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The Effect of 12-Week Face-to-Face and Online HIFT Training on Certain Cardiovascular Biomarkers

Serra Ayse CAKAR SAKA [1], Asiye Filiz CAMLIGUNEY [2]

Abstract

Aim: The aim of our study is to examine the effect of high-intensity functional training performed face-to-face and online for 12 weeks on body composition and blood values (HDL, LDL, triglyceride and fasting blood glucose) in sedentary women.
Methods: Inactive sedentary female participants aged 24-52 participated in the study on a voluntary basis within the framework of the Declaration of Helsinki. Participants were divided into two groups as face-to-face (n= 21) and online (n=19). Participants were given functional training with 60% loading for the first 6 weeks and then 80% loading with the high-intensity functional training training method 3 days a week for 12 weeks. Bioelectrical impedance and blood tests (HDL, LDL, triglyceride and fasting blood glucose) were taken from all participants prior to the training program and after 12 weeks of training. The data were analyzed in SPSS 22.0 program. Shapiro-wilk test was used for normality test. Wilcoxon signed rank test was used for intergroup comparisons.
Results: According to the data obtained, there is a statistically significant difference between the pre and post measurement in weight, body mass index, fat percentage and fat weight in participants who trained face-to-face and online training ($p<0.05$). When the pre and post measurements were examined, there was a statistically significant difference in LDL values in both groups, but no statistically significant difference was found in triglyceride and glucose values ($p>0.05$). Although there was an increase in HDL value, there was no statistically significant result.
Conclusion: High-intensity functional training performed face-to-face or online for 12 weeks in sedentary women has been shown to have a positive effect on body composition. It was found that HIFT training with face-to-face and online training decreased LDL value but had no significant effect on other values.

Keywords
High-Intensity Functional Training,
Physical Activity,
HDL,
Triglyceride,
Covid-19 Disease.

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12 Haftalık Yüz Yüze ve Uzaktan Erişimli HIFT Antrenmanının Kardiyovasküler Biyobelirteçler Üzerindeki Etkisi

Özet

Amaç: Çalışmamızda 12 hafta süresince sedanter kadınlarda yüz yüze ve uzaktan erişimle yapılan yüksek yoğunluklu fonksiyonel antrenmanların beden kompozisyonu ve kan değerlerine (HDL, LDL, trigliserit ve açlık glukoz) etkisinin incelenmesi amaçlanmaktadır.
Materyal ve Metot: Çalışmaya, inaktif sedanter 24-52 yaş arası kadın katılımcılar Helsinki bildirgesine göre gönüllülük esası ile katılmıştır. Katılımcılar yüz yüze (n= 21) ve uzaktan erişim grubu (n=19) olarak ikiye ayrılmıştır. Katılımcılara 12 hafta boyunca haftada 3 gün HIFT antrenman metoduyla ilk 6 hafta %60 yüklenmeli, sonrasında ise %80 yüklenmeli fonksiyonel antrenman yaptırılmıştır. Tüm katılımcıların 12 haftalık antrenman öncesi ve sonrasında, biyoelektrik impedans ve kan tahlilleri (HDL, LDL, trigliserit, açlık glukoz) alınmıştır. Veriler SPSS 22.0 programında analiz edilmiştir. Normallik testinde shapiro-wilk testi, grup içi karşılaştırmalarda ise wilcoxon signed rank test kullanılmıştır.
Bulgular: Alınan verilere göre yüz yüze ve uzaktan erişim ile antrenman yapan kişilerde ağırlık, beden kütle indeksi, yağ yüzdesi ve yağ ağırlığında ilk ve son ölçümler arasında istatistiki olarak anlamlı farklılık vardır ($p<0,05$). İlk ve son ölçümlere göre, her iki grupta da LDL değerinde istatistiki olarak anlamlı fark vardır. Trigliserit ve glukoz değerlerinde ise anlamlı fark yoktur ($p>0,05$). HDL değerinde ise artış olmasına rağmen istatistiki olarak anlamlı fark yoktur ($p>0,05$).
Sonuç: Sedanter kadınlarda 12 hafta boyunca yüz yüze ya da uzaktan erişim ile yapılan yüksek yoğunluklu fonksiyonel antrenmanın beden kompozisyonu üzerine olumlu etkisi olduğu görülmüştür. Yüz yüze ve uzaktan erişim ile yapılan HIFT antrenmanı, LDL değerini düşürdüğü ancak diğer değerlerde ise anlamlı bir farkın olmadığı belirlenmiştir.

