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Original Article

The effect of aquarobics exercises on fibroblast growth factor 19 and 23 levels [FGF-19, 23] in young men

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Abstract:
A key component of success is enhancing athlete performance, which can be done in a number of ways, one of which is by ensuring that athletes have enough energy for training and competition by controlling their body's glucose and lipid levels as shown by the levels of fibroblast growth factors 19 (FGF-19) and 23 (FGF-23). As one of the water exercises, aquarobic is a modulator that works best to enhance athletic performance while preserving glucose and lipid levels. The purpose of this study is to determine how fitbar intake and aquarobic affect FGF-19 and FGF-23 levels.. Design of research, experimental 40 male athletes who were registered as students at the Faculty of Sports Science at Universitas Negeri Semarang and were 20 years old were divided up at random to four groups. —P1 intake fitbar (n=10), P2 aquarobic (n=10), P3 fitbar and aquarobic (n=10), and P4 control group (n=10). Treatment was daily for 14 days. Data collected the levels of FGF-19 and 2FGF-23 as well as the percentage of body fat before and after treatment, aquarobic intensity 75% HRmax. Using the One-Way Anova, Kruskal-Wallis, and mean difference tests (Tukey HSD and Mann Whitney's), hypotheses are tested. According to the study's findings, body fat percentage was higher in the P3 group in comparison to P1, P2, and control groups (13.73 + 4, 63; 12.96+4.28; 14.31+1.80; 12.31+0.80; p=0.000); the increase in FGF-19 levels was higher in P3 compared to P1, P2, and control group; the decreased in FGF-23 levels was higher in the P3 group in comparison to P1, P2, and control. For aquarobics fitbar group (P3) respectively, the plasma concentrations of fasted FGF-19 were 228±20 and 255±38 pg/ml, for the aquarobic fitbar group compared to the pre-exercise concentration to 189±18 pg/ml (P 0.05) and stayed through the recovery phase (P 0.05 at 3 hours post-exercise compared to pre-exercise). plasma FGF-23 levels in aquarobic and aquarobics fit bar were 146±11 and 162±17 pg/ml, respectively. FGF-23 peaked at 60 minutes (166±32 pg/ml), increased for 120 minutes after exercise, and then decreased by aquarobic 15 minutes into recovery (74 + 20 pg/ml) There are differences between the effects of intake fitbar and aquarobics on FGF-19 and FGF-23 levels in athletes. Increased levels of FGF-19 and decreased levels of FGF-23, with aquarobic and intake of fitbar having a stronger impact on these levels.
Key Words. waterfitness, blood glucose, lipid

Introduction

Efforts to improve sports achievements in Indonesia must be continued, bearing in mind that our country's sporting achievements continue to decline. The number of athletes who can excel both at international and regional levels is still limited. There are several important factors in achieving optimal athletic performance. The success of an athlete is determined by factors such as technical factors, tactics, good mental and strategic development, training methods and adequate facilities and infrastructure. However, it is no less important to maintain the athlete's physical condition or good nutritional status. Optimal performance of an athlete is largely determined by physical condition and nutritional status through a balanced supply of nutrients. The selected foods provide the necessary nutrients for the normal functioning of the body. On the other hand, if the food is not chosen correctly, ie. insufficient in quantity and quality, the body suffers from a deficiency of several essential

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nutrients. The primary energy-producing nutrients for a variety of physical activities, including sports, are carbohydrates, because carbohydrates can immediately be used for the movement of muscles, the function of the brain, the liver, and the function of red blood cells. The results of previous research (Pfeiffer et al.,2011) showed that consumption of carbohydrates in the form of glucose can increase inflammation through various events. A strategy is needed to minimize the effects of eating carbohydrate-rich foods for optimal endurance, considering that physical activity/severe exercise can also increase oxidative stress. The results of previous studies have shown that Low glycemic index foods lower the risk of obesity, diabetes, and heart disease, lower triglycerides, and increase HDL. (Barrera et al.,2022; Nur et al., 2022).

