Preventive Medicine 172 (2023) 107534

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Review Article

Cardiovascular health metrics in low and middle-income countries: A scoping review

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ARTICLE INFO

Keywords:
Epidemiology
Cardiovascular disease
Risk factors
Risk assessment
Developing countries
Scoping review

ABSTRACT

Background: In 2010 the American Heart Association defined the concept of ideal cardiovascular health to renew the focus on primordial prevention for cardiovascular disease. Evidence primarily from high-income countries suggests ideal CVH prevalence is low and decreases with age, with vulnerable populations differentially affected. We aimed to identify and characterize the evidence relevant to CVH metrics in low- and middle-income countries (LMICs).

Methods: We followed the Joanna Briggs Institute guideline for the conduct of this scoping review. We searched MEDLINE, Embase, LILACS and study registers from inception to 14 March 2022. We included cross-sectional and cohort studies in populations representing a geographically-defined unit (urban or rural) in LMICs, and with data on CVH metrics i.e. all health or clinical factors (cholesterol, blood pressure, glycemia and body mass index) and at least one health behavior (smoking, diet or physical activity). We report findings following the PRISMA-Scr extension for scoping reviews.

Results: We included 251 studies; 85% were cross-sectional. Most studies (70.9%) came from just ten countries. Only 6.8% included children younger than 12 years old. Only 34.7% reported seven metrics; 25.1%, six. Health behaviors were mostly self-reported; 45.0% of studies assessed diet, 58.6% physical activity, and 90.0% smoking status.

Conclusions: We identified a substantial and heterogeneous body of research presenting CVH metrics in LMICs. Few studies assessed all components of CVH, especially in children and in low-income settings. This review will facilitate the design of future studies to bridge the evidence gap.

This scoping review protocol was previously registered on OSF: https://osf.io/sajnh

1. Introduction

The concept of ideal cardiovascular health (CVH) was formally defined in 2010 by the American Heart Association (AHA) to renew the focus on primordial prevention for cardiovascular disease (CVD), aiming at reducing the development of cardiovascular (CV) risk factors (Lloyd-

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https://doi.org/10.1016/j.ypmed.2023.107534
Received 22 January 2023; Received in revised form 27 March 2023; Accepted 2 May 2023
Available online 3 May 2023

Jones et al., 2010). As such, CVH was defined in individuals free of cardiovascular disease, based on seven metrics, separately for adults and children (Table 1), from which the call to action of AHA's Life's Simple 7 was developed. It included four health behaviors (nonsmoking, body mass index <25 Kg/m^2 -or < 85th percentile in younger than 20 years old, physical activity at goal levels, and healthy diet) and three health factors (untreated blood pressure < 120/<80 mmHg -or < 90th percentile in younger than 20 years old, untreated total cholesterol <200 mg/dL or < 170 mg/dL, respectively, and fasting blood glucose <100 mg/dL). In addition, each metric was then categorized into three levels of cardiovascular health: poor, intermediate, and ideal, which represent 0, 1, or 2 points each, respectively. The total CVH score is then used to quantify overall CVH as high (12–14 points), moderate (9–11 points), or low (0–8 points).

While maintaining ideal CVH across the lifespan is fundamental to preventing CVD (Lloyd-Jones et al., 2010; Bundy et al., 2020), the prevalence of ideal CVH in adults is typically low. Nevertheless, fewer studies are from low- and middle-income countries (LMICs) (Younus et al., 2016; *Circulation [Internet]*, 2021; Brant and Ribeiro, 2018; Velasquez-Melendez et al., 2015; Benziger et al., 2018). This lack of data is of concern since the improvement in cardiovascular death seen in the last two decades was far less significant in poorer countries. From 2000 to 2019, the decline in the age-standardized CVD mortality rate was 43.4% in high-income countries (HICs), but 27.7% in Upper-Middle-Income countries, 18.9% in Lower-Middle-Income countries, and only 15.4% in Low-Income Countries (Organization WH and Others., 2013; Mendis et al., 2022). As such, it is fundamental to characterize CVH more adequately in LMICs, where studies on the topic are more scarce than in HICs, methodologically heterogeneous, and mostly restricted to adults. Further understanding of how and why CVH loss occurs in LMICs is essential to design effective preventative policies (Organization WH and Others., 2013; Oliveira et al., 2021; Gupta et al., 2017; Yusuf et al., 2001a). In addition, detection of studies that target or include rural populations is very important for this understanding, since the control of cardiovascular risk factors (Flood et al., 2022) and of overall cardiovascular health (Schopfer, 2021) is poorer in rural contexts (Yusuf et al., 2001a; Yusuf et al., 2001b).