Anahtar Kelimeler:
Yüksek Yoğunluklu Fonksiyonel Antrenman,
Fiziksek Aktivite,
HDL,
Trigliserit,
Covid-19 Hastalığı.

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[1] Istanbul Technicl University, Department of Physical Education, scakar@itu.edu.tr
[2] ***Corresponding Author***: Marmara University, Faculty of Sports Science, filizcamliguney@marmara.edu.tr
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INTRODUCTION

The global pandemic has changed many things in the lives of individuals in terms of health. The most important point is that our physical ability decreased during the Covid-19 restrictions (Chambonniere et al., 2021). Cardiovascular diseases are the fastest growing cause of death worldwide. Low physical activity plays a key role in the listed causes of death, particularly cardiovascular diseases.

Forouzanfar et al. (2015), in the report called "Global Disease, Injury and Risk Factor Study 2013" worked to learn the causes of death of individuals and to prevent emerging threats. In the study, data from 118 countries between 1990 and 2013 were examined and the leading causes of death were high blood pressure, followed by smoking, high body mass, childhood nutritional disorders and high level blood glucose. High cholesterol ranks 13th and low physical activity ranks 17th. In the same study, the first five causes of death worldwide were listed as high blood pressure, smoking/BMI, irregular diet and fasting blood glucose. Although it varies by country, high cholesterol and low physical activity are among the top proven causes of death worldwide (Forouzanfar et al., 2015). Causes of cardiovascular mortality such as high blood pressure, cholesterol and fasting blood glucose are also associated with low physical activity (Blair et al., 1995).

It has been firmly established that low-density cholesterol (LDL-C) level is an important risk factor for coronary heart disease (CHD). Regardless of the underlying cause, high LDL-C levels are known to be associated with CHD and cardiovascular mortality. Coronary heart disease is also common in populations with high cholesterol levels. This shows that LDL plays an important role in heart diseases. LDL cholesterol less than 130 mg/dL is considered as normal, between 130-159 mg/dL is borderline high, and 160 mg/dL and above is considered as high risk (Olsson et al., 2017). High Density Lipoprotein (HDL) has been identified to be involved in at least two dozens of important biological processes in the body. It is responsible for bringing the cholesterol formed in the arteries to the liver for removal from the body. If the HDL value is below 50 (mg/dl) in women and below 40 in men (mg/dl), it is considered low. It is known that a value of 60 (mg/dl) and above provides significant protection against cardiovascular diseases in individuals (Komodo, 2010). According to the Turkish Society of Cardiology, triglyceride is the form of fat found in nature. Heart disease was found more frequently in those with high measured levels in the blood. High triglyceride, cholesterol and low HDL values are widely used in cardiovascular risk assessment (Turkish Society of Cardiology, 2015).

Fasting blood glucose is the most important biomarker of diabetes mellutis (DM) (commonly known as diabetes). Type 2 diabetes is one of the most common diseases threatening public health. It is not exactly clear who should be screened for diabetes and when. The American Diabetes Association (ADA) recommends screening people with a body mass index of 25 kg/m^2 and above and who have at least one risk factor for diabetes. Screening over the age of 45 is also recommended for people without DM risk factors. While fasting blood glucose 70-100 mg/dl is considered normal, 100-125 mg/dl is considered a risky level. An individual with a fasting blood glucose value above 126 mg/dL is considered to have diabetes mellitus (Satman and Grup, 2011).

World Health Organization (WHO) has determined the minimum amount of physical activity as a directive for adequate health and fitness. Adults between the ages of 18-64 are most affected by Covid-19, and 70% of the cases were severely affected by the disease. According to this result, in WHO's report, it has been confirmed that 150 minutes of moderate-intensity physical activity per week (or a combination of high-intensity physical activity corresponding to this duration) has an impact on survival. Physical activity was found to be negatively correlated with cardiovascular mortality, regardless of age, gender, or diagnosis of any cardiovascular disease. It has been observed that physical fitness not only improves the quality of life, but also improves the cardiovascular structure when done regularly (WHO, 2018).