Aquarobic has a lower risk effect on limbs, joints and muscles due to the nature of water. The advantage of water resistance is that it is very suitable for muscle training, this resistance makes movement easier. This resistance acts as a load acting on all the muscles of the body. (Mukarromah et al,.2021; 2016) Previous studies reported that exercising in waist-deep water can reduce joint pressure by up to 50% chest height and joint pressure by 75%. (Li et al., 2017). Another study for 8 weeks, frequency 3-4 times a week, duration 60 minutes, can reduce TNF-µ and increase adiponectin levels. (Yanai, 2019) The findings of a different study also demonstrated that there was a substantial increase in performance over time after eating foods with a low glycemic index compared to high glycemic index foods, and fatigue in blood sugar concentrations after eating. Low glycemic index foods were significantly higher for food intake compared to high glycemic index foods.(Bauer C et al., 2022) Based on the previous description, research on the glycemic index between aquarobic and consumption of energy bars is still inconsistent and the mechanism for increasing performance is unclear. The overall goal of this research was to invetigates the impact aquarobics, intake fitbar and aquarobic fitbar on FGF-19 and FGF-23 levels in Central Java athletes.

Material & methods

Participants

The population of this study were athletes from Central Java. The sample in this study consisted of athletes who met the criteria and were willing to take part in this study and signed a form of informed consent. Before the research was carried out, there were inclusion and exclusion standards. first determined in the study population to get prospective research participants who were in accordance with the research objectives. The test subjects were selected using random sampling, after which the selected test subjects were divided into 4 groups, 3 treatment groups, P1 group (energy bar), P2 group (aquarobic), P3 group (aquarobics fit bar) and P4 control group did not receive treatment. 40 male athletes who were registered as students at the Faculty of Sports Science at Universitas Negeri Semarang and were 20 years old were divided up at random to one of four groups P1 energy bar (n=10), P2 aquarobic (n=10), P3 energy bar and aquarobic group (n=10), or P4 control group (n=10). Treatment was administered daily for 15 days. Examining the levels of fibroblast growth factors 19 and 23 as well as the percentage of body fat before and after treatment, aquarobic intensity 75% HRmax was used.

Study approval

All participants were made aware of the potential risks and read the study procedures before signing the informed consent form. The Indonesian Research Ethics Committee, Kariadi Hospital, Diponegoro University, Semarang (No.519/EC/FK/RSDK/2022) approved this study.

Aquarobic

1. Before treatment the sample's heart rate was checked before during treatment using an Omron sphygmomanometer.
2. Warm-up (15 minutes) with active and passive heating in the pool accompanied by music, heart rate monitored every 5 minutes of exercise.
3. First aquarobic session (20 minutes), in this phase the sample gets water running, jogging and aqua fitness exercises with a target of increasing heart rate to 65-70% of maximum heart rate and after 15 minutes heart rate is measured again.
4. Second aquarobic session (25 minutes), at this stage the sample is given exercise with exercise intensity increased to 75% HRmax.
5. Cool down exercise (15 minutes) with active and passive cool down in the pool accompanied by music, heart rate monitored every 5 minutes during exercise until 15 minutes after the exercise is finished.

Monitoring of Heart Rate

Monitoring heart rate while exercising is essential to achieving fitness goals, especially in sports training intended to enhance cardiovascular health and promote weight loss. Establishing training zones, or the areas of the body where aerobic exercise and fat burning are most beneficial, is crucial when creating an exercise program. without first identifying our target heart rate training zone and starting a program of exercise (Suchomel et al., 2021). Heart rate measurements were carried out from the start before exercise to the end of exercise which were monitored at each training session for 14 days of treatment. The heart rate data collection technique consisted of the subject recording his heart rate before starting the exercise while seated, after which The subject performed warm-up exercises for 15 minutes., 20 minutes of first session, 25 minutes of second session and 15 minutes cooling down and then the subject recorded his heart rate again until it returned to normal on the baseline.

