Annals of Agricultural and Environmental Medicine 2023, Vol 30, No 2, 376–383
www.aaem.pl

VARIA

The influence of architecture, design and physical environment in residential buildings on cardiovascular disease – rationale and protocol for an overview of systematic reviews

Magdalena Abramczyk[1,A-F], **Janusz Krzyszton**[2,B-C,E-F], **Adam Windak**[2,B,E-F], **Jacek Jóźwiak**[3,B,E-F], **Tomasz Tomasik**[2,A-B,D-F] ✉

[1] *Chair of Urbanism and City Structure, Faculty of Architecture, University of Technology, Kraków, Poland*
[2] *Department of Family Medicine, Jagiellonian University Medical College, Kraków; College of Family Physicians in Poland, Warsaw, Poland*
[3] *Department of Family Medicine and Public Health, University of Opole; College of Family Physicians in Poland, Warsaw, Poland*
A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

Abramczyk M, Krzysztoń J, Windak A, Jóźwiak J, Tomasik T. The influence of architecture, design and physical environment in residential buildings on cardiovascular disease – rationale and protocol for an overview of systematic reviews. Ann Agric Environ Med. 2023; 30(2): 376–383. doi: 10.26444/aaem/166089

Abstract

Introduction and Objective. Architecture and design solutions profile the environment and living conditions in residential housing and may have an impact on health. The aim of the study was to summarise all published systematic reviews (SRs) with or without meta-analysis (MAs), which assess the effect on cardiovascular disease (CVD) of the architecture, design and physical environment in residential buildings.

Materials and method. This study presents the rationale and protocol of an overview of SRs. It was prepared according to Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P). Four bibliographical databases will be searched. Eligible SRs can include RCTs, quasi-RCTs and observational studies.

Results and Summery. The expected results of the completed overview of SRs will comprehensively summarise evidence concerning the influence of residential environment on cardiovascular health. This might be of importance to physicians, architects, public health professionals and politicians.

Key words

environment, systematic review, cardiovascular disease, architecture, buildings

INTRODUCTION AND OBJECTIVES

Human health is affected by a variety of factors which, in addition to the individual characteristics and behaviour of a person, also include medical care, socio-economic status and physical environment [1]. The environment surrounds people in the regions where they live, in places where they work or study and in their homes. Many scientific studies confirm the influence of environmental factors on physical and mental health [2]. The harmful effect of air [3, 4] and water pollution [5] has been proven, as well as noise [6] and inappropriate exposure to light [7]which are associated with many diseases.

The indoor environment in residential buildings can also have a significant impact on the health of residents. It is determined by many factors, including lighting, air quality, thermal comfort, damp, acoustic conditions and materials. They are the result of the architecture, design and construction of the building. Architecture refers to the planning, design and construction of buildings and is a combination of both art and science [8, 9]. Its scientific approach is not only related to engineering, technology or other technical disciplines [10], but also includes social science [11]. There are many consequences of architecture and design interventions which affect the environment, both inside [12] and out [13]. In buildings, external and internal spaces are distinguished that allow people to move, connect, draw inspiration and relax [14]. Architecture impacts the well-being, quality of life, mood and health of people, and also influences social interactions and behaviour; for example, it can reduce crime and the fear of crime. Some of these influences may be due to the form of the building itself, but many are moderated by non-architectural factors (e.g. socio-economic status and location of the building) [15, 16].

Atherosclerotic cardiovascular diseases (CVD), mainly ischaemic heart disease (IHD) and stroke, are the leading cause of morbidity and mortality worldwide. In 2019, the total number of CVD cases was 523 million and CVD deaths were 18.6 million [17]. More than three-quarters of global deaths from CVD occur in low- and middle-income countries. In Europe, mortality from cardiovascular disease is declining but still accounts for 45% of all deaths, with CVD incidence rates estimated to be about 30% higher in middle-income countries than in high-income countries [18].

Over the past few decades, major factors that increase the probability of CVD have been identified. The main causative

✉ Address for correspondence: Tomasz Tomasik, Department of Family Medicine, Jagiellonian University Medical College, Kraków; College of Family Physicians in Poland, Warsaw, Poland
E-mail: mmtomasi@cyf-kr.edu.pl

Received: 21.03.2023; accepted: 10.05.2023; first published: 24.05.2023

and modifiable risk factors are high blood pressure, high low-density lipoprotein level, cigarette smoking, diabetes mellitus and obesity. In addition to these factors, several common risk modifiers are associated, in a dose-response pattern, with the development and progression of CVD. These include psychosocial and occupational stress, certain ethnic backgrounds, frailty, family history of premature cardiovascular diseases, low socio-economic status and exposure to environmental factors, such as air, water or soil pollutions and above-threshold noise levels [19, 20].

At the beginning of this century, the impact of the environment on human health was notoriously ignored and research was severely underfunded [21]. Now it is paid more attention and the problem has become well recognized. This fact is not surprising considering the results of published, high-quality analyses. Exposure to fine particulate matter in ambient air has been linked to an increased risk of death from lung cancer, chronic cardiovascular and respiratory disease in the United States and Europe [22]. In 2005, a new paradigm was proposed – the 'exposome', which includes the sum of environmental, external factors (all non-genetic) to which a person is exposed throughout life from conception [23]. The analysis by Prüss-Ustün et al. confirmed that nearly a quarter of global deaths in 2012 were attributable to environmental risks [24]. Eliminating these hazards would greatly benefit people's health.

