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Metabolic Responses to Exercise Across Different Age Groups: A Literature Review

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Abstract

Physical activity plays a vital role in maintaining metabolic health and preventing various chronic diseases such as obesity, type 2 diabetes, and cardiovascular disease. Metabolic responses to exercise vary across different age groups, influenced by physiological changes such as decreased muscle mass, insulin sensitivity, and aerobic capacity. This study uses a systematic literature review method by examining studies discussing metabolic changes during and after exercise in various age groups. Searches were conducted through databases including PubMed, ScienceDirect, Google Scholar, and Consensus using keywords such as *metabolic response to exercise*, *age-related metabolic adaptations*, and *exercise and metabolism across lifespan*. The studies analyzed included metabolic measurements such as oxygen consumption (VO_2), energy expenditure, insulin sensitivity, and fat and carbohydrate metabolism. The review showed that younger individuals generally have higher metabolic efficiency compared to older adults, although exercise benefits all age groups. Energy expenditure increases with exercise intensity, but no significant differences were observed across age groups during low to moderate intensity exercise. High-intensity interval training (HIIT) significantly increased fat oxidation in middle-aged adults. Additionally, older sedentary individuals exhibited higher postprandial triglyceride levels than younger or more active individuals. The timing of exercise also influenced metabolic responses: morning exercise was more effective in enhancing lipid metabolism, while afternoon workouts were more optimal for improving insulin sensitivity.

Keywords: Metabolic Response, Exercise, Age, Energy Expenditure, Fat Metabolism

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A. Introduction

Physical inactivity is considered the fourth leading behavioral risk factor for global mortality (Kohl et al., 2012). The World Health Organization (WHO) recommends that adults engage in at least 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity activity weekly, in addition to muscle-strengthening activities twice per week and minimizing sedentary time (Sallis et al., 2016). These guidelines similarly apply to individuals under 18 and older adults. More than twenty chronic conditions can be prevented through regular exercise, including coronary heart disease, stroke, type 2 diabetes, certain cancers, obesity, mental health issues like depression, and neurological conditions such as dementia (Booth et al., 2012). Exercise not only reduces disease risk but also enhances well-being and quality of life.

Harnessing the power of physical activity can have broad public health impacts. Since physical activity encompasses complex and heterogeneous actions, implementing it can be challenging. It can be categorized by domain (occupational, leisure, transportation, home), dimensions (frequency, intensity, duration), context (access to green spaces, facilities, financial and social support), motivation (reasons for engaging in PA), and type (ranging from aerobic treadmill exercises to yoga, household chores, and gardening).

Globally, exercise is a key factor in maintaining metabolic health and preventing chronic diseases such as obesity, type 2 diabetes, and cardiovascular disease. Physical activity improves energy metabolism efficiency, insulin sensitivity, and optimal use of energy substrates such as fat and carbohydrates. With aging, physiological changes occur that affect metabolic responses to exercise, such as muscle mass loss (sarcopenia), altered glucose metabolism, and decreased aerobic capacity. Studies show that although exercise increases energy expenditure across all ages, the optimal intensity and duration vary. One study found that energy expenditure during hydraulic resistance training depended on training load but showed no significant differences across age groups (Ngamsa-Ard et al., 2016).

Regionally, social, economic, and facility access factors influence patterns of physical activity. Some studies indicate that higher levels of physical activity affect postprandial metabolism, particularly in controlling triglyceride and blood glucose levels across different age groups (Koemel et al., 2019). Other research suggests that exercise timing impacts metabolic responses, with certain times of day optimizing metabolic benefits, especially in older individuals (Sato, 2023).

In Indonesia, trends show challenges in adopting an active lifestyle, especially among children and the elderly. According to the Indonesian Ministry of Health, metabolic disease prevalence like obesity and type 2 diabetes is increasing due to sedentary lifestyles. Research shows that exercise reduces metabolic syndrome risk and enhances aerobic capacity in at-risk individuals (Shin et al., 2011). Furthermore, age-

specific training programs have proven effective in improving insulin sensitivity and reducing metabolic disease risk in older adults (Finucane et al., 2010). Therefore, understanding differences in metabolic responses to exercise across age groups is crucial for designing more specific and effective physical activity recommendations within Indonesia's public health context. This study aims to review existing literature to understand metabolic mechanisms during exercise across different age groups and their implications for disease prevention and improving public quality of life.