Fit Bar Compotition

The body receives essential carbohydrates from energy bars to fuel exercise, energy bars are extra bars made with cereals, micronutrients, and flavorings that are meant to provide quick energy. Fitbar may be marketed as functional foods because they typically include extra protein, carbohydrates, dietary fiber, and other nutrients. Rice Crispy (19.7%), Oats (12%), Raisin (10.8%), Glucose Syrup Whole Wheat Flour (5.6%), Soy Puff, High Fructose Syrup, Margarine, Sucrose, Natural Sweetener Isomalt, Vegetable Humectant Glycerine, Natural Sweetener Maltitol, and Quinoa Powder (1%), White Chocolate Compound Coating (Sugar, Vegetable Fat Milk0, Inulin, Skim Milk Powder, Identical Natural Strawberry Flavor, Salt, Tocopherol and Ascorbyl Palmitate Antioxidants, Calcium Carbonate, Sodium Ascorbate, Vitamin A, and Vitamin B12. Allergens: Gluten Traces**:** Gluten, Milk, Soybeans.(Fruits Fitbar - MultiGrain - 24.0g).

Anthropometric Measurements

A 150kg (OMRON B511), a large-capacity digital platform scale with 0.5 kg of precision and a stiff 2 m by 50 cm tape measure, were used to assess the the body mass index and height (m). Body mass and In order to calculate the Body Mass Index (BMI-kg/m2), height measurements were used, Low BMI was set at 18.5, normal at 18.5-24.9, overweight at 25-29.9, and obesity at 30.4 kg/m2, and obesity grade II was 35 kg/m2.

Blood Serum for fibroblast growth factors 19 and 23

As part of a diagnostic examination process for laboratory tests, blood is drawn from a vein. The central vein, a large saphenous vein, or another monitor vein large enough to obtain a quality and representative blood sample will be used by the medical officer to draw blood. Blood was drawn from a vein as the subject rested in a chair right after the aerobic exercise treatment. The procedure for drawing blood is the same as the procedure used to draw blood during the pre-test. Before, after, and 24 hours after exercise, blood samples were taken. Spectrophotometer measurements of FGF 19 and FGF-23 should be made. The Human Fibroblast Growth Factor 19 (Hu FGF-19) Hu FGF-19 can be measured using an ELISA in human serum, plasma, or cell culture medium. Both natural and recombinant Hu will be exclusively recognized by the assay FGF-19 was used. Human FGF-23 quantitates human FGF-23 in the supernatant, plasma, and serum. Both natural and recombinant human proteins will only be recognized by the assay. FGF-23 Tumor-derived hypophosphatemia inducing factor, phosphotonin, fibroblast growth factor 23 N-terminal peptide, and C-terminal peptide (Human Q9GZV9) Tumor-derived hypophosphatemia-inducing factor Sandwich ELISA Kit).

Statistical analysis

The gathered information is cleaned, coded, and tabulated electronically. Analyzing data also involves testing hypotheses and descriptive analysis. In graphs and tables, Mean and standard deviation are displayed for interval and ratio data, while frequency distributions are displayed for nominal and ordinal data. Prior to putting the theory to the test, the data were examined for homogeneity of variance using the Levene Statistics Test of Homogeneity of Variance and normality using the Shapiro-Wilk test. After performing a parametric one-way ANOVA, data with a normal distribution and homogeneous data variance were examined using the Tukey's HSD post hoc test (open significant difference). The data were analyzed non-parametrically by first performing the Kruskal-Wallis test, then the Mann-Whitney differential test, despite the fact that they were not normally distributed or that the variance was not homogeneous. The SPSS system for Windows version 21 was used to test the results of measurements and calculations (Agus, 2009; Hartono, 2011). For the entire analysis, a 95% confidence level was used.

Results

Table 1. An overview of the subject's age, energy intake, protein intake, fat intake, height, weight and percentage of body fat before and after treatment is presented in Table 1.