During the Covid-19 restrictions, physical activity rates have dropped drastically around the world. This difficult situation, both physically and psychologically, has decreased the possibility of doing physical activity with the closure of sports areas. During the restrictions, the internet and online classes have taken an important place in our lives, and even when the restrictions are lifted, the new education style has become a part of our lifestyle. There is a lack in the literature due to the recent experience of this research topic. Although various studies have been carried out on the HIFT training method in the last 10 years, there are still deficiencies in the field of health. For this reason, physical activity through distance education has become an important option for individuals. The aim of this study is to examine the effects of face-to-face and online HIFT training on BMI, fat ratio, fat percentage, and, HDL, LDL triglyceride and glucose values.

HIFT

The popularity of the HIFT training method has increased in the last 10 years and functional exercises have recently become more preferred in fitness areas. HIFT training is a method that is made with multiple joints of the body involving multiple motor skill movements. This method does not aim to develop the sportive skill itself, but to transfer the functional power to the sporting skill. It has been found that this method, which is based on weight lifting and gymnastic movements, and performed in sets and repetitions in which rest periods are adjusted, improves not only muscle strength, but also endurance, cardiovascular capacity and aerobic-anaerobic adaptations when done with high intensity (Gibala et al., 2012). An important aspect of high-intensity functional training is to focus on moving the fastest and doing the most repetitions within the specified time. Therefore, no additional rest time is given except for the change of position while performing the specified movements in the sets. In addition, it has been reported that psychologically, the duration of participation in the HIFT program (weekly or monthly) is positively related to concepts such as revitalization, enjoyment, commitment, and competition. What is more, HIFT training done as a group exercise has a positive effect on socialization and participation in exercises (Bycura et al., 2017). HIFT training is preferred seeing that it can be done with more accessible, lower cost and simpler equipment than expensive fitness centers regardless of location (Dawson, 2015).

METHOD

Model of the Research

The research was carried out with the experimental model, which is one of the quantitative research methods. Our study was approved by Marmara University Faculty of Medicine Clinical Research Ethics Committee with the date and number of 03.12.2021/09.2021.1314.

The Universe and Sample of the Research/Study Group of the Research

The population of the research is sedentary individuals who have not exercised regularly. The sample of the study consisted of inactive, sedentary, female, academic and administrative staff, aged 24-59, who had not participated in sports activities with a professional assistant in the last 6 months, whose inactivity level increased during the pandemic period, and spent working hours sitting/passive 5 days a week. In addition, the participants were given detailed information about the study and were told that they could withdraw from the study at any time according to the Helsinki protocol. In the study, the sample power size was determined as 0.80, the error level as 0.05, and the effect size as 0.80 (Faul et al., 2007), and accordingly, each group started to work in 24 participants. In the face-to-face training group, 3 participants who wanted to give up the study and 2 other participants who were diagnosed with the Covid 19 virus were separated and the study was completed with n=19 participants. In the online training group, there were 3 participants who left the study voluntarily and the group completed the study with n=21 participants.

Data Collection Tools of the Research

The pre and post tests were applied in person and the online group participated in the training program at the same day with the face-to-face group through Zoom online meeting platform. Participants participated in the study voluntarily and no fee was requested.

Determination of height and body weight: Lengths were measured with a wall-mounted stadiometer (Holtain Ltd, UK) with a measurement accuracy of ±0.1 mm. Measurements were taken by the same person in the early morning with bare feet and the lightest clothing they could wear.

Weight and bioelectrical impedance analysis: Measurements taken by Bioelectrical Impedance Analysis (BIA) were obtained using Tanita Body Composition Analyzer Type BC-418MA (Japanese). In order for the accuracy of body composition measurements to be high, the participants were asked not to consume alcoholic beverages within 48 hours before the bioelectrical impedance measurements, not to do high-intensity training within 24 hours, not to consume caffeinated beverages within 12 hours, not to work the digestive function within 4 hours, and to empty their bladders before impedance. In addition, they were asked not to do moderate-heavy exercise other than their daily activities within 48 hours before the measurement day. These issues were determined as the criterias for inclusion in the study.

*Blood Tests***:** Blood tests were taken under the control of a general practitioner after 12 hours of fasting at rest. 7 ml of blood, 5 ml for blood tests and 2 ml for hemogram count, were taken from the participants in the biochemistry laboratory. The blood tests were taken by the health professional working in the Medical Department of Istanbul Technical University where the research was conducted, and the results were evaluated by the biochemist.

