Vol. 3 No. 4 (2024)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN	Print ISSN
3007-2387	3007-2379

Inayat et al - 2024

Impact of Diverse Intensities of Acute Exercise on Lipid Profiles and Cardiorespiratory Fitness in Prediabetic Populations Postprandially

Inayat Shah, PhD

Professor Department of Physiology, Institute of Basic Medical Sciences, Khyber Medical University, Peshawar, Pakistan MBBS, Mphil, PhD Physiology. ORCID ID: https://orcid.org/0000-0003-1900-6181. Email: drinayatshah@kmu.edu.pk

Fazeelat Hajra Kareem

Department of Physiology, Khyber Girls Medical Collage, Peshawar, Pakistan MBBS, Mphil, PhD Scholar Physiology

Saman Tauqir, PhD*

Assistant Professor Department of Physiology, Bahria University of Health Sciences, Karachi, Pakistan. ORCID: 0009-0005-9457-1123. Corresponding Auhtor Email: samantauqir@gmail.com

Author Details

Keywords:

Exercise and Prediabetes, Lipid profile, Cardiorespiratory Fitness, Acute Exercise

Received on 24 Nov 2024

Accepted on 20 Dec 2024

Published on 22 Dec 2024

Corresponding E-mails & Authors*:

Saman Tauqir

samantauqir@gmail.com

Abstract

Background: The sedentary lifestyle common in modern society significantly contributes to various metabolic disorders, including prediabetes and dyslipidemia. Physical activity is known to influence metabolic health, but the effects of different exercise intensities on lipid profiles and cardiorespiratory fitness, particularly in prediabetic individuals, remain to be fully understood. This study aims to examine the impact of varying intensities of acute aerobic exercise on lipid profiles and cardiorespiratory fitness in a prediabetic population postprandially. **Methods:** A crossover study was conducted in 25 middle-aged, sedentary adults with prediabetes. Participants engaged in four sessions of anaerobic exercise at intensities of 50%, 60%, 70%, and 80% of their predicted maximum heart rate, with each session spaced one week apart. Lipid profiles were assessed at fasting, pre-exercise, and 30 and 60 minutes post-exercise. **Results:** The study demonstrated that acute aerobic exercise at higher intensities significantly improved lipid metabolism, evidenced by decreases in total cholesterol and triglycerides, and increases in high-density lipoprotein (HDL) across higher exercise intensities. Low-density lipoprotein (LDL) showed a slight decrease that became significant 60 minutes post-exercise at higher intensities. These changes suggest an intensity-dependent effect of exercise on lipid profiles. **Conclusion:** Acute aerobic exercise at varying intensities significantly affects lipid profiles in prediabetic individuals, in a dose response manner, with higher intensities yielding more pronounced benefits. This study supports the role of tailored exercise programs in managing prediabetes and associated metabolic risks, emphasizing the importance of exercise intensity in enhancing cardiovascular health and metabolic responses.

Introduction

The sedentary lifestyle prevalent in today's society poses a significant threat to metabolic health, with physical inactivity acknowledged as a key risk factor for various metabolic conditions. This includes diabetes, abnormal blood lipid levels, coronary artery disease (CVD), and increased general mortality.[1] The lack of exercise, accompanied by poor dietary habits, critically influences the onset and progression of these conditions.[2] These conditions are often marked by adverse changes in lipid profiles, such as elevated levels of low-density lipoprotein (LDL) and reduced high-density lipoprotein (HDL), along with imbalances in triacylglycerol (TAG) levels and fasting glycemia.[3] Such imbalances can lead to severe health complications, emphasizing the need for regular exercise as a preventive measure.[4]

Engaging in physical activities provides numerous health benefits. It not only enhances overall well-being but also plays a crucial role in managing metabolic conditions. Regular exercise helps maintain a healthy weight, improves cardiovascular health, and reduces the risk of chronic diseases.[4] Aerobic exercise routines, especially those of moderate intensity, are highly effective in controlling the lipid profile. This regulation occurs through the modulation of enzymes like lecithin-cholesterol acyltransferase (L-CAT) and cholesteryl ester transfer protein (CETP), which are helpful in the process of reverse cholesterol transport.[4]

