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Gut health and Exercise: A Review of Current Evidence

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Abstract: ***Gut microbiota are the microorganisms in the human Gastro Intestinal Tract that plays a major roles in human health. Human microbiomes are present as much higher levels than the normal number of cells in human body. Microbiota helps to regulate the nutritional activities, various metabolic functions and protection from pathogenic microorganisms. Now a days many researchers showing the importance of physical activities like exercise on gut microbiome and human health. This review conveys the current status of exercise induced microbiota alterations and to explain how these changes helpful for human health.***

Keywords: Exercise, Microbiome, Gut microbiota, Physical activity

1. Introduction

The World Health Organization (WHO) states that regular exercise can reduce cardiovascular risks and metabolic diseases, including type 2 diabetes, insulin resistance, and obesity, as well as some mental and cognitive problems, such as anxiety and depression, and maybe some cancers [1]. The human Microbiome consist of a group of microorganisms as symbiosis with human body. It is estimated to have 10^{14}–10^{15} bacteria [2]. These microorganisms found many of the parts of body. Those are mostly concentrated in the oral cavity, Gastro intestinal tract and skin. The human gut microbiome has more than 150 times number of genes that usually present on human genome [3]. Those increased number denotes the complexity and diversity of composition, metabolic compound productions, host interaction and health- disease relationship.

The gut microbiota is a essential thing of our body. It will help the regulation of many metabolic pathways, which leads to the host – microbiome interaction that connect muscle, gut and brain. These interactions are contributed to the metabolic activity of host [4]. Imbalanced gut microbiota was seen on peoples with diseases like metabolic syndrome, cognitive dysfunction than healthy peoples. This imbalanced gut microbiome will lead to disease onset and as well as vicious cycles [5]. Here investigated whether exercise training led to balance the gut microbiota and contribute to health improvement.

2. Gut Microbiome and Exercise

Exercise have the ability to significantly modify the composition of the gut microbiota. Physical activities like Exercise protects against various chronic diseases, and the gut microbiome might be takes place in majority of these beneficiary effects [6]. By the positive role of physical activities in homeostasis and energy regulation induces alterations in intestinal microbial composition. The change of gut microbiome depends on some of the factors of physical activities like type of Exercise, frequency of Exercise, intensity etc [7].

Several studies have conducted to correlate the composition and metabolic capacity of the microbiota with physical activities. According to study of Bressa et al. they state that increased level of *Faecalibacterium prausnitzii, Akkermansia muciniphila* and *Roseburia hominis* are found in women who performed at least 3 h of exercise per week than sedentary controls. *R. hominis* and *F. prausnitzii* are known butyrate producers. *A. muciniphila* has been linked with a lean body mass index (BMI) and also in better metabolic health [8]. Clarke et al. conducted a study on professional rugby players, greater diversity and higher relative occurance of 40 different bacterial taxa among professional rugby players than the intestinal microbiota of sedentary controls [9]. Another study of Durk et al. found that ratio of Firmicutes to Bacteroidetes were significantly correlated with maximum oxygen uptake of body [10]. Estaki et al. concluded that microbial diversity and presence of butyrate producing bacteria were positively linked with cardio respiratory fitness in younger adults [11]. A metagenomic analyses of Barton et al stated that altered intestinal microbial pathways for the amino acid synthesis, metabolism of carbohydrate and higher fecal Short Chain Fatty Acid (SCFA) concentrations in athletes [12].

3. Effect of Exercise on gut microbiota

Wide range of studies indicates that Exercise will modulates the SCFA production. The upregulation of SCFA directly improve gut microbiome and also positively improve brain function [13]. Higher Butyrate concentration was found on rats on 5 weeks of voluntary running wheels than sedentary controls by a study of Matsumoto et al. [14]. Another study of Estaki et al. found that increased production of SCFA in C57BL/6 mice subjected to voluntary running wheels for 6 weeks [15]. Fecal Microbiota Transplantation from C57BL/6J mice subjected to exercise was shown increased SCFA concentration than the sedentary mice [16]. Physical Exercise on human also seems to have the SCFA upregulation, higher fecal SCFA concentration seen among athletes [12].

Butyrate is a well-known compound to inhibit histone deacetylase [17]. Histone acetylation is process associated with chromatin relaxation, which can able to activate gene transcription [18]. The enzyme Histone deacetylases have the ability to remove histone-acetyl groups, which allows the DNA to wrap histones very tightly and repressing the

transcription [17]. Tight junction regulation proteins have crucial role on gut for the epithelial integrity maintenance, avoiding pro- inflammatory endotoxins translocation, especially lipopolysaccharides (LPS) into circulations. Lower level circulatory LPS seen in athletes than sedentary controls [19].