With regard to housing, indoor air pollution and unsafe water sources were among the top ten leading risk factors for death in the world in 1990. They have moved down the risk ranking a little, but are still important [25], and is a welcome change has come about through socio-economic development. Worldwide in 2017, household air pollution was associated with 1.8 million deaths, with the highest risk in low- and middle – income countries. Moreover, it is also definitely associated with diseases that have a poor prognosis, including lung cancer, asthma, chronic obstructive pulmonary disease, cerebrovascular disease and ischaemic heart disease [26]. The WHO estimates that 30% of the European population is exposed to nightly levels of noise which exceed 55 dB. This level is associated with hypertension, arteriosclerosis, CVD mortality, IHD, and stroke [27, 28].

International teams developing clinical guidelines are paying increasing attention to environmental issues. An example is the European Society of Cardiology (ESC) guidelines on CVD prevention, issued in 2021. They include a recommendation for policy intervention at the population level, to reduce air pollution in order to prevent CVD. Furthermore, they discuss the potential impact of soil and water pollution, and excessive noise [20]. Medical professionals are well aware of the importance of physiological and behavioural risk factors in the development of CVD [29]; however, they may pay too little attention to the impact of architecture, design and the physical environment in homes. Furthermore, architects are more likely to focus on aesthetic and technological issues rather than health matters. An increasing number of studies show that architectural solutions can negatively affect health and interact synergistically with classical risk factors.

Systematic reviews (SRs) are secondary studies prepared in accordance with rigorous methodological standards that minimize the risk of bias. The authors of these studies implement formal approaches and systematic methods for framing a research question, appraising and collating evidence, and interpreting the findings. SRs summarize the results of primary studies and often include a quantitative synthesis – metanalysis. Therefore, the results of SRs are considered to be one of the leaders in the hierarchy of clinical data reliability. They are now widely accepted as the most trustworthy source of knowledge from research [30], and the number of SRs being published is increasing. Hoffmann F et al. revealed that in 2019, a total of 80 SRs were published per day [31].

The large number of publications of primary and secondary research makes it impossible for medical professionals to become familiar with their results on an ongoing basis; therefore, an overview of SRs may be of some help in this regard [32]. This type of research may also show deficiencies in secondary studies conducted and published on architecture and its effects on CVD.

Our team will perform an overview of published SRs which have assessed the influence of building attributes and indoor environment in homes on CVD. The objectives of this study are to analyse the existing evidence of: (1) the association between architecture, design and the physical environment in residential buildings (exposure) on inhabitants' CVD mortality, morbidity and risk factors, and (2) the impact of various interventions to improve housing conditions on CVD compared with no intervention.

MATERIALS AND METHOD

The protocol follows the 'Preferred Reporting Items for Systematic review and Meta-Analysis Protocols' (PRISMA-P) [33]. The PRISMA-P checklist is attached in Appendix 1. Published systematic reviews and meta-analyses will be analytical units of this overview [34].

Eligibility criteria

Study design. Studies will be included in the overview if they meet the criteria specified below.

Only SRs, with or without meta-analysis, which focus on the influence of residential housing architecture, design and environment on CVD, will be eligible. These reviews may include randomised control trials (RCTs), quasi-RCTs and observation studies. If an SR is updated and the scope is the same, we will include only the latest version.

We will assume that a review is systematic if it involves a clearly formulated question, a comprehensive search for relevant reports, and the included studies are appraised according to an explicit method [35, 36]. Meta-analysis will be considered if the statistical method of combining results is objective and allows the resolution of discrepancies in clinical research [37].

Publication status and language. Studies reported as full-text, in English, and published in peer-reviewed journals.

Setting. There will be no restrictions imposed by the type of setting. Residential buildings, whether urban, suburban or rural, will be included, regardless of geographical location.

Time frame. Since only a very small number of reviews were conducted in a systematic way before 1990, we will consider that year as the starting point of our search and will carry it out until the present time.

Participants. People of all ages and gender, regardless of health, function and socio-economic status who live in houses or apartments with different architectural and design solutions, as well as different physical environments.

Exposure/interventions and comparators. The exposure factors and interventions of interest that are assessed for CVD impact are: architectural and design solutions which form the specific, physical environment in residential buildings. They can be measured or modelled. Aspects of this environment will include but are not limited to:

- spatial layout of the dwelling (e.g. size, zones, rooms, internal communication and physical activity spaces);
- air (e.g. fresh air, pollutants, ventilation, opening windows and air filtration/purification systems);
- water and sanitation (e.g. internal installation, water quality, handwashing facilities and humidity);
- lighting (e.g. natural, artificial, light pollution, window size and electrical installations);
- acoustics (e.g. acoustic zones, noise level, sound insulation and window placement);
- thermal comfort (e.g. inside temperature, controls, thermal zones and insulation).

By intervention is meant 'procedure or solution undertaken to improve residential building and prevent disease'. The comparator will be non-specific architectural and design solutions which are found in standard dwellings, or which are other than interventions.