B. Methods

This study uses a systematic literature review to examine metabolic responses to exercise in various age groups. Data sources include relevant scientific journals published within the last ten years, accessed via databases such as PubMed, ScienceDirect, Google Scholar, and Consensus. Keywords included *metabolic response to exercise*, *age-related metabolic adaptations*, and *exercise and metabolism across lifespan*. Article selection was based on predetermined inclusion and exclusion criteria. Only studies discussing metabolic changes during or after exercise in different age groups and including measurements like oxygen consumption (VO_2), energy expenditure, insulin sensitivity, and fat/carbohydrate metabolism were included. Only peer-reviewed experimental or clinical trials were considered valid.

The research stages began with article identification and selection based on abstracts and topic relevance. Relevant articles were examined in detail to identify research methods, results, and reported conclusions. Data from various studies were analyzed descriptively to compare metabolic response differences across age groups. Additionally, trends, influencing factors, and research implications were explored to provide a comprehensive understanding. Synthesized findings were presented narratively and in tables to ease interpretation. This approach aims to offer deeper insights into how metabolism responds to physical activity throughout life stages and inform scientifically grounded exercise program designs suited to the metabolic needs of different age groups.

C. Results and Discussion

The literature review indicates that metabolic responses to exercise vary by age, particularly in terms of oxygen consumption, energy expenditure, fat and carbohydrate metabolism, and insulin sensitivity. Generally, younger individuals display higher metabolic efficiency compared to older adults, although physical activity still offers benefits across all age groups.

1. Energy Expenditure and Oxygen Consumption

Several studies indicate that energy expenditure increases with exercise intensity, though differences between age groups are not significant during low to moderate intensity exercise. A study analyzing double-

hydraulic resistance exercises (DHRE) across age groups found that despite increased energy expenditure with higher loads, there was no significant age difference between the 18–59 age range (Ngamsa-Ard et al., 2016).

Age Group (years)	Max Load Energy Expenditure (kcal/min)
18–24	7.2 ± 0.5
25–34	7.0 ± 0.6
35–49	6.8 ± 0.4
50–59	6.7 ± 0.5

2. Fat and Carbohydrate Metabolism

Energy substrate metabolism during exercise also varies by age. A study by Amaro-Gahete et al. (2020) found that middle-aged individuals undergoing 12 weeks of high-intensity interval training (HIIT) experienced significant increases in fat oxidation during rest and exercise compared to those performing standard aerobic training.

Group	Pre-Intervention Fat Oxidation (g/min)	Post-Intervention Fat Oxidation (g/min)
Control	0.34 ± 0.02	0.36 ± 0.03
Aerobic	0.36 ± 0.02	0.42 ± 0.04
HIIT	0.35 ± 0.03	0.50 ± 0.05*
HIIT + EMS	0.37 ± 0.02	0.52 ± 0.06*

3. Insulin Response and Postprandial Metabolism

Research shows that age and physical activity level affect metabolic responses to high-fat meals. Koemel et al. (2019) found that older sedentary individuals had higher postprandial triglyceride levels than younger or physically active individuals.

Group	Total Triglyceride AUC (mg/dL × 6h)
Active Youth	618.8 ± 103.1
Sedentary Youth	836.4 ± 402.6
Active Elderly	609.0 ± 234.6
Sedentary Elderly	993.4 ± 80.9*
*Significantly higher vs. active youth, $p < 0.05$	

4. Optimal Timing for Exercise

Beyond intensity and type, exercise timing influences metabolic responses, especially in older adults. Sato (2023) found that time of day affects metabolic outcomes: morning exercise is more effective for lipid metabolism, while afternoon exercise better enhances insulin sensitivity.

This review highlights that metabolic responses to exercise vary by age, exercise type, and timing.

Despite decreased metabolic efficiency in older adults, exercise significantly improves energy expenditure, fat oxidation, and insulin sensitivity. Thus, age- and metabolism-specific training programs can help optimize long-term health benefits.

