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REVIEW

Effects of ultraviolet light exposure on blood pressure: a systematic review

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Abstract

Background Hypertension is the leading global risk factor for cardiovascular disease. Ultraviolet (UV) radiation exposure has been proposed as a potential modifiable environmental factor influencing blood pressure regulation. While traditionally associated with vitamin D synthesis, emerging evidence suggests alternative mechanisms, including nitric oxide (NO) mobilization, may play a significant role.

Objective To systematically review the available evidence on effects of UV exposure on blood pressure, with a focus on hypertension in human populations.

Methods A systematic review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Electronic databases were searched for studies investigating the impact of UV exposure (UVA and/or UVB) on blood pressure. Eligible studies included randomized controlled trials (RCTs), clinical trials, and observational studies involving human participants. Data extraction and risk of bias assessment were performed independently.

Results A total of 14 studies were included in the final analysis. The majority demonstrated that UV exposure, particularly UVA, was associated with a reduction in blood pressure. Several studies suggested that this effect is mediated through NO release from cutaneous stores, independent of vitamin D pathways. However, findings were heterogeneous, with studies reporting no significant effects, likely due to differences in study design, population characteristics, and exposure protocols.

Conclusions UV exposure, especially UVA, demonstrates a blood pressure-lowering effect, potentially mediated by NO-related mechanisms. However, clinical translation requires a balanced quantitative risk-benefit assessment that considers potential cardiovascular benefits, all-cause mortality-related evidence, and dermatological risks. Further large-scale and well-designed RCTs with standardized exposure protocols and long-term safety follow-up are required before UV-based interventions can be recommended for cardiovascular prevention or hypertension management.

Keywords UV radiation · Blood pressure · Hypertension · Nitric oxide · Phototherapy · Cardiovascular risk

1 Introduction

Hypertension remains one of the leading modifiable risk factors for cardiovascular morbidity and mortality worldwide, contributing substantially to the global burden of disease [1, 2]. Despite advances in pharmacological management and established guideline-based treatment strategies [3], a significant proportion of patients fail to achieve optimal blood pressure control, highlighting the need to explore additional environmental and non-pharmacological determinants of cardiovascular regulation.

Epidemiological evidence has long suggested that blood pressure varies according to geographical and environmental

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factors. Large population-based studies have demonstrated an inverse relationship between blood pressure levels and geographical latitude, as well as associations with solar radiation exposure and ambient temperature. For example, data from the Chilean Health Survey revealed significant correlations between blood pressure and environmental variables, including solar radiation, supporting the hypothesis that sunlight exposure may play a role in cardiovascular regulation [4]. Earlier hypotheses proposed that differences in UV radiation exposure could contribute to geographical and racial variations in blood pressure, suggesting a potential link between sunlight and vascular health [5].

Traditionally, the cardiovascular effects of UV radiation have been attributed primarily to vitamin D synthesis. UVB radiation stimulates cutaneous production of vitamin D, which has been associated with cardiovascular health and blood pressure regulation [6]. However, accumulating evidence indicates that this pathway may not fully explain the observed associations between sunlight exposure and blood pressure [7]. More recent research has identified an alternative mechanism involving the mobilization of NO from cutaneous stores following UVA exposure [8]. This process can induce vasodilation and reduce systemic vascular resistance independently of vitamin D pathways.

Importantly, UV radiation comprises distinct spectral ranges with different biological effects. UVA radiation (320–400 nm) penetrates more deeply into the dermis, reaching vascular structures and enabling the mobilization of NO from cutaneous stores, which may directly contribute to systemic vasodilation and blood pressure reduction. In contrast, UVB radiation (280–320 nm) is primarily absorbed in the epidermis and is mainly responsible for vitamin D synthesis [9].

These differences are not only mechanistically relevant but also clinically important, as UVA is more strongly associated with acute hemodynamic effects, whereas UVB exposure is linked to longer-term metabolic pathways. At the same time, both UVA and UVB exposure carry potential risks. UVA contributes to photoaging and indirect DNA damage via oxidative stress, while UVB is more strongly associated with direct DNA damage and photocarcinogenesis, including non-melanoma skin cancer [10, 11]. Therefore, any potential cardiovascular benefits of UV exposure must be carefully balanced against these well-established risks.

Experimental and clinical studies have provided further support for this mechanism. UVA exposure has been shown to increase circulating NO metabolites and promote vasodilation, leading to reductions in blood pressure. These findings suggest that sunlight exposure may exert rapid cardiovascular effects through photolabile NO derivatives stored in the skin. Seasonal variations in NO bioavailability have also been proposed as a contributing factor to increased cardiovascular risk during periods of reduced sunlight exposure, further reinforcing the biological plausibility of this pathway [8].

Non-UV light-based approaches may also influence vascular physiology, but they are outside the scope of the present systematic review and were therefore not included in the systematic synthesis.

Despite these promising findings, the overall evidence remains heterogeneous. While several interventional and observational studies report blood pressure-lowering effects of UV radiation, others have demonstrated no significant associations. Differences in study design, population characteristics, UV spectrum (UVA versus UVB), and exposure protocols may account for these inconsistencies. Furthermore, the relative contributions of NO-mediated mechanisms compared to vitamin D-related pathways remain incompletely understood [5].

Given these uncertainties, a comprehensive synthesis of the available evidence is warranted. Therefore, the aim of this systematic review is to evaluate the effects of UV light exposure on cardiovascular outcomes, with a primary focus on blood pressure in human populations.

This systematic review specifically focuses on blood pressure as a primary outcome and integrates evidence from experimental, clinical, and epidemiological studies. By emphasizing NO-mediated mechanisms and UV exposure characteristics, this review provides a more targeted and clinically relevant synthesis of the available human evidence.