Outcomes. The outcomes of interest in embedded SRs will include mortality, morbidity and risk factors of CVD. They are listed in this protocol in the section 'Outcomes; prioritisation and definitions'.

Exclusion criteria. The following will be excluded: (1) studies in which exposure to a risk factors (e.g. noise and air pollution) was assessed outside and not inside the building; (2) studies related to outdoor environments, workplace, school, grounds around buildings, recreational areas, gardens and landscaping; (3) studies related to non-permanent elements of interior design, in particular room décor, floor covering, furniture and home equipment; (4) studies related to materials (e.g. lead paint, asbestos and other hazardous components). Moreover, SRs which analyse surrogate CVD outcomes and indirect measures of health (medicine or health services use, ECG abnormalities and heart rate) will also be excluded. The reason for the exclusion of certain SRs will be provided.

Our overview will not include: narrative reviews, government and institutional reports, textbook chapters, architectural or clinical guidelines without SR, summary reports, preliminary data and conference abstracts.

The focus will be on the environment inside the place of residence. In the case of reviews that relate to both the internal and external environment, we will try to isolate and include only data related to the former.

Intended information sources. Relevant reviews will be identified through systematic searches of the following databases:

- MEDLINE (PubMed).
- EMBASE.
- CENTRAL(Cochrane Central Register of Controlled Trials).
- SCOPUS.

To identify additional relevant studies, we will also track the reference lists of all included SRs. The search will be supplemented by looking for unpublished, ongoing, or recently completed SRs in PROSPERO.

Search strategy. The search strategy will be developed by an experienced librarian with input from the project team and will not be limited to any language. It will then be peer reviewed by a second librarian.

The draft of the search to be used for MEDLINE (PubMed) is presented in Appendix 2. We will implement optimal search strategies in this database for retrieving systematic reviews [38]. This search strategy will be adapted for other databases.

Study records

Data management. All abstracts and full text articles obtained as a result of the literature search will be entered into Mendeley (Elsevier). Duplicates will then be removed.

Selection process. In the first step of the selection process, titles and abstracts of SRs will be reviewed to identify potential study, in accordance with eligibility criteria. After that, the full text of all potentially relevant publications in English will be analysed for final inclusion. Restrictions regarding publications in English will be imposed only at the stage of choosing the studies, and not at the stage of searching the literature. A list of possibly relevant studies in other languages will be provided in an appendix.

SRs that meet the eligibility criteria will be included in our overview. The processes of screening, eligibility assessment and study inclusion will be undertaken by two authors working independently. They will not be blind to the journal titles and to the study authors or institutions. Any disagreements will be resolved through discussion and when necessary by a third author. If any unpublished or ongoing study is identified, an attempt will be made to contact the authors in order to obtain information about the expected date of publication of the review.

Data collection process. Two authors will independently extract outcome data from each of the included SRs. They will take into account the guidelines from the PRISMA statement [39] and the Cochrane Handbook of Systematic Reviews of Interventions [36]. In the case of lack of consensus, a third author will arbitrate. We will use a standard data extraction form created in word processor software (Microsoft Word; Microsoft Corporation). At the beginning of the data extraction process, we plan to conduct a pilot study using the first three eligible SRs. We will determine if any fields in the form should be added or clarified.

If an SR presents a synthesis of findings in a narrative way, the original words and text related to CVD outcomes will be extracted and, if necessary, simplified or summarised. If data are presented in graphical form we plan to translate it into a usable, numeric format. All quantitative data, e.g. continuous, categorised and dichotomous will be taken into account. In the case of composite outcome information, each component will be provided as the authors of the SR

presented it. If meta-analysis has been performed, results and methodology elements (e.g. types and unity of data, effect measured and analysis of heterogeneity) will be extracted.

Data items. To collect the data of interest from the eligible SRs, the following information will be extracted: (1) bibliographic data (authors, title, journal, publication date, volume and pages); (2) the characteristics of each SR: research objectives/questions/hypothesis; inclusion and exclusion criteria, details of population and participants, exposure (its intensity) data, intervention and comparison, outcomes, quality of evidence as reported by authors, number of primary studies included and time frame of search; (3) reported limitations of each SR; (4) results of the review (if possible including statistical measures such as odds ratio, risk ratio, hazard ratio, weighted mean differences and 95% confidence intervals); (5) conclusions of the review as stated by the authors; and (6) additional information (reported conflicts of interest, funding sources and role of study sponsors).

Outcomes – prioritisation and definitions. As primary outcomes we will choose those which are important to ordinary people living in houses and apartments, are clinically relevant and can be objectively measured. They are:
- All-cause mortality.
- CVD mortality (death attributable to myocardial ischaemia, heart failure, cardiac arrest or ischaemic stroke).

As secondary outcomes, we will select those that may indicate additional health effects resulting from specific architectural and design solutions. These include:
- Cardiovascular morbidity and non-fatal events (myocardial infarction, acute or chronic coronary artery disease, heart failure, stroke, transient ischaemic attack and peripheral artery diseases).
- Changes in patient CVD risk factors (obesity, lipid level, blood pressure, smoking, physical activity, diet and alcohol consumption).
- Adverse events (e.g. any physically, psychologically and socially unfavourable impact).