The effectiveness of an exercise regimen in regulating metabolic processes varies with its intensity. While moderate exercise is beneficial, there is growing interest in the significances of high-intensity physical activity.[5, 6] It appears that exercise intensity plays a crucial role in eliciting positive metabolic responses, particularly in managing inflammatory reactions and improving lipid metabolism.[7]

The level of an individual's physical fitness significantly influences the metabolic response to exercise. Individuals with lower fitness levels tend to show increased responsiveness and experience more significant adaptations from exercise training, regardless of its intensity. This highlights the importance of tailoring exercise programs to individual fitness levels. For those with prediabetes or diabetes, aerobic exercise is important in managing blood sugar levels.[7, 8] It improves insulin sensitivity and aids in overall blood sugar control, making it an essential component of diabetes management.[8]

Thus, the purpose of the present study was to analyze the changes in lipid profile and cardiorespiratory fitness in response to acute aerobic exercise sessions performed at different intensities in prediabetic population.

Methodology

The (Institute of Basic Medical Sciences) IBMS Review Board gave this crossover study ethical approval, with reference number NO: KMU/IBMS/IRBE/meeting/2022/8075. Initially, with the significance level (α) of 0.05 and power (β) of 0.80, 12 participants were required, according to G Power 3.1.9.2 software, however, we increased the sample size to 25 individuals in order to impart more power to the study. To make sure that our sample was especially chosen to meet the goals of the study, we used a non-probability purposive sampling technique.

25 adults diagnosed according to the ADA[9] criteria of prediabetes were consented and included in the study. In our investigation, fasting plasma glucose levels 100 mg/dL- 125 mg/dL and glycosylated hemoglobin (HbA1c) values between 5.7% and 6.4% were indicative of prediabetes. These people had sedentary lifestyles per IPAQ[10], exercising for less than half an hour each day, three days a week or less and were ready to exercise as per PARQ.[11] After an overnight fast of 10 to 12 hours, all study procedures were conducted at Khyber Medical University's (KMU) Sports Research Unit (SRU) starting around 8:00 AM.

Study Protocol

Each participant taking part in the study served as their control. Participants were advised to refrain from eating junk food such as sweets and fizzy drinks. They were advised not to engage in strenuous exercise activities for at least 24 hours before the scheduled exercise session. The participants visited the lab four times in total seven days apart. After an isocaloric meal consisting (250Kcal), the participants worked out for 40 minutes (including 5 minutes warm up and cool down) at different submaximal intensities (50%, 60%, 70% and 80%) 30 minutes' post-meal, timing optimized from the first study.

In order to maintain participants' comfort, treadmill speed was changed during these sessions if they were having trouble keeping the prescribed PMHR. In addition, the treadmill's inclination was progressively adjusted every five minutes to reach the required heart rates. The PMHR was calculated using 220-age.[12] For cardiorespiratory fitness breath by breath analyzer (COSMED Italy) was used. To ensure the participants were exercising within the required intensities they wore a heart belt (Garmin HRM) displayed on the screen of the analyzer software which used the telemetry technology.

Assays

Whole blood samples were collected immediately and centrifuged to get ready for serum lipid profile. The samples were carefully kept at a temperature of -80°C until the time of analysis to evaluate the lipid profile. Statistical analysis was carried out using SPSS version 23, applying repeated measure ANOVA for comparison of inter and intra visit analysis.

Results

The results of the study indicate that the average age of the participants was approximately 34.88 years, with a significant age difference between both the genders; females averaged 32.25 years and males 36.11 years (*p*=0.025) indicating that females were slightly younger than males. The overall average height was 170 cm, with females with males being taller than females (*p*=0.002). Waist circumference also presented a statistically significant gender difference, with females at 98.75 cm and males at 103.76 cm (*p*=0.035). In contrast, differences in hip circumference and weight between genders did not reach statistical significance, (*p*=0.467) and weight (*p*=0.545). The Body Mass Index (BMI) averaged 30.34 kg/m^2 across all participants, with females on the higher BMI average of 31.48 kg/m^2 compared to males at 29.81 kg/m^2, though this difference was not statistically significant (*p*=0.372) as described in Table 1.

