono necessari.
However, even though a wealth of evidence testifies to the beneficial effects of probiotics on health in general (Figure 1), further studies are necessary to understand the specific action of the different strains, which have significant and disparate effects.

**Studies on probiotics in athletes**

Several studies have demonstrated how probiotic bacteria can strengthen the immune response of the host, modulate inflammatory phenomena, reduce the incidence and length of upper airway infections, change the lipid profile and in some instances, determine an improvement in athletic performance. Their multiorgan effect may be ascribed to the complex communication between the mucosa-related lymphoid tissue of the intestine and all the other lymphoid tissues associated with other organs or systems: it is precisely through this cross-talk of the immune system that the intestinal bacterial flora is able to interact and maintain the host in good health.

Studies on athletes may be subdivided into two groups: reviews and controlled and randomised clinical trials conducted with the following species *Lactobacillus casei*, *L. fermentum*, *L. acidophilus* and *L. rhamnosus*.

A recent review by Pyne et al. identified 15 significant clinical trials that investigated the

![Diagram of Probiotics](image)

**Figure 1.** Potential benefits of probiotic supplementation.

*Figura 1.* Potenziali effetti benefici dei probiotici.
immunomodulating and clinical effects of the regular use of probiotics in athletes. Of the 8 clinical trials that studied the incidence of URTI, 5 found a reduced frequency or fewer days with fever, 3 did not find any effect or any significant effect. To this day, the trials showing a reduced incidence rate of URTI in athletes used *Lactobacillus* and *Bifidobacterium* with daily doses of $10^{10}$ alive bacteria. Even though a majority of the studies have examined the effects of probiotics on a small number of active subjects over a time period of less than 6 months, an understanding of the mechanism of action of certain strains has been gained and sufficient evidence has been obtained from studies conducted on athletes and physically active individuals. Nevertheless, additional larger scale clinical trials are necessary to confirm that the consumption of probiotics can reduce the number of training days lost due to illness and especially to determine which probiotic strains are most effective, what protocol is most effective and whether or not their effects are strain-specific.

A study by Clancy et al. showed how four-week supplementation with *Lactobacillus acidophilus* improved the immune function of athletes suffering from fatigue by increasing the secretion of the gamma interferon and regulating the activity of CD4$^+$ lymphocytes. In this clinical trial, the subjects were administered $2.0 \times 10^{10}$ cells per day. These results suggest a defect in the T cells of athletes suffering from fatigue and a possibility of treating such a deficiency with probiotics therapy. T lymphocytes being a type of lymphocyte that plays a central role in cell-mediated immunity and the preservation of immune homeostasis.

Subsequently, Cox et al. observed that a month of supplementation with *Lactobacillus fermentum* during the winter period in 20 elite category runners reduced to less than half the number of days of URT infections compared with the subjects taking a placebo. Furthermore, the infection episodes that occurred during the supplementation were seen to be less severe.

In a controlled, randomised study conducted on 99 subjects of both sexes, West et al. observed a substantial reduction in gastrointestinal and respiratory symptoms in male subjects, but not in female subjects, following 77 days of supplementation with *L. fermentum*. The numbers of *Lactobacillus* detected in faecal samples increased by 7.7 times in male subjects, whereas in women the increase was not as clear. A randomised double-blind study examined 141 runners and evaluated the immune function of athletes suffering from fatigue by increasing the secretion of the gamma interferon and regulating the activity of CD4$^+$ lymphocytes. In this study, the subjects were administered $10^{10}$ alive bacteria. Even though a majority of the studies have examined the effects of probiotics on a small number of active subjects over a time period of less than 6 months, an understanding of the mechanism of action of certain strains has been gained and sufficient evidence has been obtained from studies conducted on athletes and physically active individuals. Nevertheless, additional larger scale clinical trials are necessary to confirm that the consumption of probiotics can reduce the number of training days lost due to illness and especially to determine which probiotic strains are most effective, what protocol is most effective and whether or not their effects are strain-specific.

In one study of Clancy and collaborators, it was stated as a response to the supplementation for four consecutive weeks with *Lactobacillus acidophilus* in athletes, the improvement was also observed in female subjects, following 77 days of supplementation with *L. fermentum*.