As some outcomes may be presented as a composite measure (e.g. MACE – major adverse cardiovascular events), we will report them and if possible also extract the individual outcomes.

Risk of bias in included systematic reviews. The risk of bias of individual SRs included in our overview at the study level will be assessed. Comprehensive critical appraisal instruments that assess these errors are scarce. We have chosen AMSTAR (A MeaSurement Tool to Assess systematic Reviews), one of the most widely-used instruments, the description of which was published in 2007 [40]. We will use a new version – AMSTAR-2, a 16-item assessment tool with 7 critical domains, used to check the quality of an SR which includes both randomised and non-randomised studies. It allows the determination of whether the most important elements of SRs are reported, and provides us with an overall rating based on weaknesses in critical domains [41]. We will rate confidence in the results of the SR as: high (no or one non-critical weakness), moderate (more than one non-critical weakness), low (one critical flaw with or without non-critical weaknesses), critically low (more than one critical flaw with or without non-critical weaknesses).

Two reviewers will independently appraise the risk of bias of the included SRs. Disagreements will be resolved through discussion and by a third author, if necessary.

With regard to the bias of the primary studies within each included SR, we will extract the assessments provided by the authors and present them as narrative or tabular summaries.

Data – Data synthesis. A PRISMA flow diagram will be used to visually summarise the literature screening process. We plan to present outcome data as a systematic narrative synthesis (meta-synthesis) and describe them as they are presented in included SRs. At the beginning of the result section, we will present findings related to the first objective of the overview (exposure) and after that to the second (interventions). Within them, primary and secondary outcomes will be presented. Primary analysis will include studies with a low risk of bias (no critical weakness in AMSTAR-2 assessment). An analysis will then be carried out, taking all the studies into account. We plan to present each outcome measure in turn across SRs. Where the scope of a relevant SR is broader then our overview, only a part of the studies that fulfill the inclusion criteria will be incorporated. To enhance the clarity of our reporting, we will supplement textual description with a series of summary Tables and Figures. We plan to prepare Tables on the characteristics of qualified reviews and tables on primary and secondary outcomes. If possible, sub-group analysis will be conducted, taking into account, inter alia, age, gender and country classification by income level. Outcomes of interest for which no SRs have been found will be presented.

We are not planning to carry out a meta-analysis of the meta-analyses found in SRs since there is no well-established quantification method in this field. Authors who have analysed methodological challenges in such analyses highlight the importance of the fact that data from individual studies should not be used more than once. The risk of such a situation exists when several suitable meta-analyses include the same primary study [42, 43].

Meta-biases. Attempts will be made to investigate the possibility that the identified data is biased due to non-study related processes.

We plan to *assess* eligible SRs to determine whether *outcome reporting* is sufficiently complete and transparent (outcome reporting bias). We will compare outcomes which were planned to be assessed in the systematic review protocols (or, if unavailable, in the Methods Section of the published report of SRs) and those reported in the results section of the final report of SRs.

To minimise publication bias, the PROSPERO database will be searched to identify all relevant unpublished or ongoing SRs. If successful, we will contact the corresponding author and ask whether there was an attempt to publish a review and the paper was rejected.

To minimise language bias, we will not use a language restriction at the stage of searching the literature. Due to the fact that we plan to include in the overview only articles published in English, other articles that are not qualified will be listed in the Appendix.

Confidence in cumulative evidence. To present the confidence we have in the effect estimate, we will report the assessment of the quality of evidence performed by the SRs' authors

and included in an original publication. Otherwise, we will consider assessing the certainty using the data reported in SRs. In particular, the number of RCTs and quasi-RCTs included in particular SRs will be analysed, assuming that their greater number confirms the certainty of the results. If authors report Grading of Recommendations, Assessment, Development and Evaluations (GRADE) assessments, the results will be presented.

Amendments. If there is a need to modify this protocol, we will describe the changes with the rationale in the final version of the overview.

Ethics. This research is exempt from ethics approval because the work is carried out on published papers.

DISCUSSION

Our research project, which is prepared as a joint work of architects and physicians, aims to address an interdisciplinary problem related to the population. We will provide information on the impact of residential architecture, design and physical environment on CVD. This protocol was prepared to document the planned overview methods, to explicitly present participants, interventions and outcomes of interest and to avoid changes during the further review process. The main outcome of this overview will be a comprehensive description of the most up-to-date evidence.

Our overview of SRs will visibly have some limitations. Firstly, we will not review the quality of every, primary study included in the SRs or perform an independent analysis of the data from those studies. Secondly, the electronic search strategy will be limited to 4 bibliographic databases. Only SRs published as full text article, in peer-reviewed journals and in English will be consider. Grey literature for unpublished articles and conference abstracts will not be considered. Moreover, our overview will not allow direct comparison of the different interventions to improve the environment in residential buildings that have been examined in various systematic reviews. We have no intention of determining which intervention is best for CVD. This is due to the fact that SRs evaluating individual interventions tend to differ in many respects, and it is difficult to assess the reliability of indirect comparison based solely on information from SRs [36].