D. Conclusion

Based on this review, metabolic responses to exercise vary across age groups, especially regarding energy expenditure, oxygen consumption, fat and carbohydrate metabolism, and insulin sensitivity. Younger individuals generally have higher metabolic efficiency than older adults, though exercise remains beneficial for all ages. Energy expenditure increases with intensity, but age-related differences are negligible at low to moderate intensities. HIIT has proven effective in significantly enhancing fat metabolism in middle-aged groups, suggesting it as a suitable intervention. Additionally, metabolic responses to high-fat meals are influenced by age and activity levels, with older sedentary adults showing higher postprandial triglyceride levels. Exercise timing also plays a role: morning workouts better improve lipid metabolism, while afternoon sessions enhance insulin sensitivity. Therefore, age-specific, tailored training programs based on exercise type and timing can maximize the metabolic benefits of physical activity for maintaining health and preventing metabolic diseases across age groups

Bibliography

Amaro-Gahete, F., De-La-O, A., Jurado-Fasoli, L., Sanchez-Delgado, G., Ruiz, J., & Castillo, M. (2020). Metabolic rate in sedentary adults, following different exercise training interventions: The FIT-AGEING randomized controlled trial. *Clinical Nutrition*. https://doi.org/10.1016/j.clnu.2020.02.001

Booth, F. W., Roberts, C. K., & Laye, M. J. (2012). Lack of exercise is a major cause of chronic diseases. *Comprehensive Physiology*, *2*(2), 1143–1211. https://doi.org/10.1002/cphy.c110025

Finucane, F., Sharp, S., Purslow, L., Horton, K., Horton, J., Savage, D., Brage, S., Besson, H., Rolfe, E., Sleigh, A., Martin, H., Sayer, A., Cooper, C., Ekelund, U., Griffin, S., & Wareham, N. (2010). The effects of aerobic exercise on metabolic risk, insulin sensitivity and intrahepatic lipid in healthy older people from the Hertfordshire Cohort Study: a randomised controlled trial. *Diabetologia*, *53*, 624–631. https://doi.org/10.1007/s00125-009-1641-z

Koemel, N., Sciarillo, C., Tomko, P., Bode, K., Jenkins, N., & Emerson, S. (2019). Impact of Age and Physical Activity on Postprandial Metabolic Responses (OR22-07-19). *Current Developments in Nutrition*, *3*, nzz028.OR22-07-19. https://doi.org/https://doi.org/10.1093/cdn/nzz028.OR22-07-19

Kohl, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., & Kahlmeier, S. (2012). The pandemic of physical inactivity: global action for public health. *The Lancet*, *380*(9838), 294–305. https://doi.org/https://doi.org/10.1016/S0140-6736(12)60898-8

Ngamsa-Ard, C., Chaunchaiyakul, R., Widjaja, W., & Pinthong, M. (2016). Metabolic Responses During Repeated Double-Hydraulic Resistance Exercises Among Different Aged-Groups. *J Sports Sci Technol [Internet]*, *16*, 65–73. https://he01.tci-thaijo.org/index.php/JSST/article/view/53526

Sallis, J. F., Bull, F., Guthold, R., Heath, G. W., Inoue, S., Kelly, P., Oyeyemi, A. L., Perez, L. G., Richards, J., & Hallal, P. C. (2016). Progress in physical activity over the Olympic quadrennium. *The Lancet*, *388*(10051), 1325–1336. https://doi.org/https://doi.org/10.1016/S0140-6736(16)30581-5

Sato, S. (2023). Run For Anti-Aging: Exercise Timing Specifies Metabolic Responses. In *Innovation in Aging* (Vol. 7, Issue Suppl 1, p. 512). https://doi.org/10.1093/geroni/igad104.1681

Shin, K., Kim, Y., Park, S., & Oh, J. (2011). The Change in Exercise Capacity , Cardiac Structure and Function in Pre-Metabolic Syndrome Adults. *J. Exp. Biomed. Sci*, *17*(4), 321–328. https://www.bslonline.org/journal/download_pdf.php?spage=321&volume=17&number=4