Systematic reviews showed that the global prevalence of ideal CVH status was unsatisfactory (Peng et al., 2018; Janković et al., 2021). However, the existing reviews failed to address the difference in CVH between geographical regions as most of the included studies were conducted in HICs (Younus et al., 2016; Peng et al., 2018; Janković et al., 2021; Ramírez-Vélez et al., 2018). In addition, the systematic reviews excluded studies that did not strictly follow the seven metrics of CVH defined by AHA, representing an information loss from LMICs where it may be less frequent to measure clinical metrics due to limited resources. Moreover, most of these reviews included data from adults (aged ≥18 years) only, limiting the understanding of CVH status among children and adolescents, an important target population for primordial prevention.

Regarding assessment methods of these seven metrics used in individual studies, while those used to assess health factors are more uniform across studies, assessment of health behaviors is challenging. Systematic reviews highlighted the heterogeneity in assessment methods of behavioral CVH metrics (Younus et al., 2016; Peng et al., 2018; Ramírez-Vélez et al., 2018). This was not systematically assessed in LMICs. Reviewing the sources of heterogeneity would identify the gaps in CVH metrics measurement to inform the methodology of new epidemiological surveys.

Given these considerations, the objective of our study was to identify and document characteristics of the evidence on CVH metrics from early childhood to middle age and beyond in LMICs.

Table 1
Definition of ideal cardiovascular health, according to the American Heart Association, 2010.

Goal/metric	Ideal cardiovascular health definition
Current smoking	
Adults ≥20 y of age	Never or quit >12 months ago
Children 12–19 y of age	Never tried; never smoked a whole cigarette
Body mass index	
Adults ≥20 y of age	<25 kg/m^2
Children 2–19 y of age	<85th percentile
Physical activity	
Adults ≥20 y of age	≥150 min/wk. moderate intensity or ≥ 75 min/wk. vigorous intensity or combination
Children 12–19 y of age	≥60 min of moderate- or vigorous-intensity activity every day
Healthy diet score*	
Adults ≥20 y of age	4–5 components*
Children 5–19 y of age	4–5 components*
Total cholesterol	
Adults ≥20 y of age	<200 mg/dL
Children 6–19 y of age	<170 mg/dL
Blood pressure	
Adults ≥20 y of age	<120/<80 mmHg
Children 8–19 y of age	<90th percentile
Fasting plasma glucose	
Adults ≥20 y of age	<100 mg/dL
Children 12–19 y of age	<100 mg/dL

* Five components: Consumption of fruits and vegetables (≥4.5 cups/day), whole grain (≥3 one-ounce servings/day), sodium (<1500 mg/day), sugar-sweetened beverages (≤36 oz./week), and fish (≥2 3.5 oz. servings/week). 1 oz. represents approximately 28.4 g. at least four of these five components must be present to consider the diet in the ideal healthy diet range. Source: (Lloyd-Jones et al., 2010).

2. Methods

We followed the Joanna Briggs Institute guideline for the conduct of this scoping review (Peters et al., 2020). We registered the details for these methods in a predefined protocol at the Open Science Framework (Franco et al., 2022) (available at https://osf.io/sajnh). We reported this review following the PRISMA-Scr extension for scoping reviews (Tricco et al., 2018).

2.1. Eligibility criteria

We defined the eligibility criteria following the Population, Concept and Context (PCC) framework for scoping reviews (Peters et al., 2020). Our population and context included people of all ages living in low-, lower-middle, and upper-middle-income countries (globally denominated LMICs) as per the World Bank Classification, including urban or rural settings (*How are the Income Group Thresholds Determined? – World Bank Data Help Desk [Internet]*, 2023).