Tabel 1. Characteristic of Subject

Variabel	P1 Mean ± SD [n-10]	P2 Mean ± SD [n-10]	P3 Mean ± SD [n-10]	Control group Mean ± SD [n-10]	p
Age (year)	20.49±1.41	20.74±1.30	20.79±1.35	20.79±1.35	0.225(1)
Intake energi (ccal)	2157± 119.97	2125± 165.81	2134± 136.11	2134± 136.11	0.112(1)
Iintake protein (g)	48.38±1.67	44.91±1.63	45.38±1.78	45.38±1.78	0.608(1)
Intake fat (g)	69.87±3.83	63.93±3.12	65.66±3.34	65.66±3.34	0.265(1)
Height (m)	1.52 ± 0.04	1.55 ± 0.05	1.52 ± 0.04	1.52 ± 0.04	0.151(1)
Weight (kg) *pre*	56.41±3.11	55.66±5.54	55.41 ±6.61	55.41 ±6.61	0.539(1)
Weight (kg) *post*	54.25±3.49	53.16±4.60	55.41 ± 6.61	55.41 ± 6.61	0.370(1)
Fat percentage [%] *pre*	15.54±3.43	16.53±2.74	14.38 ± 1.54	14.38 ± 1.54	0.362(1)
Fat Percentage [%] *post*	13.73±4.63	12.96±4.28	14.31 ± 1.80	12.31 ± 0.80	0.000(1)

The average age, height and weight of the subjects before and after the treatment were not statistically significant in all groups, while the percentage of body fat after the treatment was significantly different compared to the control group in the treatment group (p=0.000). Calculation of nutrient consumption is based on nutritional needs according to Ministerial Regulation No. 75 of 2013 concerning the recommended nutritional adequacy of the Indonesian population according to age and sex, energy needs of children aged 20 years. Age 39 years is 2625 kcal, protein 65 g, fat 73 g, and the energy needs of women aged 40-54 years are 2325 kcal, protein 65 g, and fat 65 g. In this study, a 24-hour food recall was used to measure food intake. Based on the calculation results of the Nutrisoft software, it was found that the energy, The amount of protein and fat consumed by each group did not differ significantly (p=0.112, p=0.608, p=0.265). These findings suggest that the food is the same in all groups during the treatment, so food does not affect the results of this study.

Fibroblast growth factors 19 (FGF-19)

For aquarobics fitbar group (P3) respectively, the plasma concentrations of fasted FGF-19 were 228±20 and 255±38 pg/ml. FGF-19 remained unchanged during the three-hour recovery period and was not impacted by aquarobics (P3) (Figure 1). FGF-19, on the other hand, was significantly reduced the 90 minute of the Recovery period for the aquarobic fitbar group compared to the pre-exercise concentration to 189±18 pg/ml (P 0.05) and stayed through the recovery phase (P 0.05 at 3 hours post-exercise compared to pre-exercise). However, there was not a statically significant significant difference between the control group and another fit bar group's plasma FGF-19 concentration during the recovery phase (P>0.05).

The level of FGF-19 changed significantly after treatment on day 14 as shown in Figure 1. FGF-19 levels in the treatment group have changed as a result of insulin deficiency, which has an impact on lipid metabolism. In food, fat is used to store energy. Carbohydrates are transformed into fat deposits by the liver and adipose tissue. In earlier research, insulin-deficient animals used less glucose and had to mobilize stored fat to provide energy for cellular processes. Free fatty acids and triglycerides, two types of blood fat, rise in blood levels. The tricarboxylic acid cycle is used by the liver to complete the oxidation of fatty acids to 2-carbon acetyl-CoA. However, in insulin-deficient animals, both glucose absorption and acetyl-CoA oxidation are decreased (Bloomgarden, 2018). Lack of insulin results in decreased glucose uptake, which stimulates increased gluconeogenesis by boosting protein catabolism. When there is intercellular dehydration, the increase in protein catabolism is more pronounced. This is followed by potassium diuresis, which is caused by insulin deficiency impairing enzymes like hepatic glucokinase that are involved in fatty acid synthesis. In contrast, higher hepatic enzyme concentrations in diabetic animals were linked to increased gluconeogenesis (Yang et al., 2020; Rodgers, 2022).

