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The Impact of Regular Cycling on Cardiovascular Health: A Review of Current Evidence

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Abstract

Introduction: Cycling is an accessible form of aerobic physical activity that can be used for recreation, active transport, prevention, and rehabilitation.

Aim: To evaluate the relationship between regular cycling and cardiovascular risk factors, vascular function, cardiovascular disease (CVD), and mortality.

Methods: A structured narrative review of studies published from 2017 to August 2026 was conducted using PubMed/MEDLINE, supplemented by publisher records and reference lists. Cohort studies, randomized trials, systematic reviews, and meta-analyses were considered.

Results: Cycling was associated with lower CVD incidence and cardiovascular mortality in large observational cohorts and meta-analyses. Evidence also supports favorable effects of aerobic exercise on endothelial function, arterial stiffness, blood pressure, cardiorespiratory fitness, and cardiometabolic risk factors. Cycle ergometry is a useful modality in structured cardiac rehabilitation.

Conclusions: Regular cycling is associated with favorable cardiovascular outcomes and can contribute to prevention, active-transport strategies, and supervised rehabilitation.

Keywords: cycling, cardiovascular system, active commuting, ischemic heart disease, cardiovascular prevention, endothelial function

1. Introduction

Cardiovascular diseases (CVD), alongside cancer, remain among the leading causes of mortality worldwide, while a sedentary lifestyle is one of their key modifiable risk factors [1]. According to World Health Organization (WHO) guidelines and evidence on active commuting, regular aerobic physical activity, including cycling, is an important component of cardiovascular prevention [1, 2]. Cycling also offers a practical way to incorporate physical activity into daily transportation [2].

Aerobic exercise during cycling increases vascular shear stress and activates endothelial mechanotransduction, including nitric oxide-dependent pathways [3]. These responses support vasodilation and favorable vascular adaptation; exercise training is also associated with improvements in endothelial function and arterial stiffness, particularly in people with cardiovascular risk factors [4, 5, 6]. Cycling-specific evidence demonstrates improvements in cardiorespiratory fitness, body composition, and selected cardiometabolic risk factors [7].

Epidemiological evidence supports the clinical relevance of these mechanisms. Large cohort studies and meta-analyses indicate that regular cycling and cycle commuting are associated with lower cardiovascular disease incidence and cardiovascular mortality [8, 9, 10]. These benefits have also been observed in high-risk populations, including adults with diabetes [11].

Recent evidence has expanded the range of cycling modalities considered in prevention and rehabilitation. A systematic review with meta-analyses concluded that e-cycling can improve health and cardiorespiratory fitness, although many included studies had methodological limitations [12]. Exercise training in people with hypertension improves endothelial function and vascular health [4], while long-term aerobic exercise is associated with attenuation of age-related vascular dysfunction [13]. Cycle ergometry is also widely incorporated into exercise-based cardiac rehabilitation after myocardial infarction [14, 15].

2. Literature search and review methodology

This article was prepared as a structured narrative review. PubMed/MEDLINE was used as the primary biomedical database, while bibliographic details and source relevance were cross-checked using publisher records and the reference lists of relevant systematic reviews. The eligible publication window was January 2017 through August 2026. The final set of references selected for narrative synthesis was published between 2017 and 2024; no unverified or unsuitable 2025-2026 records were retained.

2.1 Search strategy and keywords

The search strategy combined terms related to cycling and cardiovascular health using Boolean operators (AND, OR). Search concepts included cycling, bicycling, commuter cycling, active commuting, e-bike, stationary cycling, cardiovascular disease, cardiovascular health, endothelial function, shear stress, arterial stiffness, blood pressure, mortality, and major adverse cardiovascular events (MACE). Because this was a narrative rather than a PRISMA systematic review, the search was used to identify clinically relevant evidence rather than to generate a formally pooled study set.

- cycling OR bicycling OR commuter cycling OR active commuting OR e-bike OR stationary cycling;
- AND cardiovascular disease OR cardiovascular health OR endothelial function OR shear stress OR arterial stiffness OR blood pressure OR mortality OR MACE.