We designed this study and the search strategy before the publishing of the new theoretical framework of Life's Essentials 8 (LE8) (Lloyd-Jones et al., 2022). Therefore, the variables of CVH considered for eligibility criteria corresponded to the AHA's landmark paper of 2010 (Lloyd-Jones et al., 2010). Our concept included the assessment of at least four clinical metrics -blood pressure, total cholesterol, glycemia, and body mass index-, as this is the minimum number of factors included in most risk scores, and at least one extra health behavior -smoking status, physical activity, or diet. After the publication of LE8, we decided to include sleep as an extra variable to be assessed, although only in the

retrieved studies, and not as a new inclusion criterion.

These variables could be measured by direct observation (i.e. measurement of Glycemia) or by self-report (i.e. questionnaires). We included cross-sectional and cohort studies representative of a geographically-defined unit. The minimum geographic unit was a city or a rural area.

2.2. Search methods for the identification of studies

We searched the following databases from the inception of each resource to the date of the search (14 March 2022) and no language of publication restrictions were imposed: Ovid MEDLINE(R) ALL; Embase (Elsevier); LILACS (Bireme; https://lilacs.bvsalud.org/en/); ClinicalTrials.gov (https://clinicaltrials.gov/); WHO International Clinical Trials Registry Platform (www.who.int/ictrp/en/).

The search strategy for each database is available in the **Appendix A**.

Additionally, we searched on national health agencies' websites (i.e. ministry of health or equivalent) from one of the largest LMIC countries in each WHO region (African Region, Region of the Americas, South-East Asian Region, European Region, Eastern Mediterranean Region and Western Pacific Region) to gather additional data on potential studies that were not published or identifiable in electronic searches. We did not place restrictions on language or publication status.

2.3. Data collection and analysis

We used Covidence for study selection. Two review authors (JVAF and LG) and a group of research assistants independently scanned the retrieved title, abstract, or both, of records to determine which studies to be assessed further through Covidence. They also investigated all potentially relevant records as full text, mapped records to studies, and classified studies as included studies, excluded studies, and studies awaiting classification or ongoing studies, following the criteria for each provided in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2019). We resolved discrepancies through consensus or recourse to a third review author (GP). If the resolution of a disagreement was not possible, we designated the study as *Awaiting classification* and contacted the study authors for clarification. We documented the reasons for excluding studies that may have reasonably been expected to be included in the review in a *Characteristics of excluded studies* table. We presented a PRISMA flow diagram showing the process of study selection.

2.4. Data extraction

We developed a dedicated data abstraction form in Google Spreadsheets (Google inc.) that we piloted and tested ahead of time. For studies that fulfilled the inclusion criteria, review authors and a group of research assistants independently extracted the following information from a sample of 10% of the included studies to reach a consensus. We extracted the rest of the studies single-handedly by one researcher:

- Years of data collection
- Details of the study design (adult cohort studies/birth cohort studies, cross-sectional studies) and sample size
- Sampling frame / geographical unit
- Rural/urban population
- Country and World Bank Classification (low income, lower-middle-income, upper-middle-income)
- Age of study population (young children, school-aged children, adolescents, young adults, middle-aged adults, older adults)
- Gender or sex as defined by study authors: male, female, trans, non-binary or other.
- Socio-economic status: defined by income, Unsatisfied Basic Needs (UBN) or other types of categorisation.
- Cardiovascular Health Metrics: type of measurements (measured or self-reported/categorisation).
- Self-reported metrics: collected in questionnaires or surveys without an objective measurement of the health factor or behavior.
  - Measured metrics: collected with objective measures, for instance: capillary/serum glucose, blood pressure measurement, etc.

2.5. Data synthesis and analysis

We presented the characteristics of the included in tabular form with descriptive statistics of the extracted data. We did not assess the risk of bias nor rate the certainty of the evidence for the included studies.

3. Results

Figure 1 shows the PRISMA flow diagram summarizing the results of our systematic literature search. Results from databases included 17,396 records. After removing duplicates, we screened 14,121 records, of which 13,470 were excluded by inspection of title and abstract, and 607 were assessed as full text. Of these, 345 were excluded for various reasons (see Supplementary material at https://osf.io/34zpy/). Additionally, we identified 19 reports from the hand search, of which 7 were excluded. We finally included 272 reports, corresponding to 251 unique studies. We could not retrieve 44 reports and two studies were classified as awaiting classification.