Overviews of SRs analysing cardiovascular risk factors have been published over the last decade. They concern exposure to specific risk factors [44–46], interventions effective in reducing them [47], and interventions targeting global/total cardiovascular risk [48]. These publications generally concern classical risk factors. There are also overviews of SRs related to CVD [49, 50]. We also conducted a preliminary search of one database (MEDLINE-PubMed) in a not systematic way to gain a general idea of the overviews of SRs related to the environment. There are a limited number of such publications for the outdoor environment [51], but not for the indoor environment in residential buildings.

CVD prevention needs an integrated, interdisciplinary approach, including input from several disciplines [20]. We hope that our overview will be of interest to a wide range of scientists, healthcare professionals, architects, engineers, technicians, and other construction professionals. The results of our study may also be important to government officials, health care funding agencies and construction support agencies. They can help plan and implement CVD prevention programmes in the future and show where efforts and founds should be focused. We expect that we will clearly demonstrate the importance of architecture in the analysed area of cardiovascular health.

If we reveal obvious knowledge gaps and unexplored fields, our overview may also be of interest to researchers. It is hoped that the results of this study will expand knowledge concerning the relationship between architecture and CVD. Architectural design can lead to an improvement in the health of the population, especially in developing countries.

CONCLUSION

It can be concluded that our protocol for an overview of SRs provides a solid basis for preparing the final SR. It presents the reason why we decided to prepare such a study, and outlines the actions and processes that we will perform to achieve the research aim. In addition, it allows for a proper estimation of resources and time to complete the study. Comparing the protocol with the review published at the end of the study will allow readers to assess any discrepancies with the proposed overview plan. The published protocol makes our project available in the public domain and opens it for remarks, comments, and critique.

Registration

In accordance with the guidelines, this systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) on 20 February 2023 (Registration No.: CRD42023397994).

REFERENCES

1. WHO. What are the determinants of health. Available from: https://www.who.int/news-room/questions-and-answers/item/determinants-of-health (access: 2023.03.01).
2. Theron LC, Abreu-Villaça Y, Augusto-Oliveira M, et al. A systematic review of the mental health risks and resilience among pollution-exposed adolescents. J Psychiatr Res. 2022;146:55–66. https://doi.org/10.1016/j.jpsychires.2021.12.012
3. Niu Z, Liu F, Yu H, et al. Association between exposure to ambient air pollution and hospital admission, incidence, and mortality of stroke: an updated systematic review and meta-analysis of more than 23 million participants. Environ Health Prev Med. 2021;26(1):15. https://doi.org/10.1186/s12199-021-00937-1
4. Saleh S, Shepherd W, Jewell C, et al. Air pollution interventions and respiratory health: a systematic review. Int J Tuberc Lung Dis. 2020;24(2):150–164. https://doi.org/ 10.5588/ijtld.19.0417
5. Gundry S, Wright J, Conroy R. A systematic review of the health outcomes related to household water quality in developing countries. J Water Health. 2004;2(1):1–13.
6. Farooqi ZUR, Ahmad I, Ditta A, Ilic P, et al. Types, sources, socioeconomic impacts, and control strategies of environmental noise: a review. Environ Sci Pollut Res Int. 2022;29(54):81087–81111. https://doi.org/ 10.1007/s11356-022-23328-7
7. Bożejko M, Tarski I, Małodobra-Mazur M. Outdoor artificial light at night and human health: A review of epidemiological studies. Environ Res. 2023;218:115049. https://doi.org/ 10.1016/j.envres.2022.115049
8. Moore ChW. Architecture: Art and Science. J Architect Educ. 1965;19:53–56.
9. Troiani I, Ewing S, Periton D. Architecture and culture: architecture's disciplinarity. Architect Culture. 2013;1:6–19.