Data Analysis of the Research

Shapiro-wilk test was used for normality test. SPSS 22.0 package was used to evaluate the pre- and post-training tests of the two experimental groups. In the study, wilcoxon signed rank test was used for intergroup comparisons. The significance level was accepted as p<0,05 in all statistical procedures. The data obtained at the end of the study was evaluated with wilcoxon signed rank test (Alpar, 2006).

Experimental Procedure

Table 1. The outlook and the shedule of the experiment applied to both face-to face and online group

Bioelectrical Measurement	**Exercise of 1-6 week**	**Bioelectrical Measurement**
Height Body Mass Index (BMI) Fat % Fat kg	Load: %50-60 Set duration: 45 sec Rest of set: 45 sec Repeat of set: x4 Example of program: Jumping jack, squat, hip kick, jog, plunk.	Heigth Body Mass Index (BMI) Fat % Fat kg
Blood test	**Exercise of 7-12 week**	**Blood test**
HDL LDL Triglyceride Glucose	Load: %70-80 Set duration: 45 sec Rest of set: 30 sec. Repeat of set: x4 Example of program: Squat jump, burpee, russion twist side lunch, skip rope	HDL LDL Triglyceride Glucose

Table 1 shows the outlook and the schedule of the study. Bioelectrical impedance measurements and blood tests were taken prior to and at the end of the training program. Considering the adaptation process of the 12-week training program, the intensity of the load was increased after the physiological adaptation period.

RESULTS

Table 2. Demographic characteristics of the participants

Variables		**n**	**Min**	**Max**	**Mean**	**SD**
Face-to-Face Training Group	Height (cm)	21	150	171	160,11	5,68
	Age (year)	21	27	58	41	8,7
Online Training Group	Height (cm)	19	157	172	164,11	4,62
	Age (year)	19	24	52	39,8	9,4

n: Sample Size, Min.: Minimum, Max.: Maksimum, Mean: Avarage, SD: Standart Deviation,

In Table 2, Age and height information of the participants are given. The mean age of the face-to-face training group was 41±8,7 years, and the height was 160,19±5,68 cm. In the online training group, the mean age was 39,8±9,4 cm and the height was 164,11±4,62 cm.

Table 3. Measurements taken by bioelectric ımpedance of the face-to-face training group

Variables		n	Min	Max	Mean	SD	p
Face-to-Face Training Group	Pre-weight kg	21	49,00	90,10	67,70	11,11	,000*
	Post-weight kg	21	49,00	84,50	65,40	10,45	
	Pre-BMI kg/m^2	21	18,00	38,00	26,40	4,67	,000*
	Post-BMI kg/m^2	21	18,00	35,80	25,54	4,35	
	Pre-fat %	21	17,30	45,40	31,61	7,06	,000*
	Post-fat %	21	16,90	43,40	29,75	7,47	
	Pre-fat kg	21	8,50	40,90	22,00	7,99	,000*
	Post-fat kg	21	8,00	36,80	20,40	7,94	

BMI; Body Mass Index, p<0.05 wilcoxon signed rank test

In Table 3, the measurements taken by the bioelectrical impedance analysis of the face-to-face training group are given. There was a statistically significant difference in weight, body mass index, fat percentage and fat weight between the first and last measurement (p<0,05).

Table 4. Measurements taken from online training group bioelectrical impedance

Variables		n	Min	Max	Mean	SD	p
Online Training Group	Pre-weight kg	19	53,4	101,70	75,47	15,22	,001*
	Post-weight kg	19	52,80	99,50	71,51	13,22	
	Pre-BMI	19	18,90	41,30	27,51	5,58	,000*
	Post-BMI	19	18,70	40,00	26,45	5,10	
	Pre-fat %	19	18,90	43,20	33,28	6,23	,001*
	Post-fat %	19	15,90	42,70	31,48	6,40	
	Pre-fat kg	19	10,10	43,40	25,37	9,31	,003*
	Post-fat kg	19	8,40	40,00	23,52	8,60	

BMI; Body Mass Index, P<0,05 Wilcoxon Signed Rank Test

In Table 4 shows the measurements taken by the bioelectrical impedance analysis of the online training group. There is a statistically significant difference between pre and post measurement in weight, body mass index, fat percentage and fat weight (p<0,005)

Table 5. Pre-test and post-test measurement results of the face-to-face training group and the online training group blood tests