A total of 46 studies (18.33%) were published before the year 2010 (31 in the 2000s, 14 in the 1990s, and 1 in the 1980s). Most of the studies were available as journal articles in English. As for study design, the majority were cross-sectional studies. Most studies were conducted in upper-middle-income countries representing the WHO's Western Pacific and the South East Asian Region, with less than 3% of studies conducted in low-income countries. Approximately 20% of all studies included children and adolescents, but less than 3% of all studies included young children up to six years. See Table 2 for the full characteristics of included studies and Table 3 **for the individual country contribution to included studies by WHO region.** The measurement of health behaviors by study design and age are charted in Table 4.

Assessment methods for each metric were highly variable. Most clinical metrics were measured by laboratory testing and visits to a health care provider. Health behaviors were mostly self-reported, with tobacco exposure being the most self-reported health behavior across studies and mostly collected in questionnaires or surveys without an objective measurement. For example, tobacco exposure was mostly self-reported in a dichotomous fashion (smoking vs not smoking), with only a few studies objectively recording duration or frequency and types of tobacco products. Physical activity was also usually self-reported in a dichotomous fashion (no physical activity vs doing physical activity), with an objective assessment of the dose-response of volume, duration, intensity and pattern of physical activities only in a minority of studies. Some studies used more than one assessment method for a given metric (for example, self-reported and measured; see Table 5**)**.

Diet measurements were highly heterogeneous, with most studies reporting the intake of fruits and vegetables only. A minority of studies reported three or more of the components of the healthy diet score. Physical activity was mostly assessed by frequency or time of activity per week or day. More than half of the studies assessing physical activity reported data on physical activity intensity. First-hand smoking was the most reported tobacco exposure, while second-hand smoking or other forms of tobacco consumption were less reported. See Table 6 for full detail on the measures used in studies for health behaviors.

Only eight studies reported on sleep, the newly proposed eighth factor of ideal cardiovascular health. Five studies assessed it through self-report and three through measurement.