FGF-19 functions as an endokrin hormone in the regulation of lipid metabolism, glucose homeostasis, and asam empedu syncytia. As a parakrin effector, FGF-19 is involved in angiogenesis, differentiation, embriogenesis, and pertumbuhan, whereas as an autokrin function mediator, FGF-19 promotes metastasis invasion and cell proliferation. FGF-19 was activated and returned to the heart in order to activate the biosynthetic asam empedu jarl. (Camilleri, 2022; Nakamura et.al., 2013). FGF-19 regulates endokrin metabolism in the asam empedu hati, according to earlier research that indicated that FGF-R4 is the receptor for FGF-19, which is expressed in the ileum. Interest in FGF-19 as a metabolic regulator was sparked by the observation that, given the role of FGF-19 in various physiological events, transgenic mice expressing FGF-19 had reduced levels of lipids, hepatic triglycerides and glucose, as well as increased fatty acid oxidation capacity and improved insulin profiles (Schmid et al., 2015) by blocking CYP7A1, the first and rate-limiting enzyme in the main bile acid synthesis pathway, FGF19 has a significant impact on hepatic bile acid homeostasis (Hu et al., 2020; Dolegowska et al., 2019). Following a meal, FGF-19 also encourages rest and gallbladder refilling, has roles in bile acid metabolism in addition to lowering triglycerides and blood sugar in diabetic mice through an unknown mechanism (Wu et al., 2012; 2011).

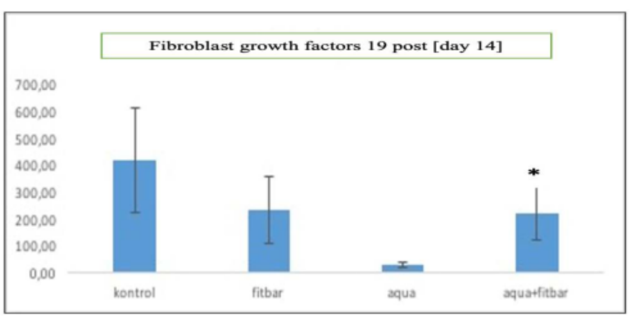

Figure 1. Profile of Fibroblast growth factors 19 (FGF-19) after treatment [day 14]

FGF-23

FGF-23 a phosphaturic hormone that aids in maintaining phosphate homeostasis and inhibits the 1,25-dihydroxyvitamin D production is involved in the mineralization of bones. Recent research has focused on the pertinent direct myocardial effects of FGF-23, and elevated plasma levels of this protein have been associated with negative cardiovascular outcomes in people, including arrhythmias and heart failure. FGF-23 has consequently developed over the past ten years into a novel biomarker of cardiovascular risk. FGF-23 is in fact a direct mediator of the emergence of cardiac hypertrophy, cardiac fibrosis, and cardiac dysfunction, according to experimental data. through a particular activation of the myocardial FGF receptor (FGF-R). Therefore, decreasing FGF-23's detrimental effects on the cardiovascular system may be achieved by the therapeutic goal of the FGF-23/FGF-R pathway. Understanding the intracellular FGF-23 dependent mechanisms, elucidating the downstream pathways, and choosing the most appropriate targets for an improved therapeutic intervention, more study is required (Vázquez et.al., 2021; Leifheit, 2018).

Prior to exercise, plasma FGF-23 levels in aquarobic and aquarobics fit bar were 146$\pm$11 and 162$\pm$17 pg/ml, respectively. FGF-23 peaked at 60 minutes (166$\pm$32 pg/ml), increased for 120 minutes after exercise, and then decreased by aquarobic 15 minutes into recovery (74 + 20 pg/ml) (P 0.01 for 15 min; P 0.001 for 30 min; 60 min; and 90 min) at any time point, aquarobics a had no effect on the plasma FGF-23 concentration (Figure 2). As a result, from 30 to 120 minutes after aquarobics and aquarobics fit bar compared to fit bar and control group, The level of plasma FGF-23 was higher (P = 0.023 for 120 minutes after aquarobics and P 0.001 for 30, 60, and 90 minutes after exercise and aquarobics fitbar). The level of FGF-23 changed significantly after treatment on day 14 as shown in Figure 2. Bone produces some amount of FGF-23 as a 251 amino acid peptide, The protein FGF23 that is secreted is 32 kD and has 227 amino acids in size, it has a 24 amino acid signal peptide (Liu et.al., 2021). These biochemical and molecular interactions' potential mediators have been identified as a number of signaling factors produced by bone and muscle. These include the IGF family and myostatin, as well as the bone and muscle growth factors Wnt1 and Wnt3a, PGE2, FGF9, RANKL, osteocalcin, and sclerostin. The possibility of developing novel pharmaceutical strategies that will enable the simultaneous treatment of illnesses like osteoporosis and sarcopenia, which frequently coexist, is both very real and exciting. This is because the discovery of these signaling molecules and the mechanisms that underlie them opens up this possibility (Lara-Castillo, 2020; Karampatsou, 2022).