Table 1:. *Demographic and Anthropometric Profile of participants in the study*

Participant Characteristics	Total	Female (n=8)	Male (n=17)	*p*-value
Age	34.88±4.11	32.25±4.23	36.11±3.53	0.025
Height (cm)	170±6.70	164.25±2.91	172.70±6.28	0.002
Weight (kg)	87.85±14.56	85.21±13.77	89.1±13.77	0.545
BMI (kg/m^2)	30.34±4.27	31.48±4.30	29.81±4.28	0.372
Waist Circumference (cm)	102.16±12.22	98.75±17.10	103.76±10.73	0.035
Hip Circumference (cm)	105.13±12.43	106.41±9.93	102.42±17.10	0.467
Waist to hip ratio (WHR)	0.97±0.04	0.92±0.05	1.01±0.02	0.659

All the values in the table are presented as means ± standard deviation (SD) values for the demographic and anthropometric parameters of the study participant's, categorized overall and by gender, age (years), height (centimeters), waist and hip circumference (centimeters), weight (kilogram) and Body Mass Index (BMI).

Table 2: *Comparative Analysis of Lipid Profile Parameters at Different Intensities Relative to Exercise*

Lipid parameters		Fasting Mean±SD	Pre-exercise Mean±SD	30 minutes post exercise Mean±SD	60 minutes post exercise Mean±SD	*p*-value
Cholesterol (mg/dL)	50%	198.64±24.87	208.84±32.86	185.6±20.78	180.76±22.7	<0.001
	60%	191.88±25.56	197.84±28.15	179.6±17.79	175.32±12.56	<0.001
	70%	190.24±24.7	193.84±26.87	179.52±17.42	174.2±12.68	<0.001
	80%	188.08±20.7	193.4±23.84	172.6±16.65	171.12±12.61	<0.001
	p-value	0.444	0.186	0.102	0.184	------
Triglycerides	50%	184±30.69	201.52±38.23	182.56±25.89	176.52±27.36	0.007
	60%	179.72±22.62	191.12±23.74	183.32±29.18	173.36±19.15	<0.001
	70%	174.36±21.66	186.44±23.69	175.2±23.36	167.48±18.33	<0.001
	80%	176.12±19.45	184.40±21.18	171.64±16.45	168.32±15.76	<0.001
	p-value	0.502	0.131	0.252	0.363	------
HDL	50%	39.92±1.78	39.68±2.06	40.16±2.53	40.88±2.09	0.052
	60%	40.04±1.74	39.44±1.56	42.12±1.64	45.00±2.69	<0.001
	70%	39.8±2.52	39.76±1.56	42.72±1.72	47.8±2.24	<0.001
	80%	41.12±1.39	40.2±2.2	41.84±2.64	42.48±3.44	0.019
	p-value	0.06	0.541	0.001	<0.001	-------
LDL	50%	90.92±14.68	94.88±14.11	90.2±12.67	86.41±13.29	0.002
	60%	88.72±11.97	93.08±10.94	89.28±12.52	85.8±12.18	0.002
	70%	88.24±12.36	92.36±11.05	87.6±10.07	78.56±9.04	<0.001
	80%	84.6±10.54	91.04±10.50	85.04±9.70	81.52±10.18	0.03
	p-value	0.352	0.707	0.396	0.05	------

For the inter visit analysis across the different exercise intensities ANOVA was applied. For changes in the mentioned parameters over four time points (Fasting, pre-exercise, 30 min and 60 minutes post exercise) Repeated measure ANOVA was applied

Table 2 examines the impact of different exercise intensities on lipid parameters at fasting, pre-exercise, and 30 and 60 minutes post-exercise, analyzed with p-values reported for both visit-wise analysis and across the four time points.