2.2 Inclusion and exclusion criteria

Studies were eligible for detailed analysis if they met the following criteria:

1. Study design: prospective and retrospective cohort studies, randomized controlled trials (RCTs), systematic reviews, and meta-analyses.
2. Population: adults, including both the general population and groups at increased cardiometabolic risk.
3. Intervention/exposure: regular cycling for transportation or recreation, stationary cycling, or e-bike use.

4. Outcomes: changes in hemodynamic parameters (e.g., blood pressure, endothelial function, arterial stiffness), metabolic indices, and hard clinical endpoints (CVD events and mortality).

Case reports, conference abstracts, non-peer-reviewed publications, and studies in which the effects of cycling could not be clearly distinguished from those of other forms of physical activity were excluded.

2.3 Study selection and narrative synthesis

Records were screened for relevance to the predefined scope on the basis of titles, abstracts, and, where needed, full-text information. Thirty publications were retained for the final narrative synthesis. The analysis considered high-intensity interval and continuous exercise [16, 17], vascular adaptations in type 2 diabetes [18], injury risk associated with bicycle commuting [19], and exercise-induced muscle–organ signaling as a broader biological mechanism relevant to metabolic health [20].

3. Physiological mechanisms of cardiovascular adaptation to cycling

Cycling induces a range of acute and chronic cardiovascular responses involving both the peripheral vasculature and the heart. During dynamic exercise, cardiac output and peripheral blood flow increase, raising frictional forces at the luminal surface of blood vessels (shear stress). Repeated exposure to exercise-induced shear stress is an important stimulus for endothelial adaptation and vascular remodeling [3].

3.1 Molecular mechanisms and endothelial function

Stimulation of endothelial mechanosensitive pathways by shear stress activates signaling that includes Akt-mediated phosphorylation of endothelial nitric oxide synthase (eNOS), increasing nitric oxide (NO) bioavailability and supporting vasodilation [3]. Flow-mediated dilation (FMD) is a widely used non-invasive method for assessing endothelial function and is associated with cardiovascular risk and outcomes, provided that standardized measurement procedures are followed [21].

3.2 Peripheral adaptations and arterial stiffness

Regular, long-term aerobic exercise may favorably influence vascular ageing and help limit age-related endothelial dysfunction and arterial stiffening [5, 13]. Repeated hemodynamic stimulation and nitric oxide-dependent signaling contribute to vascular adaptation [3]. Exercise-induced muscle-derived signals (myokines) may additionally influence systemic metabolic and inflammatory pathways, although these effects are not specific to cycling [20].

The regularity and total volume of physical activity are important determinants of cardiovascular adaptation. Current evidence supports a dose-response association between cycling and mortality risk, although the optimal dose and the shape of this relationship may differ between all-cause and cardiovascular mortality [22].

3.3 Central hemodynamic adaptations and cardiac remodelling

In contrast to many static or high-load resistance efforts, cycling is a dynamic form of exercise characterized by rhythmic muscle contractions and a substantial volume-loading component. Repeated endurance exercise produces physiological cardiovascular remodelling, including adaptations in cardiac chamber dimensions and function that should be distinguished from pathological remodelling [23].

Central adaptations include:

- Stroke volume (SV): Increased venous return and enhanced diastolic filling contribute to a higher stroke volume as part of physiological endurance-training adaptation [23].
- Heart rate (HR): Endurance training is commonly associated with a lower resting heart rate, reflecting autonomic and intrinsic cardiac adaptations [23].
- Cardiac output (Q): Training increases the capacity to deliver blood during exercise, while a lower heart rate at a given submaximal workload can reduce the relative cardiovascular demand [23].

3.4 Applications in clinical populations

These physiological mechanisms provide a rationale for the use of aerobic exercise, including bicycle ergometry, in patients with cardiovascular disease. In heart failure with preserved ejection fraction (HFpEF), structured exercise training improves exercise capacity; however, available evidence does not demonstrate consistent improvements in all cardiac structural or vascular endpoints [24].

4. Effects of cycling on cardiovascular risk factors and cardiovascular events

Regular cycling- whether recreational or incorporated into daily transportation-is associated with favorable changes in modifiable cardiovascular risk factors. Stationary cycling can also be used as an aerobic training modality. At the population level, observational cycling studies associate these exposures with lower cardiovascular disease incidence and mortality, although causality cannot be inferred from cohort data alone [8, 9, 10, 22].