Variables		n	Min	Max	Mean	SD	p
Face-to-Face Training Group	Pre-HDL	21	38	105	62	16,14	,442
	Post-HDL	21	39	92,80	63,13	15,23	
	Pre-LDL	21	66,70	250	134,51	45,93	,017*
	Post-LDL	21	37	212,20	120,98	39,67	
	Pre-Triglyceride	21	44,70	272,80	102,25	52,11	,073
	Post-Triglyceride	21	39,50	208	88,19	41,12	
	Pre-Glucose	21	73,50	109,20	92,77	7,61	,627
	Post-Glucose	21	71	106	91,72	8,55	
Online Training Group	Pre-LDL	19	42	109	64,05	14,92	,097
	Post-LDL	19	51	130	70,89	17,98	
	Pre-HDL	19	72	155	108,19	22,50	,002*
	Post-HDL	19	68	122	94,11	18,20	
	Pre-Triglyceride	19	39,50	300	89,84	60,29	,286
	Post-Triglyceride	19	46	216	102,26	51,11	
	Pre-Glucose	19	80,00	101,70	91,36	6,84	,067
	Post-Glucose	19	74,00	106,00	86,89	8,86	

HDL: High Density Lipoprotein, LDL: Low Density Lipoprotein, p<0.05 wilcoxon signer rank test

In Table 5, the results of the blood tests of face-to-face training group and online training group are given. When the first and last measurements were examined, a statistically significant difference was found in LDL values in both groups (p<0,05). Although there was no statistically significant difference in HDL cholesterol value, it increased in the last measurements and took place in healthy reference value range. There was no statistically significant difference in triglyceride and glucose values in both groups (p>0,05).

Discussion

Our study differs from other studies in the literature in as much as it was conducted with female participants aged 24-52 and being a comparative study in that it compares and contrasts the face-to-face and online training method. Physical activity has declined rapidly worldwide, especially after the Covid-19 restrictions. It is known that low physical activity seriously threatens cardiovascular health. It is very important that, HDL LDL, triglyceride and glucose values, which are blood values primarily related to cardiovascular health, are within the normal reference range. Considering these factors, the effects of face-to-face and online HIFT training on health values were examined.

According to the Bioelectric Impedance results in Table 2 and Table 3, a significant difference was observed in the pre-post training measurements. The reduction in weight, body mass index, fat percentage and fat weight was the same in both training groups. In a study conducted by Cavedon et al., (2020), they found a significant reduction in weight, BMI, fat% and fat weight in men who trained HIFT, and also found that skeletal muscle accumulation was greater in individuals who trained for more than a year. In people who did HIFT training for less than a year, they also saw a decrease in lean body mass. A significant increase in %fat, lean body mass and bone density was seen in male athletes who trained at least a day a week for more than a year. Although this study is a current HIFT study, it gave similar results to our findings. However, it differs from our study in terms of gender. In the studies scanned since 2010, there has not been a study examining the effects of HIFT training on specific body composition.

The blood values of the face-to-face and online training groups are given in Table 4. There was a decrease in LDL values in both groups. There was an increase in HDL values between the first test and the last test, but it was not statistically significant. Vasankari et al., in their study of 34 men and 70 women, which lasted for 10 months, established a basic program for sedentary individuals that included walking, skiing, cycling and dancing. As a result of the program in which men moved for 257 minutes and women for 209 minutes per week on average, VO^2max values increased by 19% in both men and women. Concomitantly, there was a 15% increase in men and 5% in women in HDL, and a decrease in LDL of 10% and 11% ($p<0.05$). There was no change in total cholesterol and triglyceride values. The bioelectrical impedance results during the exercise program gave similar data to our study. A weight loss of 1,8 kg and a decrease in body fat percentage of 2,3% were observed in women (Vasankari et al., 1998).

Temur et al., (2018) also did not find statistically significant results in HDL, LDL, triglyceride, and total cholesterol values in their 8-week pilates study with 16 women with a mean age of 30.81 ± 9.49 years. According to the results of the study, they suggested that the exercise load intensity, duration, participant age, nutrition program and lifestyle should be included in the study in order to give positive results in the blood parameters of the exercise.

Tiainen et al., (2016) worked over sedentary women between the ages of 43-63 doing at least 50 minutes of aerobic exercise 4 days a week and followed the participants for 6 months. As a result of the study, they found a significant difference in HDL value. They found that aerobic exercise for 6 months increased HDL value by 5% and decreased triglyceride value by 6%. In the control group, there was a 2% decrease in HDL level. There was no change in total cholesterol and LDL cholesterol values in the study. Although this study on sedentary women is up-to-date and similar to our hypothesis, it differs from our study in terms of training method, training duration and frequency. In sports sciences, small changes made in the training program can produce different statistical results. Despite this, aerobic exercise was found to play a positive role in HDL cholesterol with similar results.

