The Role of the Gut Microbiome in Dancers

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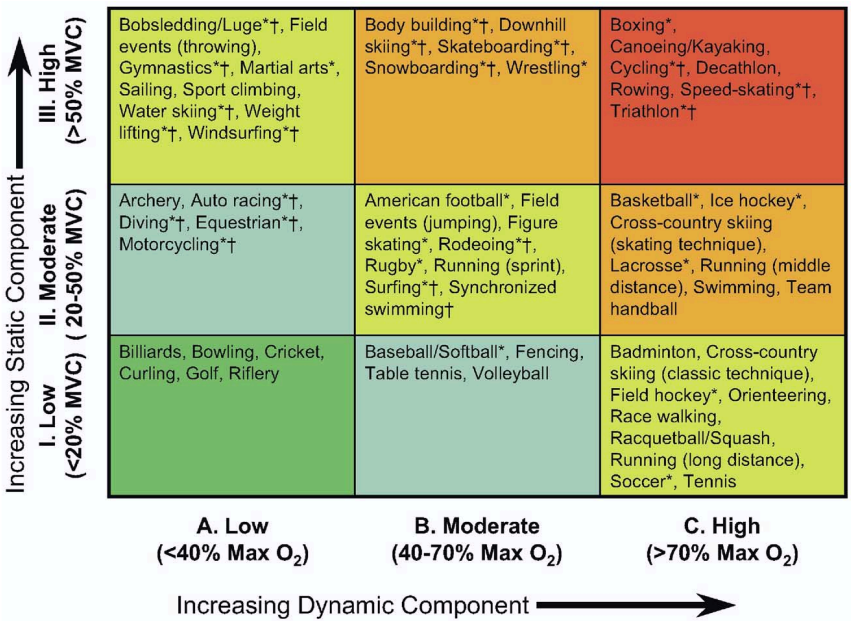
Introduction

The gut cavity has proven to be a significant regulator of health in humans; affecting everything from sickness to mental health. One area of research that is beginning to be explored is the role of the gut microbiome in athletes. If bacteria can impact someone's mental health, can bacteria also impact someone's athletic performance? Recent studies have shown that there are several different types of bacteria associated with improved athletic performance. The specific bacteria present in athletes vary based on whether a sport is more dynamic or static. Dynamic sports are those that involve more cardio exercise, while static sports are those that involve more muscle contraction. In a study by Mitchell et al., various sports were classified based on maximal oxygen uptake and maximal voluntary contraction.[1]



[1]https://www.semanticscholar.org/paper/Task-Force-8%3A-classification-of-sports.-Mitchell-Haskell/15ff2036f16bdf12b31eaefd9d887b4d66fb423e

One sport that was found to be missing from all of these studies was dance. Dancers are unique in that they perform both highly dynamic and static movement with a main goal of achieving an artistic or aesthetic quality. Research on the association of the microbiome and dancer's performance may explain certain injuries that dancers experience and provide information about nutritional habits that may improve performance. This review will analyze what is known about the gut microbiome of elite athletes and examine if any of that information could apply specifically to dancers. Additionally, this review will identify gaps that remain in the research of the microbiome and will suggest possible topics for future research.

Dynamic Sports

Dynamic sports, which involve high amounts of oxygen uptake, have several gut bacteria associated with them. The majority of research has been done on marathon runners and a bacteria named *Veillonella Atypica*. In a study conducted by Scheiman *et al*.,[2] stool samples were collected before and after a marathon, and when compared, *V. Atypica* was found to be more abundant in the runners' stool post-marathon. Further tests concluded that a higher abundance of *V. Atypica* is associated with a longer run time. This bacteria is able to reduce muscle fatigue through metabolizing the increased amount of lactate produced during exercise. During exercise, the body does not get enough oxygen to complete the cellular respiration cycle, so it goes into anaerobic glycolysis. This is essentially the first step of cellular respiration which produces a little bit of energy and lactate as a byproduct. When the lactate enters the gut, *V. Atypica* metabolizes it to short-chain fatty acids (SCFAs) acetate and propionate through the

[2] O'Donovan, C. M., Madigan, S. M., Garcia-Perez, I., Rankin, A., O' Sullivan, O., & Cotter, P. D. (2020). Distinct microbiome composition and metabolome exists across subgroups of elite Irish athletes. *Journal of Science and Medicine in Sport*, *23*(1), 63–68. https://doi.org/10.1016/j.jsams.2019.08.290

methylmalonyl-CoA pathway. Another study by Wierzchowska-McNew[3] showed that individuals with higher concentration of SCFAs, including acetate and propionate, demonstrated less muscle fatigue than individuals with lower concentration of SCFAs. SCFAs were found to act as metabolic fuel during long periods of muscle use. So the more lactate that is produced during exercise, the more propionate and acetate *V. Atypica* can produce which reduces muscle fatigue. Additionally, bacteria *Bifidobacterium animalis, Lactobacillus acidophilus, Prevotella intermedia, and Faecalibacterium prausnitzii* were found to be associated with sport classification group C1 (high dynamic, low static) in research by O'Donovan's et al. Additionally, in a review by Dziewiecka et al.[4] it is mentioned that moderate exercise may increase the abundance of these bacteria more than extreme exercise. *V. Atypica* is currently known to be the most predominant bacteria to assist athletes with dynamic movements, by metabolizing lactate into propionate and acetate to reduce muscle fatigue.