In a Japan based study on 33 elderly individuals, it is found that endurance Exercise for 5 weeks reduced the presence of *Clostridium difficile*, which is the main agent of infectious diarrhea by the toxin production in host intestine [20]. In addition to the increased abundance of beneficiary bacteria Exercise may also reduce the levels of few pathogenic bacteria.

Physical activities can enhance the levels of lactic acid bacteria, like *Bifidobacterium* and *Lactobacillus.* These organisms can produce lactate by fermentation of various carbohydrates. Subsequently, lactate can be used for Butyrate and Propionate production by the utilization of lactate [21].

Irisin production is another mechanism of Exercise influence on gut microbiota. Irisin protein shown reduced inflammations in animal model with ulcerative colitis in mice, which is a effect associated with altered intestinal microbiome [22].

Physical activities like exercises have ability to influence on the production of various amino acids like Tryptophan, Tyrosine and Phenylalanine by the intestinal microbiome, as seen in half marathon runners [23]. These amino acids have the ability regulate various metabolic functions of body.

Some studies found that adverse effect on gut microbiome when performing the endurance exercises such as microbial diversity decreasing, distress increasing and decrease intestinal permeability. Lowest benefits of microbiota obtained by strengthen physical activities. However, the studies obtained components that helps the microbiome and other activities at a time. These matters leading us to believe that there is a deficiency of absolute clarity on the mechanisms and environmental and personal factors that leads to the positive or negative effects of the microbiome as a function of physical activities [24].

4. Future Aspects

Future studies should perform on the number of physical activities that must be have a favourable effect on microbiome and the cut-off point of exercises that starts to worsen the gut microbiota.

5. Conclusion

Exercises were as a potential factor that favours the diversity of gut microbiome both in qualitative and as well as in quantitative manner. Beneficial effects of exercises on Gastro Intestinal Tract function, brain functions and mood, could be regulated by alteration of microbiota. Exercises have several effects like diversity enrichment of microbiota, improving Bacteroides/Firmicutes ratio, enhance mucosal immunity, improve barrier functions, stimulate bacterial species to produce substances have protective nature like SCFA, Butyrate etc.

The factors like duration and intensity of exercise have crucial role in significant changes in gut microbiota. Further studies are need to understand complete mechanism causing alteration on functions and composition of microbiome by exercises.

References

[1] World Health Organization (2020) WHO guidelines on physical activity and sedentary behaviour. World Health Organization. [Accessed 2024 Nov 5]. https://apps.who.int/iris/handle/10665/336656.
[2] Sender R, Fuchs S, Milo R. Revised estimates for the number of human and bacteria cells in the body. PLoS Biol [Internet]. 2016;14(8):e1002533.
[3] Qin J, MetaHIT Consortium, Li R, Raes J, Arumugam M, Burgdorf KS, et al. A human gut microbial gene catalogue established by metagenomic sequencing. Nature [Internet]. 2010;464(7285):59–65.
[4] Nicholson JK, Holmes E, Kinross J, Burcelin R, Gibson G, Jia W. Innovation in microbiome-based strategies for promoting metabolic health. Curr Opin Clin Nutr Metab Care. 2012;336:484–91.
[5] Romani-Perez M, Agusti A, Sanz Y. Innovation in microbiome-based strategies for promoting metabolic health. Curr Opin Clin Nutr Metab Care. 2017;20:484–91.
[6] Mailing LJ, Allen JM, Buford TW, Fields CJ, Woods JA. Exercise and the gut microbiome: a review of the evidence, potential mechanisms, and implications for human health. Exerc Sport Sci Rev. 2019;
[7] Clauss M, Gérard P, Mosca A, Leclerc M. Interplay between exercise and gut microbiome in the context of human health and performance. Front Nutr. 2021; 8:637010.
[8] Bressa C, Bailén-Andrino M, Pérez-Santiago J. Differences in gut mi crobiota profile between women with active lifestyle and sedentary women. PLoS One. 2017;12(2).
[9] Clarke SF, MurphyEF,O'SullivanO, et al. Exerciseand associated dietary extremes impact on gut microbial diversity. Gut. 2014; 63(12):1913–20.
[10] Durk RP, Castillo E, Márquez-Magaña L, et al. Gut microbiota composi tion is related to cardiorespiratory fitness in healthy young adults. Int. J. Sport Nutr. Exerc. Metab. 2018; 1–15.
[11] Estaki M,Pither J,BaumeisterP,et al. Cardiorespiratory fitness as a predictor of intestinal microbial diversity and distinct metagenomic functions. Microbiome. 2016; 4:42.
[12] Barton W, Penney NC, Cronin O, et al. The microbiome of professional athletes differs from that of more sedentary subjects in composition and particularly at the functional metabolic level. Gut. 2018; 67(4):625–33.
[13] Dziewiecka, H.; Buttar, H.S.; Kasperska, A.; Ostapiuk-Karolczuk, J.; Domagalska, M.; Cicho´n, J.; Skarpa´nska-Stejnborn, A. Physical activity induced alterations of gut microbiota in humans: A systematic review. BMC Sports Sci. Med. Rehabil. 2022, 14, 122.