Cholesterol levels significantly reduced post-exercise at all intensities. At 50% PMHR, cholesterol decreased from 198.64 mg/dL (±24.87) fasting to 180.76 mg/dL (±22.27) at

60 minutes post-exercise (p < 0.001). Similar decreases were observed at 60%, 70%, and 80% PMHR, with levels dropping to 175.32 mg/dL (±12.56), 174.20 mg/dL (±12.98), and 171.12 mg/dL (±12.61) respectively (*p*< 0.001 for all). No significant differences were found across visits (p = 0.444 to 0.186). Triglycerides also showed significant reductions. At 50% PMHR, levels fell from 201.52 mg/dL (±38.23) to 176.52 mg/dL (±27.36) post-exercise (p = 0.007). At 60%, 70%, and 80% PMHR, they dropped to 173.36 mg/dL (±19.15), 167.48 mg/dL (±18.33), and 168.32 mg/dL (±15.76) respectively (*p* < 0.001 for all). No significant differences were found across visits (*p* = 0.502 to 0.131). HDL levels increased significantly with higher intensities. At 50% PMHR, HDL rose slightly from 39.92 mg/dL (±1.78) to 40.88 mg/dL (±2.09) (p = 0.052). More significant increases occurred at 60%, 70%, and 80% PMHR, with levels reaching 45.00 mg/dL (±2.69), 47.80 mg/dL (±2.24), and 42.48 mg/dL (±3.44) respectively (*p* < 0.001, *p* < 0.001, and *p* = 0.019). No significant differences were found across visits (*p* = 0.060 to 0.541). LDL levels decreased significantly post-exercise. At 50% PMHR, LDL dropped from 94.88 mg/dL (±14.11) to 86.40 mg/dL (±13.29) (*p* = 0.002). At 60%, 70%, and 80% PMHR, LDL levels fell to 85.80 mg/dL (±12.18), 78.56 mg/dL (±9.04), and 78.56 mg/dL (±9.04), respectively (p = 0.002, *p* < 0.001, and *p* = 0.030). No significant differences were found across visits (*p* = 0.352 to 0.707).

Further, the data was explored for trends in each visit, ranging from changes in fasting to pre-exercise and 30 – 60 minutes' post-meal changes in each intensity. For the intra-analysis inside each visit, a General Linear Model was used.

Table 3: *Dynamic Effects of Exercise on Lipid Profiles: A Detailed Analysis Across Multiple Time Point*

Parameters	Blood Time points	Visit 1			Visit 2			Visit 3			Visit 4		
		Mean Difference	Std. Error	*p*-Values	Mean Difference	Std. Error	*p*-Values	Mean Difference	Std. Error	*p*-Values	Mean Difference	Std. Error	*p*-Values
Cholesterol	Pre-exercise vs 30 min	23.24	3.33	<0.001	18.24	3.74	<0.001	14.32	3.53	0.003	20.8	2.44	<0.001
	Pre-exercise vs 60 mins	28.08	3.59	<0.001	22.52	4.7	<0.001	19.64	4.44	0.001	22.3	3.23	<0.001
	30 mins vs 60 min	4.84	2.24	0.247	4.28	3.14	1	5.31	2.55	0.285	1.5	2.07	1
Triglyceride	Pre-exercise vs 30 min	18.96	5.21	0.008	14.8	3.7	0.003	15.68	2.76	<0.001	12.8	2.84	<0.001
	Pre-exercise mins vs 60 mins	25	6.18	0.003	28.44	2.93	<0.001	30.96	2.8	<0.001	16.1	3.33	<0.001
	30 mins vs 60 min	6.03	2.26	0.08	13.64	4.16	0.019	15.28	1.04	<0.001	3.3	1.87	0.527

HDL	Pre-exercise mins vs 30 min	-0.48	0.62	1	-2.68	0.34	<0.001	-2.96	0.25	<0.001	-1.6	0.65	0.107
	Pre-exercise mins vs 60 mins	-1.2	0.62	0.393	-5.56	0.61	<0.001	-8.04	0.48	<0.001	-2.3	0.78	0.043
	30 mins vs 60 min	-0.72	0.32	0.216	-2.88	0.7	0.002	-5.08	0.43	<0.001	-0.6	0.38	0.643
LDL	Pre-exercise mins vs 30 min	4.68	1.35	0.012	3.8	0.93	0.002	4.76	0.99	<0.001	4.8	0.99	<0.001
	Pre-exercise mins vs 60 mins	8.48	1.86	0.001	7.28	1.31	<0.001	13.8	1.66	<0.001	13.8	1.66	<0.001
	30 mins vs 60 min	3.8	0.84	0.001	3.48	1.01	0.012	9.04	1.01	<0.001	9	1.01	<0.001

For cholesterol, there was a consistent and significant decrease from pre-exercise levels to both 30 and 60 minutes post-exercise across all visits. The mean decreases ranged from 14.32 to 23.24 mg/dL at 30 minutes and from 19.64 to 28.08 mg/dL at 60 minutes post-exercise. This indicates a strong cholesterol-lowering effect of exercise that extends beyond the immediate post-exercise period. However, the changes between 30 and 60 minutes post-exercise were smaller and not always significant, suggesting that the most substantial reduction occurs within the first half-hour after exercise.