4.1 Modification of metabolic and structural risk factors

High-intensity interval training can improve cardiorespiratory fitness and selected cardiometabolic outcomes, but responses depend on population and training dose [16, 25]. Low-volume HIIT appears particularly effective for improving cardiorespiratory fitness, whereas effects on body composition are less consistent [25].

Exercise training is beneficial for vascular health in hypertension. Meta-analytic evidence supports improvements in endothelial function [4] and reductions in arterial stiffness [6]. Cycling can be used as an aerobic exercise modality within such programs; however, current evidence does not justify claiming that stationary cycling is categorically superior to walking.

4.2 Summary of selected cardiometabolic effects

Lipid profile: cycling is associated with favorable changes in blood lipids and related cardiometabolic risk factors [7].

Glucose metabolism: structured exercise improves glycemic control, with evidence for benefits of interval training in type 2 diabetes [26].

Blood pressure and arterial stiffness: exercise training can reduce arterial stiffness in adults with hypertension [6], while a single bout of aerobic exercise can produce short-term reductions in ambulatory blood pressure in patients with hypertension [27].

Vascular function with ageing: long-term aerobic exercise is associated with better preservation of endothelial and arterial function with advancing age [5, 13].

4.3 E-bikes versus conventional cycling

Electrically assisted bicycles (e-bikes) represent a potentially effective active-transport option for individuals with lower baseline physical capacity. A systematic review with meta-analyses found that e-cycling can improve cardiorespiratory fitness and other health outcomes, while also noting substantial heterogeneity and risk of bias in the available studies [12].

4.4 Vascular function and hard cardiovascular endpoints

Taken together, metabolic and vascular benefits of regular aerobic activity may contribute to healthier vascular ageing. Long-term aerobic exercise is associated with better endothelial function and arterial health in older adults, but a specific numerical reduction in 'vascular age' should not be claimed without a validated directly applicable study [5, 13].

Hard clinical endpoints provide an important measure of the population-level benefits of cycling. Prospective cohort studies and meta-analyses associate cycling and active commuting with lower cardiovascular disease incidence and mortality [8, 9, 10, 22].

5. The role of cycling in primary and secondary prevention

Cycling is a practical means of increasing physical activity and can contribute to public-health and preventive cardiovascular strategies [1, 2]. Its versatility-including commuter cycling, recreational cycling and structured stationary bicycle exercise-allows it to be used in population-level activity promotion and in supervised clinical exercise settings.

5.1 Primary prevention and public health

In primary prevention, a major population-level challenge is the high proportion of adults who do not meet recommended physical-activity levels [1]. Active commuting by bicycle can integrate physical activity into routine travel and is associated with multiple favorable health outcomes [2].

Widespread adoption of cycling as a mode of transportation may generate important population health benefits:

- Reduction in cardiometabolic risk: Regular cycling is associated with a more favorable cardiovascular and metabolic risk profile, including better cardiorespiratory fitness and body-composition measures [7]. Active commuting is also associated with multiple favorable health outcomes at the population level [2].
- Prevention of cardiovascular events: Large cohort studies associate cycle commuting with lower cardiovascular disease incidence and cardiovascular mortality [8, 10].
- Inclusiveness through e-bike technology: E-bikes may reduce barriers related to difficult terrain, longer travel distances, or lower baseline fitness. E-cycling still requires physical effort and can provide a meaningful cardiorespiratory stimulus, although the quality of evidence varies across outcomes [12].
- Vascular health with ageing: Regular aerobic exercise is associated with better preservation of endothelial function and lower age-related arterial dysfunction [5, 13].

5.2 Secondary prevention and cardiac rehabilitation

In secondary prevention, bicycle ergometry and stationary cycling can be used as components of structured aerobic exercise. Exercise-based cardiac rehabilitation after myocardial infarction and coronary intervention improves functional outcomes and is supported by systematic-review evidence [14, 15].

Precise control of exercise dose: Stationary cycle ergometry allows external workload to be quantified in watts while heart rate and blood pressure are monitored, facilitating individualized continuous or interval exercise prescription in supervised rehabilitation settings [17].