In a study conducted to examine the effect of high-intensity training on glucose value in individuals with and without diabetes, it was found that there was an improvement after 1-3 training sessions in individuals with and without diabetes (Adams, 2013). In a similar study demonsterated that the glucose value could remain at low levels even 14-20 hours after the exercise performed with the 80% loading principle (Mitchell, 1988).

Kovacevic et al., (2019) studied 30 sedentary female participants aged between 29-35 to determine the magnitude of the effects of short-term HIIT training on the transformation of morphological features and motor skills. The study specifically examined the effect of hands-on exercise on reductions in body mass and volume. They did 7 sets of hard body exercises with the HIIT method for 45-50 minutes 4 times a week during a-four-week period. As a result of the study, they obtained significant results in all values except for the morphological waist/hip ratio. They found significant reductions in weight, body mass index, waist and hip circumference. They proved that this training had a positive effect on morphological and motoric variables with HIIT training performed 4 days a week during a-4-week period. The study showed that the HIIT training method, which was applied in a similar way to our study, gave similar results to our findings and demonstrated that there was a decrease in BMI, weight and fat ratios.

According to the results of this study, it was found that face-to-face and online training gave the same results in terms of physical fitness and changes in blood values. Although doing sports via online training causes problems from time to time depending on the technological equipment, it is a viable method for physical activities in the new normal lifestyle after Covid-19 restrictions. It is very important to correctly calculate the intensity of physical activity in online training. In addition, it is necessary to pay attention to applying training without equipment if possible or using it as little as possible. The easy application of online HIFT training is recommended. Since there was no disability or injury in either group in our study, this method is safely recommended. In addition, since rapid improvements will be seen in body composition values, it will be motivating to see immediate and positive results in online group participants who have limited meetings with the trainer. In order to prevent both cardiovascular and atherosclerotic diseases, HDL, LDL, triglyceride and glucose values should be within normal reference values. Therefore, health, genetics, nutrition and lifestyle are also very significant in human health as well as exercise. Our results in terms of blood values are similar to the studies in the literature. In order to obtain more effective results in all blood values, a study in which nutritional control is added is recommended. As a result, it has been seen that the exercises performed through online training method can be used both for scientific study purposes and as a physical activity.

Conclusion

In the findings of our study, it was found that there was a decrease in weight, BMI, fat % value and fat weight in the data obtained in both groups who performed HIFT training with face-to-face and online. In physiological biomarkers, only a significant decrease in LDL value was found. HDL value increased in both groups and reached a healthy level, but there was no statistically significant difference. Again, there was no significant change in triglyceride and glucose values in both groups. It has been observed that high-intensity functional training, whether face-to-face or online, for 12 weeks has a positive effect on body composition in sedentary women. It was determined that HIFT training carried out face-to-face and online decreased the LDL value and there were no significant results in other values.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

REFERENCES

Adams O. P. (2013). The impact of brief high-intensity exercise on blood glucose levels. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *6*, 113-122. https://doi.org/10.2147/DMSO.S29222

Alpar R, (2006). *Spor Bilimlerinde Uygulamalı İstatistik*. Ankara: Nobel Yayınları

Blair, S. N., Kohl, H. W., Barlow, C. E., Paffenbarger, R. S., Jr, Gibbons, L. W., & Macera, C. A. (1995). Changes in physical fitness and all-cause mortality. A prospective study of healthy and unhealthy men. *JAMA*, *273*(14), 1093-1098.

Borg G. (1970). Perceived exertion as an indicator of somatic stress. *Scandinavian Journal of Rehabilitation Medicine*, *2*(2), 92-98.

Bycura, D.K., Feito, Y., & Prather, C.C. (2017). Motivational Factors in CrossFit® Training Participation. *Health Behavior and Policy Review*, *4*, 539-550.