Triglyceride levels also decreased significantly after exercise. The reductions were around 12.8 to 18.96 mg/dL at 30 minutes and increased to between 16.1 and 30.96 mg/dL at 60 minutes across the visits, indicating progressive triglyceride reduction post-exercise. The differences between the 30 and 60 minutes post-exercise were generally less marked and not consistently significant.

In contrast to cholesterol and triglycerides, HDL (good cholesterol) showed minor reductions post-exercise, which were often not statistically significant, particularly at the 30-minute mark. More notable decreases occurred at 60 minutes post-exercise during visits 2 and 3. The variations from 30 to 60 minutes were modest and varied in significance, suggesting a slight but inconsistent impact of exercise on HDL levels.

LDL (bad cholesterol) levels displayed a different pattern, with small but significant increases immediately post-exercise, ranging from 3.8 to 4.76 mg/dL at 30 minutes. This increase was more pronounced at 60 minutes post-exercise, particularly in the later visits, with increases up to 13.80 mg/dL. The elevations from 30 to 60 minutes were consistently significant, indicating a delayed rise in LDL following exercise.

Overall, these findings underscore the nuanced effects of exercise on lipid metabolism, highlighting significant reductions in cholesterol and triglycerides, a slight decrease in HDL, and a delayed increase in LDL post-exercise. This complex interaction suggests that while exercise generally promotes favorable lipid changes, it also involves intricate physiological responses that vary across different lipid fractions.

Table 4: *Comparative Analysis of Respiratory and Metabolic Responses Across Exercise Intensities: A Breath-by-Breath Study*

Breath by breath	50%	60%	70%	80%	*p*-values
	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	
BSA (m^2)	1.97±0.16	1.97±0.16	1.97±0.16	1.97±0.16	1
Duration (min)	36.18±4.45	35.44±4.17	32.77±3.28	14.56±4.41	<0.001

VO2 (mL/min)	715.18±414.95	943.41±332.77	1118.57±269.89	1530.86±291.96	<0.001
VCO2 (mL/min)	456.43±177.74	759.66±161.67	808.44±159.09	812.2±119.66	<0.001
RQ	0.76±0.1	0.76±0.11	0.94±0.18	0.96±0.17	<0.001
METS	4.02±1.22	4.58±1.40	5.03±1.88	7.12±1.96	<0.001
HR (bpm)	97±10.99	109±16.76	114±24.52	116±21.13	0.002
Eeh (kcal/h)	173.38±114.92	270.89±124.18	280.47±153.31	231.41±155.93	0.055
FAT (kcal/day)	5019±737.02	5181±505.90	1988±470.6	3249±413.34	<0.001
CHO (kcal/day)	915±137.73	2401±478.21	5062±619.4 9	3030±152.58	<0.001

The table 4 presents a range of physiological measurements taken from individuals exercising at varying intensities. The Body Surface Area (BSA m^2) is constant across the exercise intensities, serving as a static physiological measure of the individuals involved. VCO2 and RQ values significantly increased with intensity, demonstrating a shift from fat to carbohydrate utilization as exercise intensity rose. This shift is evident with the lowest p-values observed in RQ ($p<0.001$) and VCO2 ($p<0.001$), suggesting a significant metabolic shift towards anaerobic pathways as intensity increases.

HR and CHO oxidation also increased significantly with intensity ($p=0.002$ and $p<0.001$, respectively), further supporting the enhanced reliance on carbohydrate metabolism at higher intensities. Fat oxidation was highest at 60% intensity and decreased significantly at higher intensities ($p<0.001$), aligning with the crossover concept where lower intensities favor fat oxidation. The duration of exercise decreased significantly as intensity increased ($p<0.001$), indicating the challenge in sustaining higher intensities. Energy expenditure in terms of kilocalories per hour (Eeh kcal/h) generally raised with the intensity of exercise.