Favorable hemodynamic profile: Cycling dynamically recruits large muscle groups, increasing shear stress and stimulating endothelial nitric oxide-mediated vascular responses [3, 21]. Exercise training can also improve endothelial function and reduce arterial stiffness in people with hypertension [4, 6].

Reduced musculoskeletal loading: Cycling is performed in a seated position and does not require repetitive weight-bearing impact, which can make it a practical aerobic option for some patients with obesity or lower-limb musculoskeletal limitations. The suitability of cycling should nevertheless be individualized.

Applications in specific clinical conditions:

- Patients after acute myocardial infarction (AMI): Exercise-based cardiac rehabilitation improves recovery and cardiovascular outcomes after myocardial infarction; cycle ergometry is commonly used as one component of supervised aerobic rehabilitation [14, 15].
- Heart failure with preserved ejection fraction (HFpEF): Structured exercise training, including protocols that use bicycle ergometry, improves peak oxygen uptake and exercise capacity in HFpEF [24].
- Diabetes and vascular metabolic complications: Exercise training improves endothelial function in type 2 diabetes, while high-intensity interval training can improve glycemic control and cardiorespiratory fitness. Cycling itself is associated with lower all-cause and cardiovascular mortality among adults with diabetes [11, 18, 26].

6. Discussion and limitations

The literature reviewed indicates that regular cycling is associated with favorable cardiovascular outcomes through several complementary pathways. Evidence includes endothelial and vascular adaptations to aerobic exercise [3, 5, 13, 21], improvements in cardiometabolic risk factors [4, 6, 7], and observational associations between cycling and lower cardiovascular disease incidence and mortality [8, 9, 10, 11, 22]. Cycling and cycle ergometry may also contribute to prevention and rehabilitation programs [12, 14, 15, 24].

Although the findings are broadly consistent, an objective interpretation of the available evidence requires consideration of methodological limitations and potential confounding factors.

6.1 Associations in epidemiological studies and population-related bias

A substantial proportion of the evidence concerning hard cardiovascular endpoints is derived from large prospective cohort studies, including UK Biobank, census-linked population data, and the EPIC cohort [8, 10, 11]. Despite their large sample sizes, observational studies remain susceptible to healthy-user effects and residual confounding. Individuals who choose active commuting may differ from non-cyclists in diet, smoking behavior, socioeconomic status, and other health-related characteristics. Although multivariable models reduce measured confounding, residual confounding cannot be completely excluded.

6.2 Subjective assessment of exposure and energy expenditure

In observational studies, cycling volume, frequency, and intensity are often assessed using self-report questionnaires. This introduces the risk of recall bias and exposure misclassification. Moreover, studies differ substantially in how cycling dose is quantified, which complicates assessment of precise dose-response relationships [2, 22].

6.3 Environmental risk factors and the balance of benefits and risks

Urban cycling involves exposure to specific environmental hazards, including:

- Air pollution: Increased ventilation during outdoor exercise may increase inhaled doses of particulate matter and traffic-related pollutants. Evidence indicates that ambient air pollution can modify or attenuate some cardiovascular benefits associated with physical activity and active commuting, particularly at high pollution concentrations [28, 29].
- Injury risk: Cycle commuting is associated with a higher risk of injury-related hospital admission than non-active commuting, emphasizing the importance of safe cycling infrastructure [19].

The overall benefit–risk balance of active transportation is context dependent and should be interpreted alongside traffic-injury risk, ambient air pollution, and local cycling infrastructure [19, 28, 29].

6.4 Heterogeneity of cycling modalities and training protocols

The reviewed literature demonstrates considerable heterogeneity in cycling modalities and training protocols, including conventional cycling, e-cycling, cycle ergometry, moderate-intensity continuous exercise, and high-intensity interval training [12, 16, 17, 25, 30]. This heterogeneity limits direct comparison between studies and makes it difficult to formulate a single universal cycling-based exercise prescription for all patient groups.