The 14-day treatment showed that FGF-23 inhibits sodium phosphate cotransporters types 2a and 2c, which are involved in physiological phosphate reabsorption, from expressing at the proximal tubular brush junction. Additionally, 25(OH)D-hydroxylase expression was inhibited and 25(OH)D-24-hydroxylase expression was elevated by FGF-23, which led to a decrease in levels of serum 1,25(OH)2D. This 1-hydroxylase mediates the formation of 1,25(OH)2D from 25(OH)D by converting 1,25(OH)2D into a more hydrophilic metabolite with lower activity. According to these findings, FGF-23 are all linked to being overweight or obese and change in response to changes in BMI. Additionally, they suggest a relationship between bone and adipose tissue and may function as potential biomarkers of glucose metabolism. Determining the physiological mechanisms underlying this association in kids and teenagers will require more research (Karampatsou, 2022).

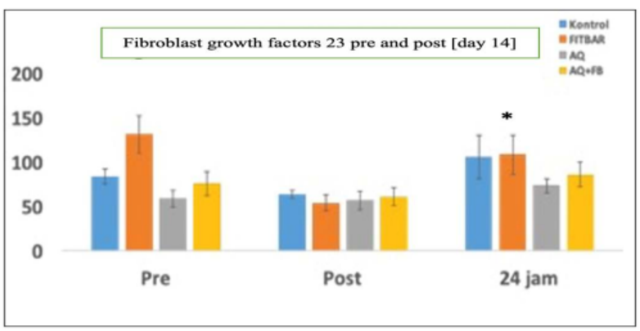

Figure 2. FGF-23 levels before and after treatment

Discussions

Here, for the first time to our knowledge, we report the effects of aquarobic on plasma concentrations of FGF-19 and FGF-23 in healthy humans. After aquarobics, we noticed a coordinated incline in FGF-19 during the healing process. On the other hand, we discovered that aquarobics fitbar decreased plasma FGF-23 and that a significant increase in plasma glucagon levels occurred suggesting that aquarobic fitbar coordinated the regulation of glucagon and FGF-23 before the FGF-19 increase. Notably, despite the fact that exercise reduced the abundance of the majority of BA species, With both Aquarobic and Aquarobic fit bar, LCA, a TGR5 receptor agonist, was significantly induced.

Recognizing the mechanisms by which physical activity controls human biology may lead to the creation of brand-new pharmacotherapies that mimic exercise as well as improved exercise regimens for disease prevention. Exercise has a variety of positive health effects (Zierath, 2015). The mode of exercise has a big effect on endocrine signals, which precede several exercise-regulated molecular and physiological adaptations. However, we still don't fully understand how the benefits of long-term systemic health are supported by factors secreted during exercise The bile acid FGF-19 axis is an endocrine feedback system that is crucial for dietary lipid absorption in the enterohepatic circulation (Chávez et al., 2017). An important endocrine axis in energy metabolism is the FGF-19 axis over the past ten years. Serum BAs improve lipid and glucose metabolism and boost energy expenditure by activating the membrane receptor TGR5, which are two metabolic advantages of bariatric surgery (Broeders et al., 2015; Szczepańska et al., 2022). When BA-activates the farnesoid X receptor (FXR) in the small intestine, endocrine FGF19 is produced (Thomas et al., 2009).