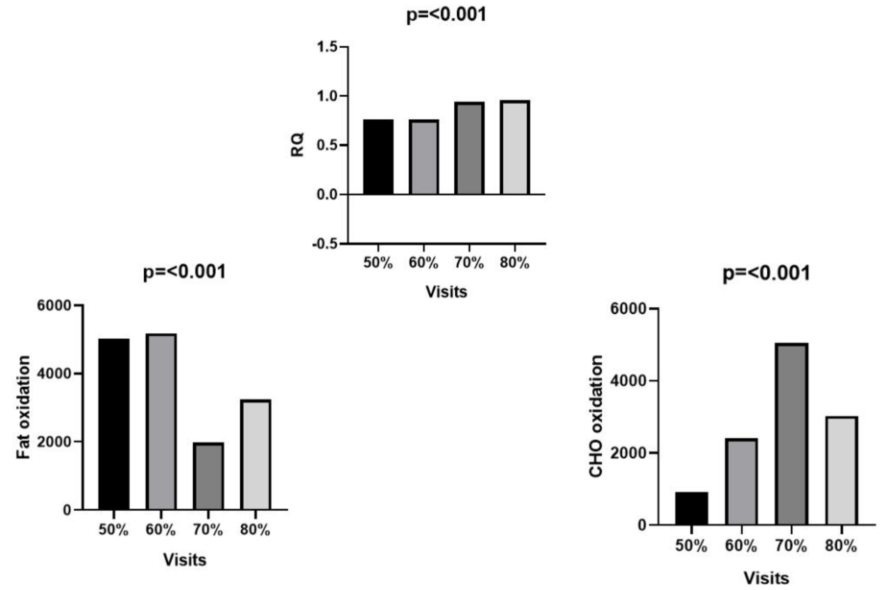

Figure 1: Metabolic Shifts in Fat and Carbohydrate Oxidation Across Exercise Intensities

The figure illustrates significant changes in metabolic fuel utilization with increasing exercise intensities, measured during different visits. The Respiratory Quotient (RQ) increases with intensity, indicating a shift from fat to carbohydrate oxidation as the primary energy source. This is visually corroborated by the significant decrease in fat oxidation and a corresponding increase in carbohydrate oxidation as exercise intensity progresses from 50% to 80%. Both fat and carbohydrate oxidation show statistically significant differences across intensities ($p<0.001$), highlighting a clear metabolic response to changes in exercise intensity.

Discussion

Our findings showed a uniform rise in HDL levels with increasing exercise intensities, with the most significant increases observed at high intensities, such as 70%. Although LDL levels varied across different exercise intensities, the general pattern indicated a reduction, particularly at higher intensities. Similarly, there was a trend towards lower TG levels, especially noticeable at higher exercise intensities. These reductions in TG levels likely play a role in the overall enhancement of lipid profiles seen with aerobic exercise interventions.

Previous reviews and meta-analyses have consistently shown that regular physical activity significantly enhances HDL levels. This study is the first trial to demonstrate the improvement in lipid profile with various intensities of exercise. The clinical significance of these findings is considerable, given that HDL is known not only for its role in reverse cholesterol transport but also for its anti-inflammatory, anti-oxidative and anticoagulant properties. [13]

Walking approximately 11 miles per week at a moderate intensity has been shown to reduce triglyceride levels by about 25% in overweight or mildly obese, sedentary middle-aged men and women.[13] Studies from the past 20 years have consistently shown that these variables are more indicative of cardiovascular risk.[14, 15] In an earlier publication regarding the impact of various amounts and intensities of exercise on lipoproteins in this cohort, the focus was on comparing differences between the exercise groups and the control group, rather than examining changes within a specific group. Therefore, the current observation is a significant addition, highlighting further negative consequences of physical inactivity in humans.[239]