[14] Matsumoto, M.; Inoue, R.; Tsukahara, T.; Ushida, K.; Chiji, H.; Matsubara, N.; Hara, H. Voluntary running exercise alters microbiota composition and increases n-butyrate concentration in the rat cecum. Biosci. Biotechnol. Biochem. 2008, 72, 572–576.
[15] Estaki, M.; Morck, D.W.; Ghosh, S.; Quin, C.; Pither, J.; Barnett, J.A.; Gill, S.K.; Gibson, D.L. Physical Activity Shapes the Intestinal Microbiome and Immunity of Healthy Mice but Has No Protective Effects against Colitis in MUC2. mSystems 2020, 5, e00515-20.
[16] Li, R.; Liu, R.; Chen, L.; Wang, G.; Qin, L.; Yu, Z.; Wan, Z. Microbiota from Exercise Mice Counteracts High-Fat High-Cholesterol Diet-Induced Cognitive Impairment in C57BL/6 Mice. Oxid. Med. Cell Longev. 2023, 2023, 2766250.
[17] Mohamed El fadil, O.; Mundi, M.S.; Abdelmagid, M.G.; Patel, A.; Patel, N.; Martindale, R. Butyrate: More Than a Short Chain Fatty Acid. Curr. Nutr. Rep. 2023, 12, 255–262.
[18] Allahverdi, A.; Yang, R.; Korolev, N.; Fan, Y.; Davey, C.A.; Liu, C.F.; Nordenskiöld, L. The effects of histone H4 tail acetylations on cation-induced chromatin folding and self-association. Nucleic Acids Res. 2011, 39, 1680–1691.
[19] Lira, F.S.; Rosa, J.C.; Pimentel, G.D.; Souza, H.A.; Caperuto, E.C.; Carnevali, L.C.; Seelaender, M.; Damaso, A.R.; Oyama, L.M.; de Mello, M.T.; et al. Endotoxin levels correlate positively with a sedentary lifestyle and negatively with highly trained subjects. Lipids Health Dis. 2010, 9, 82.
[20] Taniguchi, H.; Tanisawa, K.; Sun, X.; Kubo, T.; Hoshino, Y.; Hosokawa, M.; Takeyama, H.; Higuchi, M. Effects of short-term endurance exercise on gut microbiota in elderly men. Physiol. Rep. 2018, 6, e13935.
[21] Sales, K.M.; Reimer, R.A. Unlocking a novel determinant of athletic performance: The role of the gut microbiota, short-chain fatty acids, and “biotics” in exercise. J. Sport. Health Sci. 2023, 12, 36–44.
[22] Huangfu, L.X.; Cai, X.T.; Yang, J.N.; Wang, H.C.; Li, Y.X.; Dai, Z.F.; Yang, R.L.; Lin, X.H. Irisin attenuates inflammation in a mouse model of ulcerative colitis by altering the intestinal microbiota. Exp. Ther. Med. 2021, 22, 1433.
[23] Zhao, X.; Zhang, Z.; Hu, B.; Huang, W.; Yuan, C.; Zou, L. Response of Gut Microbiota to Metabolite Changes Induced by Endurance Exercise. Front. Microbiol. 2018, 9, 765.
[24] Bonomini Gnutzmann, R.,Plaza Diaz, J., Jorquera Aguilera, C., Rodriguez, A., & Rodriguez, F. Effect of intensity and duration of exercise on gut microbiota in humans: A systematic review. Int J Environ Res Public Health. 2022;19(15):9518.

Author Profile

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