10. Sauvé JS, Mongeon P, Larivière V. From art to science: A bibliometric analysis of architectural scholarly production from 1980 to 2015. PLoS One. 2022;17(11):e0276840. https://doi.org/ 10.1371/journal.pone.0276840.
11. Mendes MM, Sá T, Cabral J (eds.) Architecture and the Social Sciences: Inter- and Multidisciplinary Approaches between Society and Space. Springer 2017.
12. Kembel SW, Jones E, Kline J, et al. Architectural design influences the diversity and structure of the built environment microbiome. ISME J. 2012;6:1469–1479.
13. Thomas D. Architecture and the Urban Environment. Taylor and Francis. 2022.
14. Cavanaugh WJ, Farrell WR, Hirtle PW, et al. Speech Privacy in Buildings. J Acoustical Soc Am. 1962;34:475–492.
15. McIntyre MH. A Literature Review of the Social, Economic and Environmental Impact of Architecture and Design. Scottish Executive Social Research 2006. Available from: https://www.culturehive.co.uk/wp-content/uploads/2020/10/Scot-Exec-architecture-2.pdf (access: 2023.03.01).
16. Shah RC, Kesan JP. How architecture regulates. J Architect Planning Res. 2007;24:350–359.
17. Roth GA, Mensah GA, Johnson CO, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990–2019: Update From the GBD 2019 Study. J Am Coll Cardiol. 2020;76(25):2982–3021. https://doi.org/ 10.1016/j.jacc.2020.11.010
18. Timmis A, Vardas P, Townsend N, et al. European Society of Cardiology: cardiovascular disease statistics 2021: Executive Summary. Eur Heart J Qual Care Clin Outcomes. 2022;8(4):377–382. https://doi.org/ 10.1093/ehjqcco/qcac014.
19. Piepoli MF, Abreu A, Albus C, et al. Update on cardiovascular prevention in clinical practice: A position paper of the European Association of Preventive Cardiology of the European Society of Cardiology. Eur J Prev Cardiol. 2020;27(2):181–205. https://doi.org/ 10.1177/2047487319893035.
20. Visseren FLJ, Mach F, Smulders YM, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J. 2021;42(34):3227–3337. https://doi.org/ 10.1093/eurheartj/ehab484.
21. Münzel T, Hahad O, Sørensen M, et al. Environmental risk factors and cardiovascular diseases: a comprehensive expert review. Cardiovasc Res. 2022;118(14):2880–2902. https://doi.org/ 10.1093/cvr/cvab316.
22. Burnett RT, Pope CA 3rd, Ezzati M, et al. An integrated risk function for estimating the global burden of disease attributable to ambient fine particulate matter exposure. Environ Health Perspect. 2014;122(4):397–403. https://doi.org/ 10.1289/ehp.1307049
23. Vrijheid M. The exposome: a new paradigm to study the impact of environment on health. Thorax. 2014;69(9):876–878. https://doi.org/ 10.1136/thoraxjnl-2013-204949
24. Prüss-Ustün A, Wolf J, Corvalán C, Neville T, et al. Diseases due to unhealthy environments: an updated estimate of the global burden of disease attributable to environmental determinants of health. J Public Health (Oxf). 2017;39(3):464–475. https://doi.org/10.1093/pubmed/fdw085
25. GBD 2017 Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1923–1994. https://doi.org/ 10.1016/S0140-6736(18)32225-6
26. Lee KK, Bing R, Kiang J, et al. Adverse health effects associated with household air pollution: a systematic review, meta-analysis, and burden estimation study. Lancet Glob Health. 2020;8(11):e1427-e1434. https://doi.org/10.1016/S2214-109X(20)30343-0
27. Argacha JF, Mizukami T, Bourdrel T, et al. Ecology of the cardiovascular system: Part II – A focus on non-air related pollutants. Trends Cardiovasc Med. 2019;29(5):274282. https://doi.org/ 10.1016/j.tcm.2018.09.003
28. Gilani TA, Mir MS. Association of road traffic noise exposure and prevalence of coronary artery disease: A cross-sectional study in North India. Environ Sci Pollut Res Int. 2021;28(38):53458–53477. https://doi.org/ 10.1007/s11356-021-14582-2
29. Hassan D, Patel KK, Peddemul A, et al. Attitude and Health Practice towards Cardiovascular disease in Health care providers: A Systematic Review. Curr Probl Cardiol. 2022:101206. https://doi.org/10.1016/j.cpcardiol.2022.101206
30. Clarke M, Chalmers I. Reflections on the history of systematic reviews. BMJ Evid Based Med. 2018;23(4):121–122. https://doi.org/ 10.1136/bmjebm-2018-110968
31. Hoffmann F, Allers K, Rombey T, et al. Nearly 80 systematic reviews were published each day: Observational study on trends in epidemiology and reporting over the years 2000–2019. J Clin Epidemiol. 2021;138:1–11. https://doi.org/ 10.1016/j.jclinepi.2021.05.022
32. Slim K, Marquillier T. Umbrella reviews: A new tool to synthesize scientific evidence in surgery. J Visc Surg. 2022;159(2):144–149. https://doi.org/ 10.1016/j.jviscsurg.2021.10.001
33. Shamseer L, Moher D, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015;350:g7647. https://doi.org/ 10.1136/bmj.g7647
34. Aromataris E, Fernandez R, Godfrey CM, et al. Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. Int J Evid Based Healthc. 2015;13(3):132–40. https://doi.org/ 10.1097/XEB.0000000000000055
35. Klassen TP, Jadad AR, Moher D. Guides for reading and interpreting systematic reviews: I. Getting started. Arch Pediatr Adolesc Med. 1998;152:700–704.
36. Higgins JPT, Thomas J, Chandler J, et al (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.3 (updated February 2022). Cochrane, 2022. Available from: www.training.cochrane.org/handbook (access: 2023.03.03).
37. Lee YH. An overview of meta-analysis for clinicians. Korean J Intern Med. 2018; 33(2): 277–283. https://doi.org/ 10.3904/kjim.2016.195.
38. Montori VM, Wilczynski NL, Morgan D, et al. Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. BMJ. 2005;330 (7482):68. https://doi.org/ 10.1136/bmj.38336.804167.47
39. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. J Clin Epidemiol. 2021;134:178–189. https://doi.org/10.1016/j.jclinepi.2021.03.001
40. Shea BJ, Grimshaw JM, Wells GA, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol. 2007;7:10. https://doi.org/ 10.1186/1471-2288-7-10.
41. Shea BJ, Reeves BC, Wells G, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ. 2017;358:j4008. https://doi.org/10.1136/bmj.j4008.
42. Smith V, Devane D, Begley CM, et al. Methodology in conducting a systematic review of systematic reviews of healthcare interventions. BMC Med Res Methodol. 2011;11(1):15. https://doi.org/ 10.1186/1471-2288-11-15
43. Pieper D, Antoine SL, Mathes T, et al. Systematic review finds overlapping reviews were not mentioned in every other overview. J Clin Epidemiol. 2014;67(4):368–375. https://doi.org/ 10.1016/j.jclinepi.2013.11.007
44. Harrison SL, Buckley BJR, Rivera-Caravaca JM, et al. Cardiovascular risk factors, cardiovascular disease, and COVID-19: an umbrella review of systematic reviews. Eur Heart J Qual Care Clin Outcomes. 2021;7(4):330–339. doi: 10.1093/ehjqcco/qcab029
45. Chareonrungrueangchai K, Wongkawinwoot K, Anothaisintawee T, et al. Dietary Factors and Risks of Cardiovascular Diseases: An Umbrella Review. Nutrients. 2020;12(4):1088. doi:10.3390/nu12041088
46. Nie X, Liu X, Wang C, et al. Assessment of evidence on reported non-genetic risk factors of congenital heart defects: the updated umbrella review. BMC Pregnancy Childbirth. 2022;22(1):371. doi:10.1186/s12884-022-04600-7
47. Hartmann-Boyce J, Livingstone-Banks J, Ordóñez-Mena JM, et al. Behavioural interventions for smoking cessation: an overview and network meta-analysis. Cochrane Database Syst Rev. 2021;1:CD013229. doi:10.1002/14651858.CD013229.pub2
48. Studziński K, Tomasik T, Krzysztoń J, et al. Effect of using cardiovascular risk scoring in routine risk assessment in primary prevention of cardiovascular disease: an overview of systematic reviews. BMC Cardiovasc Disord. 2019;19(1):11. doi: 10.1186/s12872-018-0990-2
49. Anderson L, Taylor RS. Cardiac rehabilitation for people with heart disease: an overview of Cochrane systematic reviews. Cochrane Database Syst Rev. 2014;2014(12):CD011273. doi:10.1002/14651858.CD011273.pub2
50. Byrne P, Cullinan J, Smith A, Smith SM. Statins for the primary prevention of cardiovascular disease: an overview of systematic reviews. BMJ Open. 2019;9(4):e023085. doi: 10.1136/bmjopen-2018-023085
51. Zhang TN, Wu QJ, Liu YS, et al. Environmental Risk Factors and Congenital Heart Disease: An Umbrella Review of 165 Systematic Reviews and Meta-Analyses With More Than 120 Million Participants. Front Cardiovasc Med. 2021 Mar 11;8:640729. doi:10.3389/fcvm.2021.640729