It has long been known that consuming carbohydrates while aquarobic can increase exercise capacity and enhance exercise performance, though the precise mechanisms are still not fully understood (Jeukendrup, 2010). In comparison to placebo ingestion, carbohydrate feeding will typically prevent hypoglycemia during exercise lasting longer than 2 hours, increase endurance capacity while maintaining high rates of carbohydrate oxidation. At first, it was thought that for carbohydrates to have an impact, exercise had to last at least two hours. However, it has recently become evident that eating carbohydrates while exercising can boost even when the time is shorter bouts of exercise that is more intense (for example, an hour at 75% of VO2max). Achieving these enhancements have a totally different mechanism at work (Andrey et al., 2022; Kalmykova, 2018). In fact, it was shown that despite high rates of uptake when injected into the systemic circulation with glucose, there was no performance impact, shows that increasing the amount of glucose available during this type of activity, there is no effect on the working muscle. However, it's interesting to note that people who rinsed their mouths with a carbohydrate solution. performance improvements that were remarkably similar to those obtained with carbohydrate consumption (Kelly et al., 2010; Peinado et al., 2013; Consitt, 2019). There are currently a large number of studies that, taken together, show that this effect is real. Several recent papers review those studies, this would imply that the advantages of eating carbohydrates while exercising go beyond their usual metabolic benefits and may also contribute to the generation of a stronger afferent signal, which has the capacity to alter motor output; these effects are carbohydrate-specific and taste-independent (Kerksick et al., 2017; Lambert CP, 2018).

Conclusions

The manifestation of endogenous FGF-19 in response to BA-induced FXR activation may be partially responsible for the increase in interest in metabolic signaling molecules using BAs. FGF-19, in particular, affects the brain's glucose levels by lowering them and raising energy expenditure (Morton et al., 2013; Habegger et al., 2013; Mei et al., 2017). We hypothesized that an enterohepatic muscle axis might be involved in how FGF-19 encourages the growth of muscles in response to resistance training after it was discovered more recently that pharmacological FGF-19 had effects of anabolism on skeletal muscle (Benoit et al., 2017). Here, we provide evidence that refutes this theory. Replacing it with a potent increase in circulating FGF-19 during the recovery phase, aquarobics fit bar. This suggests that the BA/FGF-19 axis may play a role alterations in physiological processes that aquarobic and that induction is not as effective as suppression may mediate these adaptations. We discovered that aquarobics fit bar group decreased FGF-23, which is consistent with an increasing number of studies, we demonstrate that the induction of With a 1-hour delay between their peak levels, FGF-23 and glucagon are comparable, supporting the idea that fitbar group and control the glucagon/FGF-23 axis (Ramanjaneya et al., 2020; He et al., 2018). Surprisingly, FGF-23 and glucagon were unaffected by aquarobics, as a result, the metabolic pathways become disconnected from metabolic stress brought on by contraction, which is shown by the substantial increase in plasma lactate following aquarobics fit bar and the increased FGF-23 following aquarobic. The fact that the glucagon concentrations after aquarobic remained constant and gradually decreased throughout the recovery period supports the relationship between FGF-23 and glucagon (Sørensen, 2020; Gupta, 2004; Swanson, 2017).

It is important to note some restrictions on our study. The feeding status and/or particular macronutrients control each of the endocrine factors that were examined in this study. Therefore, Following controlled dietary intake on the nights before test days, we investigated the effects of exercise and post-exercise under fasting circumstances in order to reduce confounding variables. Another limitation is that our results only apply to relatively well-trained young men. Future research should therefore identify potential differences in the effects of exercise on changes in plasma BA composition and levels of circulating FGF-19 and FGF-23 based on sex, age, and metabolic condition. Last but not least, to determine the cause and effect of the herewith reported FGF-19, and FGF-23 and a potential implication for aquarobics caused health advantages, Training programs for aquarobic and aquarobic fitbar, as well as pharmacological and genetic research, are necessary. We conclude by reporting distinct effects of aquarobic and aquarobics fit bar on the levels of FGF-19, and FGF-23 found in circulation in adolescent, healthy people. We discover, to our knowledge, temporal relationships between increased FGF-19 levels after aquarobic fit bar and desreased in FGF-23 concentrations, with A noticeable increase parallel to glucose (glucagon) levels is produced during aquarobic fitbar..

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Conflict of interest statement
The authors declare no conflict of interest.

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