Static Sports

Static sports, which involve increased muscle tension, interestingly have less bacterial abundance differences associated with them. A possible reason for this is that the main functions of bacteria in the gut microbiome are to break down compounds such as complex carbohydrates and indigestible fibers. Since muscle contraction is not associated with breaking down compounds, bacteria may not be very useful in improving that function. However, there have been several

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[3] Wierzchowska-McNew, R., Marielle P.K.J. Engelen, Knoop, K. D., Kirschner, S. K., Cruthirds, C. L., & Nicolaas E.P. Deutz. (2021). Lower Plasma Short-Chain Fatty Acids Are Associated With Increased Leg Muscle Fatigue in (Morbidly) Obese Adults. *Current Developments in Nutrition*, *5*, 1258–1258. https://doi.org/10.1093/cdn/nzab055_068

[4] Dziewiecka, H., Buttar, H. S., Kasperska, A., Ostapiuk-Karolczuk, J., Domagalska, M., Cichoń, J., & Skarpańska-Stejnborn, A. (2022). Physical activity induced alterations of gut microbiota in humans: a systematic review. *BMC sports science, medicine & rehabilitation*, *14*(1), 122. https://doi.org/10.1186/s13102-022-00513-2

metabolic pathways found to increase with static athletes. From research by O'Donovan et al., samples from sport classification group C2 (moderate static, high dynamic) show an abundance of 5 pathways: SO4ASSIM-PWY, PWY821, ARGININE-SYN4-PWY, P162-PWY and ARGORNPROST-PWY, which are involved with acetate biosynthesis and sulfate degradation. Acetate can be used by the body as an alternative fuel source during periods of aerobic exercise and muscle growth.[5] The degradation of sulfate has also been shown to improve myofiber regeneration,[6] which often happens during static sports. In sport classification group C3 (high static, high dynamic) pathways involved with folate and amino acid biosynthesis were found to be 1.5 times greater than other classification groups. In classification group A3 (high static, low dynamic) 5 pathways were found to be associated and zero species were associated. This shows that pathways are the main drivers of improving muscle function for athletes who practice static sports.

Application to Dance

Dance is unique in that it is a very versatile activity. It requires strength, flexibility, and stamina. It requires both static and dynamic exercise. Because of this, it is likely that any bacteria or pathway mentioned in this review shown to assist athletic performance will also assist dancers during their training and performances. In a review done by Dziewięcka et al.,[7] species of *Veillonella, Faecalibacterium,* and others were shown to have an increase in abundance after

[5] Ismaeel, A., Valentino, T. R., Burke, B., Goh, J., Saliu, T. P., Albathi, F., Owen, A., McCarthy, J. J., & Wen, Y. (2023). Acetate and succinate benefit host muscle energetics as exercise-associated post-biotics. *Physiological reports*, *11*(21), e15848. https://doi.org/10.14814/phy2.15848

[6] Mikami, T., Koyama, S., Yabuta, Y., & Kitagawa, H. (2012). Chondroitin sulfate is a crucial determinant for skeletal muscle development/regeneration and improvement of muscular dystrophies. *The Journal of biological chemistry*, *287*(46), 38531–38542. https://doi.org/10.1074/jbc.M111.336925

[7] Dziewiecka, H., Buttar, H. S., Kasperska, A., Ostapiuk–Karolczuk, J., Małgorzata Domagalska, Jacek Cichoń, & Skarpańska-Stejnborn, A. (2022). Physical activity induced alterations of gut microbiota in humans: a systematic review. *BMC Sports Science, Medicine and Rehabilitation*, *14*(1). https://doi.org/10.1186/s13102-022-00513-2

moderate exercise. Furthermore, a study mentioned in this review, by Grosicki et al.[8], found that the highest amount of diversity in the gut microbiome in marathon runners was during periods of low intensity training. This means that participating in a moderate amount of exercise can increase the diversity of the gut microbiome. Considering the versatility of dance, participating in moderate amounts of dance training could increase various types of bacteria, not just types associated with specific sports. Furthermore, having a diverse gut microbiome is beneficial in preventing diseases and fighting illnesses. Participating in dance could be useful to improve the health of the average person as well as diversifying the microbiome of elite athletes who mainly participate in one type of exercise. Other ways to increase these beneficial bacteria is through diet. For example, *V. Atypica* is found in places with a lot of lactate so eating yogurt, sourdough bread, and kefir can increase the abundance of *V. Atypica* in the gut. For people who do not do excessive amounts of dynamic exercise, diet could help improve stamina in regular life or their respective sports.

Conclusion

Dancers train their bodies to be versatile performers. Their microbiomes are likely different from those who are not athletic, or performing both static and dynamic movements. Bacteria found to assist athletes in performing primarily dynamic movements include *Veillonella Atypica, Bifidobacterium animalis, Lactobacillus acidophilus, Prevotella intermedia and Faecalibacterium prausnitzii*. The majority of current research explores the function of *Veillonella Atypica*. In static sports, no studies have identified bacteria in the gut associated with enhancing the performance of athletes. Instead, several pathways have been identified, which

[8] Grosicki, G. J., Durk, R. P., & Bagley, J. R. (2019). Rapid gut microbiome changes in a world-class ultramarathon runner. *Physiological Reports*, *7*(24). https://doi.org/10.14814/phy2.14313

assist with acetate biosynthesis and sulfate degradation. This suggests that *Veillonella Atypica, Bifidobacterium animalis, Lactobacillus acidophilus, Prevotella intermedia and F. prausnitzii* may be present in more significant amounts in dancers to assist them with the dynamic components of dance. Current research also shows that acetate, folate, and amino acid biosynthesis as well as sulfate degradation pathways may provide the most assistance to dancers with the static components of dance by providing an alternative fuel source and improving myofiber regeneration. It is also possible that many of the bacteria in the gut may have additional functions in the body that are not yet understood. Future research should explore the microbiome of dancers to see if there are significant differences between other activities performed by humans and should explore the functions of bacteria relevant to dancers and how they differ from other athletes.

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