The observation that moderate-intensity exercise leads to a more substantial reduction in triglycerides can be attributed to the fact that moderate-intensity exercise predominantly uses lipids for fuel, suggesting it might have a more prolonged influence on lipoprotein lipase activity in muscles and hepatic lipase in the liver. This could enhance lipid uptake and oxidation in skeletal muscle, subsequently improving insulin response and reducing steady-state levels of glucose, insulin, and triglycerides.[16] On the other hand, high-intensity exercise triggers a greater release of triglycerides from fat stores due to increased catecholamine levels, which might negate any reduction in TG levels through heightened muscle utilization and oxidation. These dynamics could help explain why moderate-intensity exercise is more effective at reducing serum LDL and triglycerides compared to vigorous exercise. Additionally, vigorous exercise might boost mitochondrial capacity more than lower-intensity workouts, leading to an imbalance between energy supply and demand upon cessation of training. This imbalance can adversely affect mitochondrial fatty acid oxidation, storage, and insulin action in tissues like muscle, fat, and liver, potentially causing a "rebound" increase in serum VLDL and triglycerides in those who engage in high-intensity exercise.[16]

The influence of exercise intensity on fuel selection is crucial in determining whether the body burns fats or carbohydrates for energy. As exercise intensity increases, carbohydrate oxidation rises, while fat oxidation initially increases at lower intensities and then declines, resembling an inverted hyperbolic curve. Our research indicates that fat oxidation peaks during exercise at 60% intensity and diminishes at higher intensities. Conversely, carbohydrate oxidation escalates with workout intensity, reaching its highest at 70% before slightly dropping at 80% intensity due to participants' inability to sustain this level, indicating they could not complete the exercise duration at this high intensity. This pattern suggests that there is an optimal range of exercise intensity for maximizing fat burning, beyond which carbohydrates become the predominant energy source as intensity continues to escalate.

Findings from other studies states that fats are the main energy source during low-intensity exercise, but as intensity increases, the body shifts towards using more carbohydrates, decreasing lipid utilization. [17] Studies have observed variations in the respiratory exchange ratio (RER) as a measure of substrate utilization among both untrained and trained individuals, highlighting significant individual differences in metabolic responses under controlled conditions. [18, 19]

These insights highlight the critical role of tailored exercise regimens in managing and potentially reversing the lipid abnormalities associated with prediabetes and other metabolic syndromes. This personalized approach could optimize the preventive and therapeutic potential of exercise in metabolic disease management. Furthermore, the study underscores the importance of exercise intensity in optimizing lipid metabolism. Moderate-intensity exercise, which predominantly utilizes lipids for fuel, appears particularly effective in sustaining lipoprotein lipase activity and enhancing lipid uptake and oxidation, which are beneficial for insulin sensitivity and metabolic stability.

Conclusion

The study concludes that varying intensities of aerobic exercise differentially influence lipid profiles in a prediabetic population. We observed a consistent elevation in HDL levels across all exercise intensities, with the most substantial increases occurring at higher intensities, particularly at 70%. Conversely, LDL and triglyceride (TG) levels generally decreased, with the most notable reductions at higher exercise intensities, underscoring the beneficial effects of aerobic exercise on overall lipid management. Our findings are consistent with previous literature indicating that regular physical activity enhances HDL levels, known for their protective cardiovascular properties, including anti-inflammatory and antioxidative effects. Additionally, the reduction in LDL and TG levels at moderate to high intensities of exercise not only contributes to lower cardiovascular risk but also aligns with the efficient utilization of lipids as fuel, enhancing metabolic health.

Moderate intensities (around 60-70%) maximize fat oxidation and are sustainable for longer durations, while higher intensities shift energy metabolism towards rapid carbohydrate utilization and are associated with shorter exercise durations due to their demanding nature. This study underlines the importance of selecting appropriate exercise intensities to meet individual metabolic health goals, such as enhancing cardiovascular fitness or optimizing fat loss.