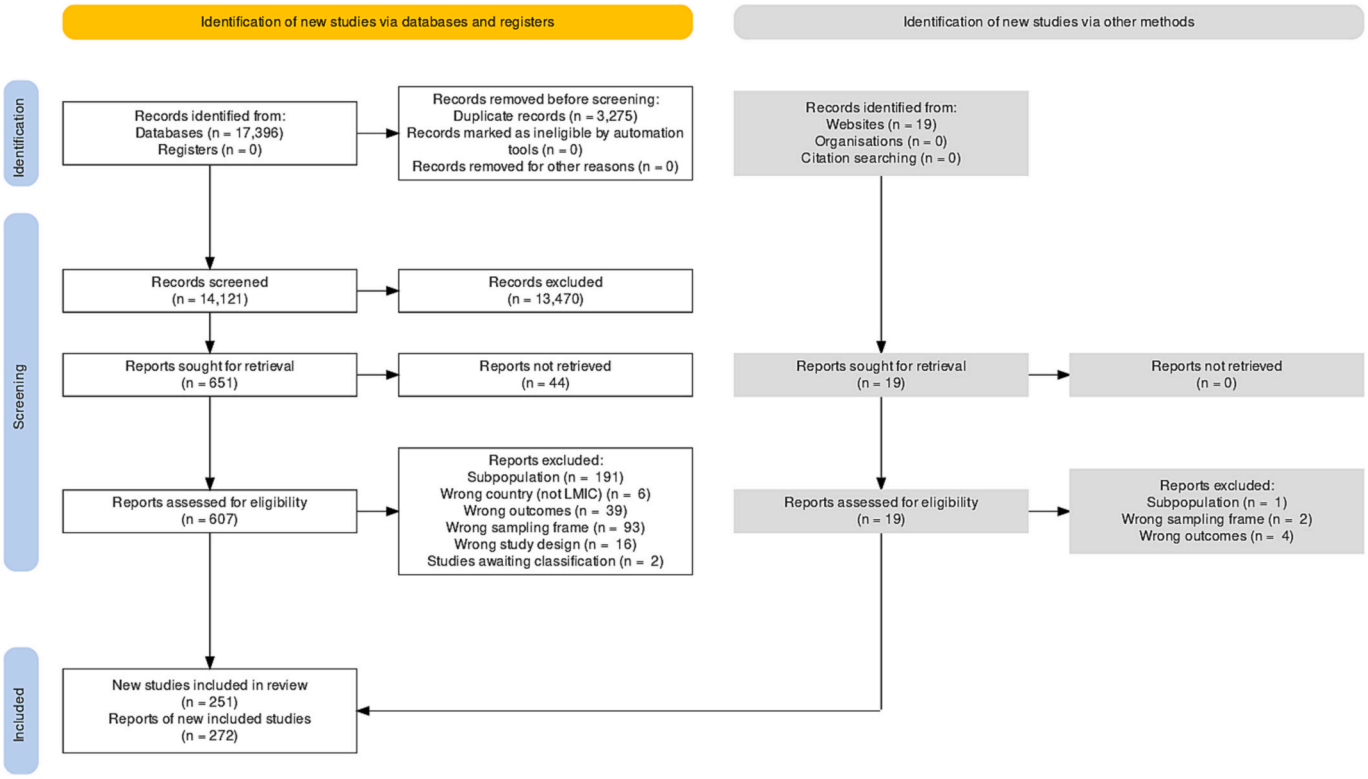

Fig. 1. PRISMA flow diagram.

4. Discussion

4.1. Main findings

We identified a relatively large body of research on CVH metrics in LMICs. Most studies were cross-sectional, focusing on adults, with only a minority of studies focusing on children, especially those under the age of 12. Measurement methods for each metric were highly variable.

4.2. Related research

To our knowledge, this is the first scoping review focusing on ideal cardiovascular health metrics in LMICs. A few systematic reviews have been published on ideal CVH (Younus et al., 2016; Peng et al., 2018; Janković et al., 2021). All restricted their literature search from 2010 onwards, the date when the concept of ideal cardiovascular health was published by the AHA (Lloyd-Jones et al., 2010). In addition, all included adults only, and two of them were restricted to studies published in English only (Younus et al., 2016; Janković et al., 2021). Thus, they retrieved only 50 studies. Peng et al. (Peng et al., 2018), included only 88 studies when applying no language restrictions. While these reviews included studies from LMICs, these were in the minority since they were not the focus of the review.

In contrast, our study sought to identify all published studies that reported data that could help characterize the cardiovascular health of populations from LMICs. We did not apply any language, age, or temporal restrictions. Moreover, even though we used the theoretical framework of ideal cardiovascular health proposed by AHA, we designed a search strategy that was not limited to these terms but included the variables that are part of this theoretical construct. This sensitive search strategy yielded a total of 251 studies, 50 of which included children or adolescents.

Even though these 50 studies reported data on adolescents, only 17 reported on children lower than 12 years old (less than 7% of all included studies). This is of particular concern since levels of CVH already differ widely as early as age 8, and the decline of CVH begins at least this early (Allen et al., 2020). Clearer definitions and simpler methods to evaluate these metrics in young individuals could also help to increase studies assessing these subgroups in the future.

Out of all 251 studies included in our research, 43.82% did not report data on education level, two-thirds did not report data on income level and 41.83% did not report either on income or education. This omission of socioeconomic data is always essential, especially in LMICs where social determinants of health are usually widely disadvantageous for their local populations. Janković et al. (Janković et al., 2021) specifically assessed the relationship between socioeconomic inequalities and ideal cardiovascular health and found that more educated and better-off individuals had more ideal CVH metrics.

Another important finding of our study is that only 10 countries contributed to 70.9% of all studies. This concentration was even higher in some WHO regions. For example, the Islamic Republic of Iran accounted for 87.0% of studies from the Eastern Mediterranean region; and China and Malaysia, for 91.6% of studies from the Western Pacific region. Although this is a merit of these countries, the overall scene is critical, since the actual knowledge of CVH in LMICs might not represent the reality in major parts of the world. International efforts should be made to foster research in more LMICs, including knowledge transfer, capacity building and financing.