Appendix 1.
PRISMA-P 2015 checklist

The influence of architecture, design and physical environment in residential buildings on cardiovascular disease – rationale, and protocol for an overview of systematic reviews

Section/topic	#	Checklist item	Information reported		Page(s) number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
TITLE					
Identification	1a	Identify the report as a protocol of a systematic review	+		1
Update	1b	If the protocol is for an update of a previous systematic review, identify as such.		Na	
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract.	+		5
AUTHORS					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of the corresponding author.	+		AAEM website
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review.	+		AAEM website
Amendments	4	If the protocol represents an amendment to a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments.		+	
SUPPORT					
Sources	5a	Indicate sources of financial or other support for the review.	+		AAEM website
Sponsor	5b	Provide name for the review funder and/or sponsor.		Na*	
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol.		Na*	
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known.	+		1–2
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO).	+		2
METHODS					
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review.	+		2–3
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage.	+		3
Search strategy	10	Present a draft of the search strategy to be used for at least one electronic database, including planned limits so that it could be repeated.	+		Appendix 2
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review.	+		3
Selection Process	11b	State the process that will be used for selecting studies. (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis).	+		3
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, performed independently, in duplicate), any processes for obtaining and confirming data from investigators.	+		3
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications.	+		4
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale.	+		4
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis.	+		4
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized.	+		4
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau).		+	
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression).	+		4
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned.	+		4
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective reporting within studies).	+		4
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE).	+		4–5

Na – not applicable (no financial or other support for the overview)

Appendix 2.
Draft of the search to be used for MEDLINE

The influence of architecture, design and physical environment in residential buildings on cardiovascular disease – rationale and protocol for an overview of systematic reviews.