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ners taking either a placebo or *L. rhamnosus* during the 3-month period preceding a marathon. No significant differences were observed in the number of episodes of gastrointestinal and respiratory illnesses during the two weeks after the marathon. However, it appeared that gastrointestinal symptoms in the group that had taken the probiotic tended to last less time. A study that examined the efficacy of a combination of *L. rhamnosus* and *L. paracasei* administered in a dosage of 2×10^9 cells per day over a 4-week period found that a combined supplementation with the two strains determined an increase in plasma levels of antioxidants. Two studies examined the effects of supplementation with *L. casei* in physically active subjects. Tiollier et al. conducted a supplementation study on a group of 47 French military cadets undertaking 3 weeks of intensive training followed by a 5-day combat course and observed a modest reduction in the incidence of respiratory tract infections. Another study conducted for 16 weeks on 84 active subjects showed a lower incidence rate of respiratory tract infections in the group taking *L. casei* compared with the control group. Better maintenance of salivary IgA levels seems to be a key element to explain this improvement in the groups taking the probiotics. 

4 clinical trials conducted in 2012 examined the effects of probiotics supplementation over a time period of between 4 and 16 weeks, using single strains (two studies) and blends (the remaining two). Only 1 of these 4 studies gave the clinical details of the upper respiratory tract diseases, and the immune system parameters specified in the studies were different: salivary IgA, white cells, concentration of antimicrobial proteins, LDL and antioxidants, intestinal permeability markers and serum cytokines. This wide range of biomarkers exemplifies the difficulties encountered in trying to identify health benefits in various groups of athletes. A small study conducted on rugby players for 4 weeks using a blend of probiotic strains revealed a 27% reduction in respiratory tract episodes, which were also seen to last less.

In a recent clinical trial, Shing et al. found that supplementing 10 runners for four weeks with capsules containing *Lactobacillus*, *Bifidobacterium* and *Streptococcus* delayed fatigue, compared to when the athletes were not taking the probiotics, and therefore determined performance improvements. In July 2016, a Serbian equipe published the results of a double-blind trial conducted on 39 elite class athletes for 14 weeks using *L. helveticus* Laffi® L10 in a
daily dose of $2 \times 10^{10}$ alive bacteria. Lafti® L10 was seen to significantly reduce the length of URTI episodes (7.25±2.90 vs. 10.64±4.67 days, P=0.047) and reduce the number of symptoms in the group treated with probiotics (4.92±1.96 vs. 6.91±1.22; P=0.035). URTI episodes severity and incidence rate did not differ between the two treatments. Hence, this strain seems effective in reducing the length of upper respiratory tract infections in elite athletes.

In view of the small number of studies and the considerable differences in experimental approach, it is hoped that well designed supplementation studies be conducted on athletes practising different disciplines, providing athletic performance data besides the clinical data.

**Susceptibility and illness in elite athletes**

Athletes engaging in intensive training or long-term competitions may experience an increased risk of developing upper respiratory tract disorders. The most common diseases in athletes include viral infections, the common cold and sore throat caused by allergies or inflammation due to inhalation of cold, dry or contaminated air. While normally such illnesses have mild consequences, in a professional athlete they may result in less effective training and poorer performance in competitions, and in some cases, they may cause the interruption or the loss of a training session. A prolonged period of intense physical activity may cause a temporary depression of leukocyte function creating an "open time window" during which the host is less protected and viruses and bacteria can take hold, causing an increased risk of occurrence of infection symptoms. Additional factors, such as the competition, the psychological stress, lack of sleep, exposure to extreme environments (e.g., altitude), and even malnutrition may impair the immune response resulting in higher risk of infection.

During physical exercise, since pulmonary ventilation rates increase, the airways are more exposed to the bacteria and viruses present in the air. An increase in the permeability of the intestinal barrier may also permit the passage of bacterial endotoxins into the blood stream, especially when physical exercise is prolonged and performed in a hot climate. In contact sports, skin abrasions may cause a higher risk for transdermal infections. Thus, a multiplicity of factors makes athletes more susceptible to infections.

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alle infezioni: stressor fisici, mentali, ambientali, psicologici, inadeguate abitudini nutrizionali e/o deficit nutrizionali, oltre ai numerosi viaggi ai quali molti sportivi di élite devono far fronte (Figura 2).

**Raccomandazioni pratiche**

I fabbisogni nutrizionali dell’atleta dovrebbero essere soddisfatti principalmente attraverso una dieta varia ed equilibrata con il consumo di cibi non raffinati e alimenti che naturalmente contengono probiotici. Tuttavia, in alcuni casi e dopo un’attenta anamnesi medica-nutrizionale è necessaria la supplementazione con formulazioni specifiche. In commercio sono disponibili diverse formulazioni di probiotici: dalle compresse alle capsule, alle bustine da sciogliere in acqua fino ai chewing-gum arricchiti in probiotici; tante soluzioni per incontrare le preferenze dei singoli atleti. I fermenti lattici non sono però tutti uguali: pur della stessa specie, sono diversi per nascita, attività, per preparazione tecnologica ed ogni ceppo esplica una specifica azione biologica.