On the other hand, we found that CVH metrics were frequently reported without sufficient detail to calculate a CVH score. This incomplete reporting was especially problematic with diet-related variables. Other variables were poorly reported, although not directly related to the 2010 concept of ideal CVH but still important, for example, second-hand smoking. Sleep-related variables were also very scarcely reported. Nevertheless, the new concept of Life's Essential 8 developed by the American Heart Association will contribute to its increased reporting in the future (Lloyd-Jones et al., 2022).

In addition to a more comprehensive and systematic reporting of all important variables related to CVH, ideally, there should be standardization methods for assessing these variables to enable comparisons

Table 2
Characteristics of the included studies ($N = 251$).

Characteristic	Summary statistic
Study design:	
Cross-sectional	214 (85.26%)
Cohort studies	37 (14.74%)
Publication type:	
Journal article	188 (74.90%)
Abstract	53 (21.12%)
Other	10 (3.98%)
Language:	
English	229 (91.24%)
Spanish	11 (4.38%)
Chinese	7 (2.79%)
Farsi	1 (0.40%)
Turkish	1 (0.40%)
Russian	2 (0.80%)
Geographic unit:	
City	97 (38.65%)
Country	79 (31.47%)
Province	38 (15.14%)
State	19 (7.57%)
Rural area	17 (6.77%)
Setting:	
Rural	39 (15.54%)
Urban	67 (26.69%)
Both	113 (45.02%)
Median sample size (interquartile range)	4090 (1352-9957.5)
WHO regions	
African region	27 (10.76%)
Region of the Americas	47 (18.73%)
South-east Asian region	51 (20.32%)
European region	13 (5.18%)
Eastern Mediterranean region	23 (9.16%)
Western Pacific region	83 (33.07%)
World Bank classification	
Low-income countries	7 (2.79%)
Lower-middle income countries	85 (33.86%)
Upper-middle income countries	154 (61.35%)
Study population	
Children and adolescents (<18 years)	50 (19.92%)
Pre-school (<6 years)	7 (2.79%)
School-aged (6–11 years)	10 (3.98%)
Adolescents (12–18 years)	50 (19.92%)
Adults	242 (96.41%)
Children and adults	43 (17.13%)
Data on sex or gender	
Studies including males and females	239 (95.22%)
Studies including only males	2 (0.80%)
Studies including only females	7 (2.79%)
Studies including other genders	0 (0%)
Data on socio-economic status	
Education	141 (56.18%)
Income	82 (32.67%)
Cardiovascular health metrics	
Median number of metrics (interquartile range)	6 (5–7)
Studies reporting on health behaviors	
Diet	
Physical activity	113 (45.02%)
Tobacco use/exposure	147 (58.57%)
Studies reporting:	226 (90.04%)
5 metrics	
6 metrics	101 (40.24%)
7 metrics	63 (25.10%)
	87 (34.66%)

among studies. In the meantime, and where possible, researchers should refer to valid data harmonization methods for comparative purposes (Staff et al., 2016; Schaap et al., 2011).

Regarding the year of publication, we retrieved 46 studies published before 2010. Although results from these studies might not be considered to represent up-to-date information, they can still be important to assess trends over time, especially given the scarcity of available studies in LMICs. On the other hand, one positive fact of the publication trend that we found is that studies published in the last decades with useful information to estimate CVH increased exponentially (1 study in the 1980s, 14 in the 1990s, 31 in the 2000s, and 166 in the 2010's). This highlights the increasing awareness of the importance of the components of ideal CVH. A step further would be to report all eight CVH metrics (including sleep), and not just five or six of them.

Table 3
Individual country contribution to included studies by WHO region.