Cavedon, V., Milanese, C., Marchi, A., & Zancanaro, C. (2020). Different amount of training affects body composition and performance in High-Intensity Functional Training participants. *PloS One*, *15*(8). https://doi.org/10.1371/journal.pone.0237887

Chambonniere, C., Lambert, C., Fearnbach, N., Tardieu, M., Fillon, A., Genin, P., Larras, B., Melsens, P., Bois, J., Pereira, B., Tremblay, A., Thivel, D., & Duclos, M. (2021). Effect of the COVID-19 lockdown on physical activity and sedentary behaviors in French children and adolescents: New results from the ONAPS national survey. *European Journal of Integrative Medicine*, *43*, 101308.

https://doi.org/10.1016/j.eujim.2021.101308

Dawson, M. (2015). CrossFit: Fitness cult or reinventive institution? SAGE Publications. 1–19. doi:10.1177/101269021559179

Dupuit, M., Rance, M., Morel, C., Bouillon, P., Pereira, B., Bonnet, A., Maillard, F., Duclos, M., & Boisseau, N. (2020). Moderate-Intensity Continuous Training or High-Intensity Interval Training with or without Resistance Training for Altering Body Composition in Postmenopausal Women. *Medicine and science in sports and exercise*, *52*(3), 736-745. https://doi.org/10.1249/MSS.0000000000002162

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, *39*(2), 175–191. https://doi.org/10.3758/bf03193146

GBD 2015 Risk Factors Collaborators (2016). *Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2015: A systematic analysis for the Global Burden of Disease Study 2015*. Lancet (London, England), 388, 1659–1724. https://doi.org/10.1016/S0140-6736(16)31679-8

Gibala, M. J., Little, J. P., Macdonald, M. J., & Hawley, J. A. (2012). Physiological adaptations to low-volume, High-Intensity Interval Training in health and disease. *The Journal of Physiology*, *590*(5), 1077–1084. https://doi.org/10.1113/jphysiol.2011.224725

Heinrich, K. M., Spencer, V., Fehl, N., & Poston, W. S. (2012). Mission essential fitness: comparison of functional circuit training to traditional Army physical training for active-duty military. *Military medicine*, *177*(10), 1125–1130. https://doi.org/10.7205/milmed-d-12-00143

Kovačević, E., Vrcić, M., Bajramović, I., Kazazović, E., & Mašnić, A. (2019). High Intensity Interval Training (HIIT) effects on physıcal abilities and morphology in females. Homo Sportıcus. 2, 9-15.

Komado, T. (2010). *The HDL handbook*. Oxford, United Kingdom. Elsevier's Science & Technology Rights Department, P:38-83.

Mitchell, T. H., Abraham, G., Schiffrin, A., Leiter, L. A., & Marliss, E. B. (1988). Hyperglycemia after intense exercise in IDDM subjects during continuous subcutaneous insulin infusion. *Diabetes Care*, *11*(4), 311–317. https://doi.org/10.2337/diacare.11.4.311

Olsson, A. G., Angelin B.G, Assmann C. J, Binder I, Björkhem A., Cedazo-Minguez J., Cohen A. von Eckardstein E., Farinaro D., Müller-Wieland K.G., Parhofer P., Parini R. S., Rosenson J., Starup-Linde M., Tikkanen J., & Yvan-Charvet L. (2017). Can LDL cholesterol be too low? Possible risks of extremely low levels. *Journal of Internal Medicine 281*(6), 534–53.

Satman, I. & Grup, T. (2011). *Türkiye diyabet, hipertansiyon, obezite ve endokrinolojik hastalıklar prevalans çalışması (TURDEP-II) sonuçları*. İstanbul Tıp Fakültesi Geleneksel İç Hastalıkları Günleri: İnteraktif Güncelleştirme. İstanbul, Türkiye 25-28.

Türk Kardiyoloji Derneği, Türkiye Kalp ve Damar Hastalıkları Önleme Programı 2015-2020. https://tkd.org.tr/ Erişim Tarihi:06.09.2022

Tiainen, S., Luoto, R., Ahotupa, M., Raitanen, J., & Vasankari, T. (2016). 6-mo aerobic exercise intervention enhances the lipid peroxide transport function of HDL. *Free Radical Research*, *50*(11), 1279–1285. https://doi.org/10.1080/10715762.2016.1252040

Vasankari, T. J., Kujala, U. M., Vasankari, T. M., & Ahotupa, M. (1998). Reduced oxidized LDL levels after a 10-month exercise program. *Medicine and Science in Sports and, exercise*, *30*(10), 1496–1501. https://doi.org/10.1097/00005768-199810000-00005

World Health Organization. Global Action Plan on Physical Activity 2018-2030.

CITING

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