1. cardiovascular[Title/Abstract]
2. circulatory[Title/Abstract]
3. cardiac[Title/Abstract]
4. heart disease[Title/Abstract]
5. myocardial infarction[Title/Abstract]
6. coronary artery disease [Title/Abstract]
7. ischemic heart disease[Title/Abstract]
8. heart failure[Title/Abstract]
9. atherosclerosis[Title/Abstract]
10. hypertension[Title/Abstract]
11. angina pectoris[Title/Abstract]
12. stroke[Title/Abstract]
13. transient ischemic[Title/Abstract] OR
14. cerebrovascular[Title/Abstract]
15. apoplexy[Title/Abstract]
16. apoplexia[Title/Abstract]
17. ischemic[Title/Abstract]
18. vascular pathology[Title/Abstract]
19. peripheral artery disease [Title/Abstract]
20. Cardiovascular Diseases[MeSH Terms]
21. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
22. obesity[Title/Abstract]
23. overweight[Title/Abstract]
24. lipids[Title/Abstract]
25. cholesterol[Title/Abstract]
26. dyslipidemia[Title/Abstract]
27. dyslipidaemia[Title/Abstract]
28. blood pressure[Title/Abstract]
29. hypertension[Title/Abstract]
30. prehypertension[Title/Abstract]
31. smoking[Title/Abstract]
32. nicotinism[Title/Abstract]
33. physical activity[Title/Abstract]
34. physical health[Title/Abstract]
35. sedentary lifestyle[Title/Abstract]
36. diet[Title/Abstract]
37. food[Title/Abstract]
38. nourishment[Title/Abstract]
39. alcohol drinking[Title/Abstract]
40. alcohol consumption[Title/Abstract]
41. alcoholism[Title/Abstract]
42. risky drinking[Title/Abstract]
43. circulatory[Title/Abstract]
44. Obesity[MeSH Terms]
45. Lipids/blood[MeSH Terms]
46. Blood Pressure[MeSH Terms]
47. Smoking[MeSH Terms]
48. Exercise[MeSH Terms]
49. Diet[MeSH Terms]
50. Alcohol Drinking[MeSH Terms]
51. Dyslipidemias[MeSH Terms]
52. Sedentary Behavior[MeSH Terms]
53. Hypertension[MeSH Terms]
54. Physical Exertion[MeSH]
55. 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51or 52 or 53 or 54
56. 21 and 55
57. Facility Design and Construction [MeSH Terms]
58. Home Environment[MeSH Terms]
59. Built Environment[MeSH Terms]
60. Noise[MeSH Terms]
61. Air Pollution, Indoor[MeSH Terms]
62. Water Quality[MeSH Terms]
63. Hand Hygiene[MeSH Terms]
64. Sanitation[MeSH Terms]
65. Drinking Water[MeSH Terms]
66. Temperature[MeSH Terms]
67. Environmental Health[MeSH Terms]
68. Light Pollution[MeSH Terms]
69. architecture[Title/Abstract]
70. home design[Title/Abstract]
71. home environment[Title/Abstract]
72. apartment design[Title/ Abstract]
73. house design[Title/Abstract]
74. residential[Title/Abstract]
75. residence[Title/Abstract]
76. apartment[Title/Abstract]
77. building[Title/Abstract]
78. bungalow[Title/Abstract]
79. indoor[Title/Abstract]
80. domestic[Title/Abstract]
81. dwelling[Title/Abstract]
82. homestead[Title/Abstract]
83. living environment[Title/Abstract]
84. living space[Title/Abstract]
85. living accommodation[Title/Abstract]
86. building characteristics [Title/Abstract]
87. housing infrastructure[Title/Abstract]
88. room size[Title/Abstract]
89. pollutant exposure[Title/Abstract]
90. fresh air[Title/Abstract]
91. air pollution[Title/Abstract]
92. room ventilation[Title/Abstract]
93. house ventilation[Title/Abstract]
94. particulate matter[Title/Abstract]
95. operable windows[Title/Abstract]
96. window size[Title/Abstract]
97. air filtration[Title/Abstract]
98. air purification system[Title/Abstract]
99. stove[Title/Abstract]
100. cooker[Title/Abstract]
101. clean fuels[Title/Abstract]
102. water Quality[Title/Abstract]
103. handwashing facilities[Title/Abstract]
104. humidity[Title/Abstract]
105. natural light[Title/Abstract]
106. artificial light[Title/Abstract]
107. light pollution[Title/Abstract]
108. windows smoothing[Title/Abstract]
109. electrical installations[Title/Abstract]
110. noise exposure[Title/Abstract]
111. noise level[Title/Abstract]
112. traffic noise[Title/Abstract]
113. transportation noise[Title/Abstract]
114. inside temperature"[Title/Abstract]
115. temperature controls[Title/Abstract]
116. thermal zones[Title/Abstract]
117. wall insulation[Title/Abstract]
118. rehousing[Title/Abstract]
119. house improvement[Title/Abstract]
120. home adaptation[Title/Abstract]
121. housing renewal[Title/Abstract] OR
122. internal environment[Title/Abstract]
123. 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102 or 103 or 104 or 105 or 106 or 107 or 108 or 109 or 110 or 111 or 112 or 113 or 113 or 114 or 115 or 116 or 117 or 118 or 119 or 120 or 121 or 122
124. 56 and 123
125. Risk Factors[MeSH Terms]
126. mortality[MeSH Subheading]
127. epidemiology[MeSH Subheading]
128. risk factors[Title/Abstract]
129. morbidity[Title/Abstract]
130. mortality[Title/Abstract]
131. adverse events[Title/Abstract]
132. adverse effect[Title/Abstract]
133. 125 or 126 or 127 or 128 or 129 or 130 or 131 or 132
134. 124 and 133
135. Review[Filter]
136. Systematic review[Filter]
137. Meta-Analysis[Filter]
138. 135 or 136 or 137
139. 134 and 138
140. 1990–2023[pdat]
141. 139 and 140