WHO region/country	Number of studies	% region	% from total (n = 251)
African region	**27**	**100**	**10.76**
- South Africa	10	37.04	3.98
- Tanzania	3	11.11	1.20
- Kenya	2	7.41	0.80
- Malawi	2	7.41	0.80
-Nigeria	2	7.41	0.80
- Benin	1	3.70	0.40
- Ethiopia	1	3.70	0.40
- Guinea	1	3.70	0.40
- Mauritius	1	3.70	0.40
- Togo	1	3.70	0.40
- Uganda	1	3.70	0.40
- Zambia	1	3.70	0.40
- Zimbabwe	1	3.70	0.40
Region of the Americas	**47**	**100**	**18.73**
- Brazil	16	34.04	6.37
- Argentina	10	21.28	3.98
- Jamaica	5	10.64	1.99
- Mexico	5	10.64	1.99
- Peru	4	8.51	1.59
- Colombia	3	6.38	1.20
- Guatemala	2	4.25	0.80
- Venezuela	2	4.25	0.80
South-East Asia region	**51**	**100**	**20.32**
- India	32	62.75	12.75
- Thailand	6	11.76	2.39
- Bangladesh	5	9.80	1.99
- Nepal	4	7.84	1.59
- Indonesia	3	5.88	1.20
- Sri Lanka	1	1.96	0.40
European region	**13**	**100**	**5.18**
- Bosnia and Herzegovina	4	30.77	1.59
- Türkiye	4	30.77	1.59
- Russian Federation	2	15.38	0.80
- Georgia	1	7.69	0.40
- Moldova	1	7.69	0.40
- Kyrgyzstan Republic	1	7.69	0.40
Eastern Mediterranean region	**23**	**100**	**9.16**
- Islamic Republic of Iran	20	86.96	7.97
- Iraq	1	4.35	0.40
- Jordan	1	4.35	0.40
- Pakistan	1	4.35	0.40
Western Pacific region	**83**	**100**	**33.07**
- China	65	78.31	25.90
- Malaysia	11	13.15	4.38
- Vietnam	3	3.61	1.20
- Philippines	2	2.41	0.80
- Fiji	1	1.20	0.40
- Samoa	1	1.20	0.40

Footnote: Five studies were conducted in more than one country, and 2 were conducted in the West Bank and Gaza.

4.3. Strengths and limitations

Our main limitation was related to the large number of studies retrieved by our search strategy and the poor reporting found in most of them, making the eligibility assessment cumbersome. Still, we were able to assess most of the studies, classifying them accordingly as included, excluded (with reason) or awaiting classification, with only a minority of records not retrieved during full-text screening. Another limitation

Table 4
Measurement of health behaviors in included studies by age and study design.

	Clinical metrics	Health Behaviors		
	Glycemia, Blood pressure, BMI, and Total cholesterol	+ diet	+ physical activity	+ smoking status
Adults (≥18 years old) Cross-sectional	206 studies	91/206 (44.17%)	119/206 (57.77%)	188/206 (91.26%)
Adults (≥18 years old) Cohorts	37 studies	17/37 (45.95%)	21/37 (56.76%)	35/37 (94.79%)
Children and adolescents (<18 years old) Cross-sectional	48 studies	23/48 (47.92%)	27/48 (56.25%)	42/48 (87.50%)
Children and adolescents (<18 years old) Cohorts	2 studies	1/2 (50%)	2/2 (100%)	2/2 (100%)
Total studies	251 studies	113/251 (45.02%)	147/251 (58.57%)	226/251 (90.04%)

Table 5
Measurement methods for cardiovascular health metrics.

	Cross-sectional studies (214 studies)		Cohort studies (37 studies)	
	Self-reported	Measured	Self-reported	Measured
Clinical metrics				
Glycemia (n = 251)	60/214 (28.04%)	199/214 (92.99%)	13/37 (35.14%)	35/37 (94.59%)
Blood pressure (n = 251)	63/214 (29.44%)	200/214 (93.46%)	14/37 (37.84%)	34/37 (91.89%)
Body mass index (n = 251)	5/214 (2.34%)	206/214 (96.26%)	2/37 (5.41%)	35/37 (94.59%)
Total cholesterol (n = 251)	28/214 (13.08%)	202/214 (94.39%)	7/37 (18.92%)	35/37 (94.59%)
Health behaviors				
Diet (*n* = 113)	58/214 (27.10%)	42/214 (19.63%)	7/37 (18.92%)	10/37 (27.03%)
Physical activity (*n* = 147)	64/214 (29.91%)	62/214 (28.97%)	9/37 (24.32%)	12/37 (32.43%)
Tobacco use/exposure (*n* = 226)	124/214 (57.94%)	64/214 (29.91%)	24/37 (64.86%)	9/37 (24.32%)

related to the large number of included studies was that we had to rely on one data extractor per study, which may have led to coding errors. Nevertheless, we took precautions, including the independent data extraction for calibration of a sample of 10% of included studies and a double-check process while calculating summary statistics.