7. Conclusions

The scientific literature reviewed (2017–2026) on the effects of cycling on cardiovascular health supports the following conclusions:

7.1 Hemodynamic stimulation and vascular adaptation: Cycling and other forms of aerobic exercise increase blood flow and shear stress, activating endothelial pathways that include nitric oxide signaling. Regular aerobic exercise is associated with favorable adaptations in endothelial function and arterial stiffness [3, 4, 5, 6, 13, 21].

7.2 Optimization of the cardiometabolic profile: Cycling is associated with better cardiorespiratory fitness, body composition, and selected cardiovascular risk factors [7]. Exercise training more broadly can improve endothelial function, arterial stiffness, ambulatory blood pressure, and glycemic control in relevant clinical populations [4, 6, 26, 27].

7.3 Reduction in hard clinical endpoints: Prospective cohorts and meta-analyses consistently associate cycling with lower cardiovascular disease incidence and mortality. In the UK Biobank, cycle commuting was associated with HR 0.54 for incident CVD and HR 0.48 for CVD mortality [8]. A separate dose-response meta-analysis reported 23% lower all-cause mortality (RR 0.77) and 24% lower CVD mortality (RR 0.76) when comparing the highest with the lowest cycling exposure categories [22].

7.4 Broad clinical applicability: Cycling is a versatile aerobic exercise modality that can be incorporated into primary prevention and structured cardiac rehabilitation. Evidence supports exercise-based rehabilitation after myocardial infarction, improved exercise capacity in HFpEF, and vascular and metabolic benefits of exercise in type 2 diabetes [14, 15, 18, 24, 26].

Disclosure

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References

1. Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., Carty, C., Chaput, J. P., Chastin, S., Chou, R., Dempsey, P. C., DiPietro, L., Ekelund, U., Firth, J., Friedenreich, C. M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P. T., Lambert, E., … Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British journal of sports medicine*, *54*(24), 1451–1462. https://doi.org/10.1136/bjsports-2020-102955
2. Dinu M, Pagliai G, Macchi C, Sofi F. Active commuting and multiple health outcomes: a systematic review and meta-analysis. Sports Med. 2019;49(3):437-452. https://doi.org/10.1007/s40279-018-1023-0.
3. Green DJ, Smith KJ. Effects of exercise on vascular function, structure, and health in humans. Cold Spring Harb Perspect Med. 2018;8(4):a029819. https://doi.org/10.1101/cshperspect.a029819.
4. Pedralli ML, Eibel B, Waclawovsky G, Schaun MI, Nisa-Castro-Neto W, Umpierre D, Pescatello LS, Tanaka H, Lehnen AM. Effects of exercise training on endothelial function in individuals with hypertension: a systematic review with meta-analysis. J Am Soc Hypertens. 2018;12(12):e65-e75. https://doi.org/10.1016/j.jash.2018.09.009.
5. Seals DR, Nagy EE, Moreau KL. Aerobic exercise training and vascular function with ageing in healthy men and women. J Physiol. 2019;597(19):4901-4914. https://doi.org/10.1113/JP277764.
6. Lopes S, Afreixo V, Teixeira M, Garcia C, Leitão C, Gouveia M, Figueiredo D, Alves AJ, Polonia J, Oliveira J, Mesquita-Bastos J, Ribeiro F. Exercise training reduces arterial stiffness in adults with hypertension: a systematic review and meta-analysis. J Hypertens. 2021;39(2):214-222. https://doi.org/10.1097/HJH.0000000000002619.
7. Nordengen S, Andersen LB, Solbraa AK, Riiser A. Cycling and cardiovascular disease risk factors including body composition, blood lipids and cardiorespiratory fitness analysed as continuous variables: part 2-systematic review with meta-analysis. Br J Sports Med. 2019;53(14):879-885. https://doi.org/10.1136/bjsports-2018-099778.
8. Celis-Morales CA, Lyall DM, Welsh P, Anderson J, Steell L, Guo Y, Maldonado R, Mackay DF, Pell JP, Sattar N, Gill JMR. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. BMJ. 2017;357:j1456. https://doi.org/10.1136/bmj.j1456.
9. Nordengen S, Andersen LB, Solbraa AK, Riiser A. Cycling is associated with a lower incidence of cardiovascular diseases and death: part 1-systematic review of cohort

studies with meta-analysis. Br J Sports Med. 2019;53(14):870-878. https://doi.org/10.1136/bjsports-2018-099099.

