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COMMENT

The effects of long-term changes in metabolic parameters on cardiac remodeling and dysfunction

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The present study by Wu Yuzhong et al. demonstrates that associations between long-term averages of metabolic parameters in adulthood and cardiac structure and function in later life. This retrospective cohort study was used data in a large community-based sample from the Framingham Heart Study (FHS). This longitudinal study in community demonstrated that long-term level of body mass index (BMI) might primarily affect the size and mass of heart chambers, secular systolic blood pressure (SBP) and diastolic blood pressure (DBP) level might differently influence left ventricular mass index (LVMi) and cardiac function, whereas higher high density lipoprotein cholesterol (HDL-c) might be preferred for better systolic function.

Metabolic homeostasis refers to the ability of living organisms to maintain a stable internal environment despite changes in the external environment. This stability is based on, and intrinsic to, energy metabolism and was established very early in the evolution of living organisms [1]. Metabolic homeostasis has been highlighted as important factor contributing to the pathogenesis of a spectrum of cardiovascular conditions, such as coronary atherosclerosis, atrial fibrillation, and heart failure (HF).

Metabolic parameters can have a direct link to cardiac structure and function [2]. Abnormalities in cardiac structure and function have been associated with metabolic syndrome [3, 4], type 2 diabetes [5], non-alcoholic fatty liver disease, obesity, and insulin resistance [6]. In a study of adults with type 2 diabetes, non-alcoholic fatty liver disease, and healthy controls, cardiac structure, function, and metabolism were assessed using high-resolution magnetic resonance imaging. The study found that changes in cardiac structure were evident in adults with type 2 diabetes and non-alcoholic fatty liver disease without overt cardiac disease and without changes in cardiac energy metabolism [5]. Metabolic signatures have also been found to be related to cardiac dysfunction, multimorbidity, and post-transcatheter aortic valve implantation death [7]. In a cross-sectional study of the general population, an increasing number of components of the metabolic syndrome were associated with cardiac structural and functional abnormalities [4]. Overall, metabolic parameters can have a significant impact on cardiac structure and function, and abnormalities in metabolic parameters can lead to changes in cardiac structure and function.

Wu Yuzhong et al. demonstrates both long-term average and visit-to-visit variability of BMI were associated with the dimension of heart chambers and left ventricular (LV) diastolic function, and the degree of relevancy varied in male and female in this study [8]. Several studies have investigated the relationship between BMI and left heart chamber size. One study found that positive correlations with BMI were observed for left atrial size and LV mass measurements assessed by cardiac magnetic resonance [9]. In addition, Wu Yuzhong et al. showed persistent high BMI was proved contributory in cardiac remodeling and worsening myocardial function using by echocardiogram [8]. As described in the Discussion, such LV changes with deteriorated diastolic function but unaltered ejection ability, together with BP alteration, could predispose to development of HF with preserved ejection fraction (HFpEF) [10, 11].

Furthermore, there is a significant relationship between blood pressure variabilities and LVMi. It was reported that increased blood pressure variability is associated with LV mass and dysfunction. A study on hypertensive patients

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Correlation between metabolic parameter and classical risk factor, and major adverse cardiovascular events.

BMI; body mass index, SBP; systolic blood pressure, DBP; diastolic blood pressure, HDL-c; high density lipoprotein cholesterol
FBS; fasting blood glucose

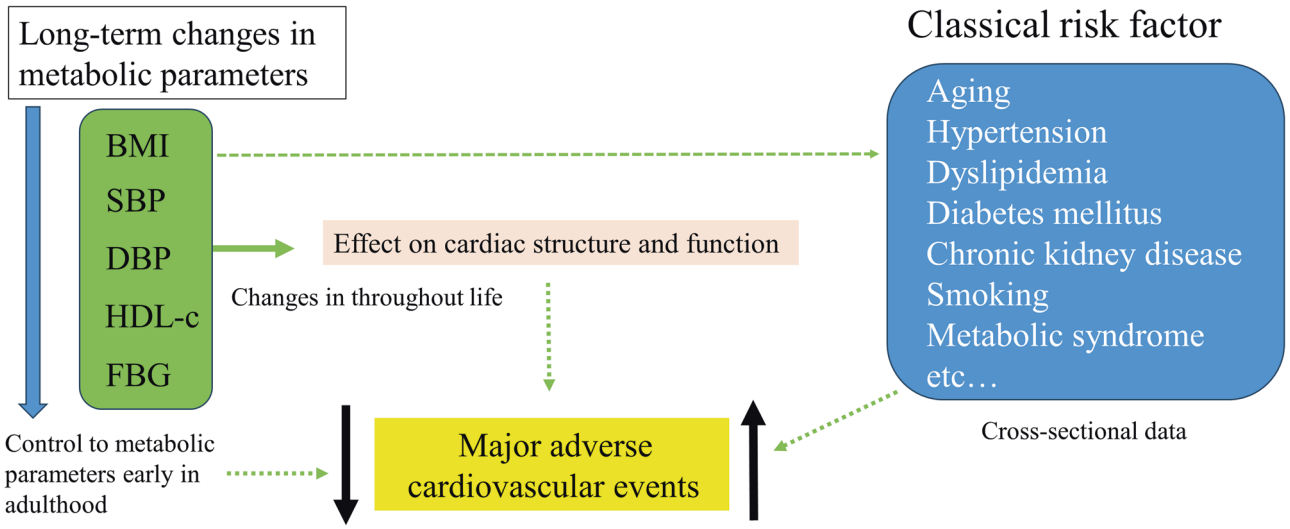

Fig. 1 Correlation between metabolic parameter and classical risk factor, and major adverse cardiovascular events