Online ISSN 3007-2387

Print ISSN 3007-2379

References

1. Adiels M, Olofsson S-O, Taskinen M-R, Borén J. Diabetic dyslipidaemia. Curr Opin Lipidol. 2006;17(3):238-46.
2. Ginsberg HN, Zhang Y-L, Hernandez-Ono A. Metabolic syndrome: focus on dyslipidemia. Obesity. 2006;14(2S):41S.
3. Zheng S, Xu H, Zhou H, Ren X, Han T, Chen Y, et al. Associations of lipid profiles with insulin resistance and β cell function in adults with normal glucose tolerance and different categories of impaired glucose regulation. PLoS One. 2017;12(2):e0172221.
4. Durstine JL, Grandjean PW, Cox CA, Thompson PD. Lipids, lipoproteins, and exercise. J Cardiopulm Rehabil Prev. 2002;22(6):385-98.
5. Delfani Z, Shahidi F, Kashef M, Namdari M. Effect of Different Volumes of High-intensity Interval Trainingon Serum Troponin I and Creatine KinaseMB Levels in Patients After Myocardial Infarction. Iranian Journal of Endocrinology and Metabolism. 2022;24(1):24-33.
6. Irving BA, Davis CK, Brock DW, Weltman JY, Swift D, Barrett EJ, et al. Effect of exercise training intensity on abdominal visceral fat and body composition. Med Sci Sports Exerc. 2008;40(11):1863.
7. Manders RJ, Van Dijk JW, Van Loon LJ. Low-intensity exercise reduces the prevalence of hyperglycemia in type 2 diabetes. Med Sci Sports Exerc. 2010;42(2):219-25.
8. Liu Y, Ye W, Chen Q, Zhang Y, Kuo C-H, Korivi M. Resistance exercise intensity is correlated with attenuation of HbA1c and insulin in patients with type 2 diabetes: a systematic review and meta-analysis. Int J Env Res Public Health. 2019;16(1):140.
9. American Diabetes A. Standards of medical care in diabetes—2010. Diabetes Care. 2010;33(Suppl 1):S11.
10. Hagströmer M, Oja P, Sjöström M. The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. Public Health Nutr. 2006;9(6):755-62.
11. Warburton DER, Jamnik VK, Bredin SSD, Gledhill N. The physical activity readiness questionnaire for everyone (PAR-Q+) and electronic physical activity readiness medical examination (ePARmed-X+). The Health & Fitness Journal of Canada. 2011;4(2):3-17.
12. Cruz-Martínez LE, Rojas-Valencia JT, Correa-Mesa JF, Correa-Morales C. Maximum Heart Rate during exercise: Reliability of the 220-age and Tanaka formulas in healthy young people at a moderate elevation. Revista de la Facultad de Medicina. 2014;62(4):579-85.

13. Slentz CA, Houmard JA, Johnson JL, Bateman LA, Tanner CJ, McCartney JS, et al. Inactivity, exercise training and detraining, and plasma lipoproteins. STRRIDE: a randomized, controlled study of exercise intensity and amount. J Appl Physiol. 2007;103(2):432-42.
14. Kamigaki AS, Siscovick DS, Schwartz SM, Psaty BM, Edwards KL, Raghunathan TE, et al. Low density lipoprotein particle size and risk of early-onset myocardial infarction in women. Am J Epidemiol. 2001;153(10):939-45.
15. Vakkilainen J, Mäkimattila S, Seppälä-Lindroos A, Vehkavaara S, Lahdenperä S, Groop P-H, et al. Endothelial dysfunction in men with small LDL particles. Circulation. 2000;102(7):716-21.
16. Couillard C, Després J-P, Lamarche B, Bergeron J, Gagnon J, Leon AS, et al. Effects of endurance exercise training on plasma HDL cholesterol levels depend on levels of triglycerides: evidence from men of the Health, Risk Factors, Exercise Training and Genetics (HERITAGE) Family Study. Atertio Thromb Vasc Biol. 2001;21(7):1226-32.
17. Brooks GA, Mercier J. Balance of carbohydrate and lipid utilization during exercise: the" crossover" concept. J Appl Physiol. 1994;76(6):2253-61.
18. Helge JW, Fraser AM, Kriketos AD, Jenkins AB, Calvert GD, Ayre KJ, et al. Interrelationships between muscle fibre type, substrate oxidation and body fat. Int J Obesity. 1999;23(9):986-91.
19. Goedecke JH, Gibson ASC, Grobler L, Collins M, Noakes TD, Lambert EV. Determinants of the variability in respiratory exchange ratio at rest and during exercise in trained athletes. American Journal of Physiology-Endocrinology and Metabolism. 2000;279(6):E1325-E34.