10. Patterson R, Panter J, Vamos EP, Cummins S, Millett C, Laverty AA. Associations between commute mode and cardiovascular disease, cancer, and all-cause mortality, and cancer incidence, using linked Census data over 25 years in England and Wales: a cohort study. Lancet Planet Health. 2020;4(5):e186-e194. https://doi.org/10.1016/S2542-5196(20)30079-6.
11. Ried-Larsen M, Rasmussen MG, Blond K, Overvad TF, Overvad K, Steindorf K, Katzke V, Andersen JLM, Petersen KEN, Aune D, Tsilidis KK, Heath AK, Papier K, Panico S, Masala G, Pala V, Weiderpass E, Freisling H, Bergmann MM, Verschuren WMM, Zamora-Ros R, Colorado-Yohar SM, Spijkerman AMW, Schulze MB, Ardanaz EMA, Andersen LB, Wareham N, Brage S, Grøntved A. Association of cycling with all-cause and cardiovascular disease mortality among persons with diabetes: the European Prospective Investigation Into Cancer and Nutrition (EPIC) study. JAMA Intern Med. 2021;181(9):1196-1205. https://doi.org/10.1001/jamainternmed.2021.3836.
12. Riiser A, Bere E, Andersen LB, Nordengen S. E-cycling and health benefits: a systematic literature review with meta-analyses. Front Sports Act Living. 2022;4:1031004. https://doi.org/10.3389/fspor.2022.1031004.
13. Campbell A, Grace F, Ritchie L, Beaumont A, Sculthorpe N. Long-term aerobic exercise improves vascular function into old age: a systematic review, meta-analysis and meta regression of observational and interventional studies. Front Physiol. 2019;10:31. https://doi.org/10.3389/fphys.2019.00031.
14. Zhang P, Niu C, Zhang L, Lai H, Liu B, Lv D, Zhuang R, Liu Y, Xiao D, Ma L, Li M. The impact of the time factors on the exercise-based cardiac rehabilitation outcomes of the patients with acute myocardial infarction after percutaneous coronary intervention: a systematic review and meta-analysis. BMC Cardiovasc Disord. 2024;24(1):35. https://doi.org/10.1186/s12872-023-03692-z.
15. Abell B, Glasziou P, Hoffmann T. The contribution of individual exercise training components to clinical outcomes in randomised controlled trials of cardiac rehabilitation: a systematic review and meta-regression. Sports Med Open. 2017;3(1):19. https://doi.org/10.1186/s40798-017-0086-z.
16. Batacan RB Jr, Duncan MJ, Dalbo VJ, Tucker PS, Fenning AS. Effects of high-intensity interval training on cardiometabolic health: a systematic review and meta-analysis of

intervention studies. Br J Sports Med. 2017;51(6):494-503. https://doi.org/10.1136/bjsports-2015-095841.

17. Ballesta García I, Rubio Arias JA, Ramos Campo DJ, Martínez González-Moro I, Carrasco Poyatos M. High-intensity interval training dosage for heart failure and coronary artery disease cardiac rehabilitation: a systematic review and meta-analysis. Rev Esp Cardiol (Engl Ed). 2019;72(3):233-243. https://doi.org/10.1016/j.rec.2018.02.015.

18. Lee JH, Lee R, Hwang MH, Hamilton MT, Park Y. The effects of exercise on vascular endothelial function in type 2 diabetes: a systematic review and meta-analysis. Diabetol Metab Syndr. 2018;10:15. https://doi.org/10.1186/s13098-018-0316-7.

19. Welsh C, Celis-Morales CA, Ho F, Lyall DM, Mackay D, Ferguson L, Sattar N, Gray SR, Gill JMR, Pell JP, Welsh P. Association of injury related hospital admissions with commuting by bicycle in the UK: prospective population based study. BMJ. 2020;368:m336. https://doi.org/10.1136/bmj.m336.

20. Bay ML, Pedersen BK. Muscle-organ crosstalk: focus on immunometabolism. Front Physiol. 2020;11:567881. https://doi.org/10.3389/fphys.2020.567881.