Another limitation is that our study was designed and performed before the new proposal of sleep as an intrinsic factor of CVH (Lloyd-Jones et al., 2022). Hence, sleep was not part of the search strategy and did not influence study retrieval. Nevertheless, we managed to assess whether the retrieved studies included sleep-related variables or not.

A final limitation, directly related to the design of some of the individual studies included, is that a percentage of them did not objectively measure the health factors they assessed, but relied on participant self-reports. This precludes the calculation of CVH scores in these studies. Nonetheless, we decided to include these studies in our scoping review because they still provide essential information.

The main strengths of our study relate to the broad and sensitive search strategy in major bibliography databases and repositories, as well as hand searches in selected countries representative of WHO regions.

Table 6
Measures used in studies for health behaviors.

Diet	
1 component of the healthy diet score*	65/113 (57.52%)
2 components of the healthy diet score*	6/113 (5.31%)
3 components of the healthy diet score*	9/113 (7.96%)
4 components of the healthy diet score*	10/113 (8.85%)
5 components of the healthy diet score*	4/113 (3.54%)
Alcohol consumption**	105/251 (41.83%)
Physical activity	
Intensity*	90/147 (61.22%)
Frequency/duration/time*	112/147 (76.19%)
Tobacco use/exposure	
First-hand smoking*	207/226 (91.59%)
Using the following categorisation:	
Current smoker*	175/226 (77.43%)
Former smoker (> 12 months)*	76/226 (33.63%)
Never smoked*	70/226 (30.97%)
Second-hand smoking*	14/226 (6.19%)
Use of other tobacco products*	32/226 (14.16%)

* The denominator indicates the number of studies that assessed this outcome. Some studies evaluated other characteristics not contemplated by the healthy diet score.

** The denominator indicates the total number of studies. **Components of the diet score**: consumption of fruits and vegetables (≥4.5 cups/day), whole grain (≥3 one-ounce servings/day), sodium (<1500 mg/day), sugar-sweetened beverages (≤36 oz./week), and fish (≥2 3.5 oz. servings/week). 1 oz. represents approximately 28.4 g. Source: (Lloyd-Jones et al., 2010).

Another strength relates to not applying language restrictions, considering the language heterogeneity of the LMIC around the world. These led us to include and analyze a large number of studies on the topic that may be useful for healthcare decision-making and resource allocation in research.

4.4. Future research

Our study set the basis for a future systematic review and synthesis of the evidence related to ideal cardiovascular health in LMICs. Given the methodological heterogeneity of previously reported individual studies, guidelines are needed for the standardization of assessment and reporting of variables related to CVH that consider the contextual nuances of research in LMICs, as well as valid harmonization methods to compare existing data. This is critical given the LMICs burden of CVD and scarcity of LMICs CVH data, especially to support and evaluate primordial prevention efforts at younger ages.

5. Conclusion

We identified a relatively large body of research on CVH metrics in LMICs, although from a concentrated group of countries. Most studies were cross-sectional, focusing on adults, with only a minority of studies including children. Measurement methods for each metric were highly variable.

Our findings can be used to plan and conduct more focused systematic reviews and meta-epidemiological studies. They also highlight the need to facilitate further research and practical guidelines with standardized methods for assessing and reporting CVH variables, with special attention to low-income settings and children.

Funding

This work was supported by the Northwestern University Institute for Global Health Catalyzer Research Fund (Award#: 1005), the National Institutes of Health (GRANT12985006) and Instituto Universitario Hospital Italiano de Buenos Aires. LJW is supported by a strategic grant [STRATGNT2023–01] from the South African DSI-NRF Centre of Excellence in Human Development. Dr. Singh is supported by grant 1K43TW011164 from the Fogarty International Center, NIH.

Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

Acknowledgments

We would like to thank Sabrina Rico, Nadia Sgarbossa, Diego Ivaldi, Lionel Trivisonno and Germán Baez for their contribution to the screening and data extraction process; and Hasan-Al-Farhan and Sara Soares for hand-searching studies in the Eastern Mediterranean and European regions, respectively.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2023.107534.

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