found that increased blood pressure variability was associated with LV mass and dysfunction, as well as arterial stiffness [12]. The current study showed that long-term average of SBP or DBP were associated with LVMi and LV systolic and diastolic function in an opposite way within SBP and DBP, whereas greater variabilities of SBP and DBP were both associated with greater LVMi [8]. These results further support the relationship between blood pressure variability and LVMi.

In addition, Wu Yuzhong et al. demonstrated that the dimension and systolic function of LV could be observed in long-term average of HDL-c rather than triglyceride and low-density lipoprotein cholesterol, and the impact of average of HDL-c on LV dimension emerged prominently in the elderly, and long-term average and visit-to-visit variability of fasting blood glucose (FBG) had scarce association with these cardiac parameters other than that between the average of FBG and Global longitudinal strain in female [8].

These findings suggest that various factors such as oxidative stress, advanced glycation end products, inflammation, and neurohormones may be involved. Therefore, it is important to intervene early on risk factors.

Previous studies researching on metabolic homeostasis used cross-sectional data and had focused on major adverse cardiovascular events (MACEs). To investigated between the associations between long-term averages and visit-to-visit variability of selected metabolic parameters such as this study is very important study which may reduce the risk of adverse cardiovascular events.

The results of this study suggested that the presence of metabolic parameters, considered a cardiovascular risk, may influence heart morphology over the long term, and this may contribute to increased cardiovascular events (Fig. 1). These findings in the current study suggest that effective prevention of subtle cardiac change underlying adverse cardiovascular outcomes requires adequate control of each metabolic parameter throughout life. However, the biochemical mechanisms between metabolic parameters and myocardial remodeling are complex. We need further basic research to prove these association.

Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

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References

1. Wilson DF, Matschinsky FM. Metabolic homeostasis in life as we know it: its origin and thermodynamic basis. Front Physiol. 2021;12:658997.
2. Brookes PS, Taegtmeyer H. Metabolism: a direct link between cardiac structure and function. Circulation. 2017;136:2158–61.
3. Aijaz B, Ammar KA, Lopez-Jimenez F, Redfield MM, Jacobsen SJ, Rodeheffer RJ. Abnormal cardiac structure and function in the metabolic syndrome: a population-based study. Mayo Clin Proc. 2008;83:1350–7.

4. Azevedo A, Bettencourt P, Almeida PB, Santos AC, Abreu-Lima C, Hense HW, et al. Increasing number of components of the metabolic syndrome and cardiac structural and functional abnormalities–cross-sectional study of the general population. BMC Cardiovasc Disord. 2007;7:17.
5. Cassidy S, Hallsworth K, Thoma C, MacGowan GA, Hollingsworth KG, Day CP, et al. Cardiac structure and function are altered in type 2 diabetes and non-alcoholic fatty liver disease and associate with glycemic control. Cardiovasc Diabetol. 2015;14:23.
6. Fulghum K, Hill BG. Metabolic mechanisms of exercise-induced cardiac remodeling. Front Cardiovasc Med. 2018;5:127.
7. Perry AS, Zhao S, Murthy V, Gupta DK, Fearon WF, Kim JB, et al. Metabolic signatures of cardiac dysfunction, multimorbidity, and post-transcatheter aortic valve implantation death. J Am Heart Assoc. 2023;12:e029542.
8. Wu Y, Chen C, Wei F-F, Liang W, Dong Y, Liu C, et al. Associations between long-term averages of metabolic parameters in adulthood and cardiac structure and function in later life. Hypertens Res. 2023. https://doi.org/10.1038/s41440-023-01475-9.
9. Turkbey EB, McClelland RL, Kronmal RA, Burke GL, Bild DE, Tracy RP, et al. The impact of obesity on the left ventricle: the Multi-Ethnic Study of Atherosclerosis (MESA). JACC Cardiovasc Imaging. 2010;3:266–74.
10. Savji N, Meijers WC, Bartz TM, Bhambhani V, Cushman M, Nayor M, et al. The association of obesity and cardiometabolic traits with incident HFpEF and HFrEF. JACC Heart Fail. 2018;6:701–9.
11. Pfeffer MA, Shah AM, Borlaug BA. Heart failure with preserved ejection fraction in perspective. Circ Res. 2019; 124:1598–617.
12. Shin SH, Jang JH, Baek YS, Kwon SW, Park SD, Woo SI, et al. Relation of blood pressure variability to left ventricular function and arterial stiffness in hypertensive patients. Singap Med J. 2019;60:427–31.