



















growth hormone, epinephrine, and fat oxidation. Growth hormone and epinephrine have lipolytic effects, and an augmented fat oxidation might beneficially influence lipid levels in individuals [46]. Given that HIIT exhibits a superior exercise intensity compared to MICT, it is plausible that the resultant elevation in growth hormone, epinephrine, and fat oxidation associated with HIIT will influence the lipid profile distinctively from MICT.

In this study, LDL and triglyceride levels experienced a significant decrease in the BE group. These findings are supported by Antonelli et al. [47] who state that breathing exercises in meditation in adults lower cholesterol

endocytosis, and receptor recycling [55]. Also, the regulatory effects of yoga on HDL-C are mediated through a reverse cholesterol transport mechanism that includes the removal of macrophage cholesterol in the arteries [55].

Voluntary diaphragmatic breathing at  $< 10$  or  $6$  breaths per minute for 10 min twice a day for 4 weeks was effective in producing positive outcomes [56]. Performing diaphragmatic deep breathing at  $6$  or  $\leq 10$  breaths per

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### Authors' contributions

Isnaini Herawati (IH) & Arimi Fitri Mat Ludin (AF) conceptualized the study with critical input from Ismarulyusda Ishak (IYI), Mutalazimah Mutalazimah (MM) and Nor M.F. Farah (NF). IH carried out the intervention and data collection. AF & NF verified the data analysis and interpretation. IH wrote the initial draft of the manuscript with critical input from NF & AF. AF, NF, IYI & MM supervised the overall study. All authors read and approved the final version of the manuscript and agree with the order of presentation of the authors.

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### Data availability

All the data generated and analysed throughout this study are included in this published article. Individual participants data are available from the corresponding author on reasonable request.

### Declarations

#### Ethics approval and consent to participate

Prior ethical clearance was obtained from the Ethics Committee of Universiti Kebangsaan Malaysia (JEP-2019–461) and the Ethics committee of Universitas Muhammadiyah Surakarta (2494.2022). Written informed consent was obtained from each individual by the researcher after the individual has received a sufficient explanation and period of time in which to make a thoughtful decision.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

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