È importante provare la supplementazione di probiotici durante la preparazione estiva per conoscere la reazione dell’atleta al prodotto somministrato o la presenza/assenza di effetti indesiderati; infatti nei primi giorni possono verificarsi un’aumentata flatulenza e borborigmi; quest’aumentata attività intestinale non deve preoccupare perché riflette la colonizzazione batterica. I supplementi contenenti probiotici dovrebbero essere trasportati e conservati in modo appropriato evitando l’esposizione a fonti di calore.

In termini pratici, all’U.S. Città di Palermo abbiamo messo a punto un protocollo di supplementazione (Figura 3) che inizia già dal ritiro precampionato e si articola in una prima fase della durata di 21 gg caratterizzata da una sequenza ben precisa: i primi sette giorni viene somministrata una miscela di fermenti lattici costituita da Saccharomyces cerevisiae sub. boulardii, Enterococcus faecium, Lactobacillus acidophilus, seguita da 7 giorni di probiotici della specie Bifidobacterium lactis, breve, bifidum e longum. Infine, altri 7 giorni di L. rhamnosus e L. acidophilus.

Il protocollo prevede alla fine di questi 21 gg un periodo di wash out di 15 giorni seguito da una seconda fase di 30 giorni nella quale, nei primi 20 giorni viene somministrata una miscela di L. rhamnosus, B. lactis, B. longum, L. plantarum e L. acidophilus e negli ultimi 10 giorni una miscela di L. fermentum e L. acidophilus. Tale schema va ripetuto dopo 15 giorni d’interruzione e poi
Probiotics supplementation during summer training activities to ascertain an athlete's reaction to a product and the presence/absence of undesired effects. During the first days of probiotic consumption, in fact, an increase in flatulence and borborygmus may be observed, but this enhanced intestinal activity should not be viewed as a cause for concern, since it merely reflects bacterial colonisation underway. Probiotics supplements should be handled and stored appropriately, avoiding exposure to heat sources.

In actual practice, at our sports club U.S. Città di Palermo we have defined a supplementation protocol (Figure 3) that begins as early as the pre-championship retreat and is comprised of an initial 21-day stage characterised by a clearly defined sequence of activities: during the first seven days, the athletes are given a blend of lactic ferments consisting of *Saccharomyces cerevisiae* sub. *bouardi, Enterococcus faecium, Lactobacillus acidophilus*, during the following 7-day period they get probiotics of the following species *Bifidobacterium lactis*, *brev, bifidum* and *longum*, and during the last 7-day period they are given *L. rhamnosus* and *L. acidophilus*. At the end of the 21-day period, the protocol provides for a 15-day wash-out period, followed by another 30-day stage during which a blend of *L. rhamnosus, B. lactis, B. longum, L. plantarum* e *L. acidophilus* is administered in the course of the first 20 days, and a blend of *L. fermentum* and *L. acidophilus* is given during the last 10 days. This sequence is repeated after a 15-day break and then repeated again at 1 month intervals for 6 months; the aim of this long-term treatment is to bring about a relatively "stable" change in the intestinal microbiota of the athletes. We believe there are no absolute certainties, and the sequence takes into due account a variety of factors: "barrier," "abdominal gas," "immune modulation," "topographic location," and "nutrient optimisation."

In day-to-day practice, with a view to promoting better compliance and more appropriate utilisation practices, athletes should be encouraged to monitor their own reactions to the quantities of probiotics consumed.

**Conclusions**

Probiotics may reduce the risk of gastrointestinal and respiratory disorders during training periods and in the course of stressful competitions. The health benefits of probiotics may be
attributed to changes in the intestinal microbiota and the modulation, enhancement and preservation of the integrity of the mucosal barriers in the gastrointestinal and respiratory tracts. Practical issues to be addressed in connection with probiotics supplementation include a medical-nutritional anamnesis of the individual athlete, strain selection and dose identification as a function of inter-individual variability.

As for the ergogenic effects of probiotics on athletic performance, at present the literature provides no evidence that athletic performance can be improved by the consumption of probiotics. However, a daily dose of 10^{10} live bacteria may offer athletes a valid support for maintaining a good state of general health, by improving their immune function, and it seems capable of providing no evidence that athletic performance, at present the literature presents only potential beneficial effects include the preservation of a healthy intestinal microbiota, which, in all likelihood, can be a valid means for preventing illness and protecting the organism against stressors such as travel, infective agents, use of antibiotics.

There is still much work to be done, however, to determine which strains are most effective, and dose-response studies are called for to define probiotics-supplementation best practices for the sports community.

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