21. Thijssen DHJ, Bruno RM, van Mil ACCM, Holder SM, Faita F, Greyling A, Zock PL, Taddei S, Deanfield JE, Lüscher TF, Green DJ, Ghiadoni L. Expert consensus and evidence-based recommendations for the assessment of flow-mediated dilation in humans. Eur Heart J. 2019;40(30):2534-2547. https://doi.org/10.1093/eurheartj/ehz350.

22. Zhao Y, Hu F, Feng Y, Yang X, Li Y, Guo C, Li Q, Tian G, Qie R, Han M, Huang S, Wu X, Zhang Y, Wu Y, Liu D, Zhang D, Cheng C, Zhang M, Yang Y, Shi X, Lu J, Hu D. Association of cycling with risk of all-cause and cardiovascular disease mortality: a systematic review and dose-response meta-analysis of prospective cohort studies. Sports Med. 2021;51(7):1439-1448. https://doi.org/10.1007/s40279-021-01452-7.

23. Martinez MW, Kim JH, Shah AB, Phelan D, Emery MS, Wasfy MM, Fernandez AB, Bunch TJ, Dean P, Danielian A, Krishnan S, Baggish AL, Eijsvogels TMH, Chung EH, Levine BD. Exercise-induced cardiovascular adaptations and approach to exercise and cardiovascular disease: JACC state-of-the-art review. J Am Coll Cardiol. 2021;78(14):1453-1470. https://doi.org/10.1016/j.jacc.2021.08.003.

24. Leggio M, Fusco A, Loreti C, Limongelli G, Bendini MG, Mazza A, Coraci D, Padua L. Effects of exercise training in heart failure with preserved ejection fraction: an updated systematic literature review. Heart Fail Rev. 2020;25(5):703-711. https://doi.org/10.1007/s10741-019-09841-x.

25. Sultana RN, Sabag A, Keating SE, Johnson NA. The effect of low-volume high-intensity interval training on body composition and cardiorespiratory fitness: a systematic review and meta-analysis. Sports Med. 2019;49(11):1687-1721. https://doi.org/10.1007/s40279-019-01167-w.
26. Liu JX, Zhu L, Li PJ, Li N, Xu YB. Effectiveness of high-intensity interval training on glycemic control and cardiorespiratory fitness in patients with type 2 diabetes: a systematic review and meta-analysis. Aging Clin Exp Res. 2019;31(5):575-593. https://doi.org/10.1007/s40520-018-1012-z.
27. Saco-Ledo G, Valenzuela PL, Ramírez-Jiménez M, Morales JS, Castillo-García A, Blumenthal JA, Ruilope LM, Lucia A. Acute aerobic exercise induces short-term reductions in ambulatory blood pressure in patients with hypertension: a systematic review and meta-analysis. Hypertension. 2021;78(6):1844-1858. https://doi.org/10.1161/HYPERTENSIONAHA.121.18099.
28. Tainio M, Jovanovic Andersen Z, Nieuwenhuijsen MJ, Hu L, de Nazelle A, An R, Garcia LMT, Goenka S, Zapata-Diomedi B, Bull F, de Sá TH. Air pollution, physical activity and health: a mapping review of the evidence. Environ Int. 2021;147:105954. https://doi.org/10.1016/j.envint.2020.105954.
29. Lin Y, Yang X, Liang F, Huang K, Liu F, Li J, Xiao Q, Chen J, Liu X, Cao J, Chen S, Shen C, Yu L, Lu F, Wu X, Zhao L, Wu X, Li Y, Hu D, Huang J, Lu X, Liu Y, Gu D. Benefits of active commuting on cardiovascular health modified by ambient fine particulate matter in China: a prospective cohort study. Ecotoxicol Environ Saf. 2021;224:112641. https://doi.org/10.1016/j.ecoenv.2021.112641.
30. Way KL, Sultana RN, Sabag A, Baker MK, Johnson NA. The effect of high intensity interval training versus moderate intensity continuous training on arterial stiffness and 24h blood pressure responses: a systematic review and meta-analysis. J Sci Med Sport. 2019;22(4):385-391. https://doi.org/10.1016/j.jsams.2018.09.228.