2 Methods

2.1 Study design and registration

This systematic review was conducted in accordance with the PRISMA guidelines [12]. The review protocol was prospectively registered in the PROSPERO international database of systematic reviews under the registration ID: CRD4201298802. Minor deviations from the original protocol were made, including a stronger focus on blood pressure outcomes as the primary endpoint and refinement of eligibility criteria. Due to heterogeneity in study designs, UV exposure protocols, and outcome measures, a narrative synthesis was performed and no quantitative meta-analysis was conducted.

2.2 Eligibility criteria

Studies were included based on the following criteria:

Inclusion criteria:

Studies involving human participants.

Studies investigating UV light exposure (UVA and/or UVB).

Studies reporting outcomes related to blood pressure or cardiovascular parameters RCTs, clinical trials, and observational studies.

Articles published in peer-reviewed journals.

Studies available in English.

Exclusion criteria:

Animal or in vitro studies.

Reviews, editorials, commentaries.

Studies without relevant cardiovascular or blood pressure outcomes.

Studies lacking sufficient methodological detail.

2.3 Information sources and search strategy

A comprehensive and systematic literature search was conducted in PubMed/MEDLINE, Embase Ovid, and Web of Science to identify studies evaluating the effects of UV radiation on blood pressure. The final search was performed on 22.03.2026.

The search strategy combined controlled vocabulary (Medical Subject Headings, MeSH) and free-text terms related to UV radiation and blood pressure. The strategy was adapted for each database.

No restrictions were applied on study design. The search was limited to studies involving human participants and published in English.

In addition, manual screening of reference lists of included studies and relevant reviews was performed to identify further eligible articles.

The full electronic search strategy for PubMed is provided in Supplementary Table S1:

((“Ultraviolet Rays“[Mesh] OR “Ultraviolet Therapy“[Mesh].

OR ultraviolet*[tiab] OR UV[tiab] OR UVA[tiab] OR UVB[tiab].

OR “narrowband UVB“[tiab] OR phototherapy[tiab]))

2.4 AND

((“Blood Pressure“[Mesh] OR “Hypertension“[Mesh].

OR “blood pressure“[tiab] OR hypertension[tiab].

OR hemodynamic*[tiab] OR vasodilat*[tiab]))

The search strategy was intentionally focused on blood pressure and hypertension outcomes to ensure specificity and relevance.

2.5 Study selection

All identified records were imported into reference management software (Zotero). Duplicate records were removed prior to screening.

Study selection was conducted in two stages:

1. Title and abstract screening.
2. Full-text review.

Studies were assessed against the predefined inclusion and exclusion criteria. A total of 14 studies were included in the final analysis.

2.6 Data extraction

Data were extracted using a standardized data extraction form. The following information was collected:

Author(s) and year of publication.

Study design.

Population characteristics.

Type of UV exposure (UVA, UVB, phototherapy).

Intervention details (dose, duration, frequency).

Comparator (if applicable).

Outcomes measured (e.g., systolic and diastolic blood pressure).

Key findings.

2.7 Risk of bias assessment

Risk of bias was assessed using established methodological frameworks [13, 14].

The methodological quality of included studies was assessed based on study design:

RCTs were evaluated using criteria based on the Cochrane Risk of Bias tool, including randomization, allocation concealment, blinding, and outcome reporting.

Observational studies were assessed using relevant domains from the Newcastle-Ottawa Scale, including selection, comparability, and outcome assessment.

Each study was categorized as having low, moderate, or high risk of bias.

2.8 Data synthesis

Due to heterogeneity in study design, populations, and UV exposure protocols, a qualitative (narrative) synthesis was performed. Results were grouped according to:

Type of UV exposure (UVA vs. UVB).

Study population (e.g., healthy individuals, patients with hypertension, specific clinical groups).

Study design.

Where appropriate, findings were compared to identify consistent patterns and discrepancies across studies.

Studies investigating non-UV light-based therapies (e.g., PBM) were not included in the systematic search or qualitative synthesis; they are mentioned only briefly as related context where appropriate.

3 Results

3.1 Study selection

The initial database search identified a total of 1326 records. After removal of 507 duplicate records, 819 unique records were screened based on titles and abstracts. Fifty-six full-text articles were assessed for eligibility. Of these, 42 studies were excluded due to irrelevant outcomes, inappropriate UV exposure interventions, review or commentary design, non-human study populations, insufficient data, or because only a congress abstract without a full peer-reviewed report was available. Ultimately, 14 studies met the inclusion criteria and were included in the qualitative synthesis. A conference abstract by Megaw et al. [15] was identified during screening but was not included in the qualitative synthesis because no full peer-reviewed report with sufficient methodological details was available. The study selection process is illustrated in Fig. 1 (PRISMA 2020 flow diagram).

The characteristics of the included studies are summarized in Table 1.

3.2 Study characteristics

The included studies comprised RCTs, interventional clinical studies, and observational cohort studies. They were conducted across diverse populations, including individuals with mild hypertension, patients undergoing hemodialysis, elderly nursing home residents and patients with chronic inflammatory conditions such as rheumatoid arthritis.

UV exposure varied across studies and included UVA irradiation, UVB exposure, and whole-body phototherapy. Exposure protocols differed in duration, frequency, and intensity, ranging from single-session exposure to repeated interventions over several weeks.

The risk of bias across included studies is summarized in Table 2.

Overall, RCTs demonstrated a low risk of bias, whereas observational and small experimental or clinical studies were more prone to confounding and selection bias. Early experimental or interventional studies, such as Krause et al. [27] and Meffert et al. [20], were limited by small sample sizes, incomplete standardization of exposure protocols, or intra-individual design features, contributing to a moderate risk of bias.

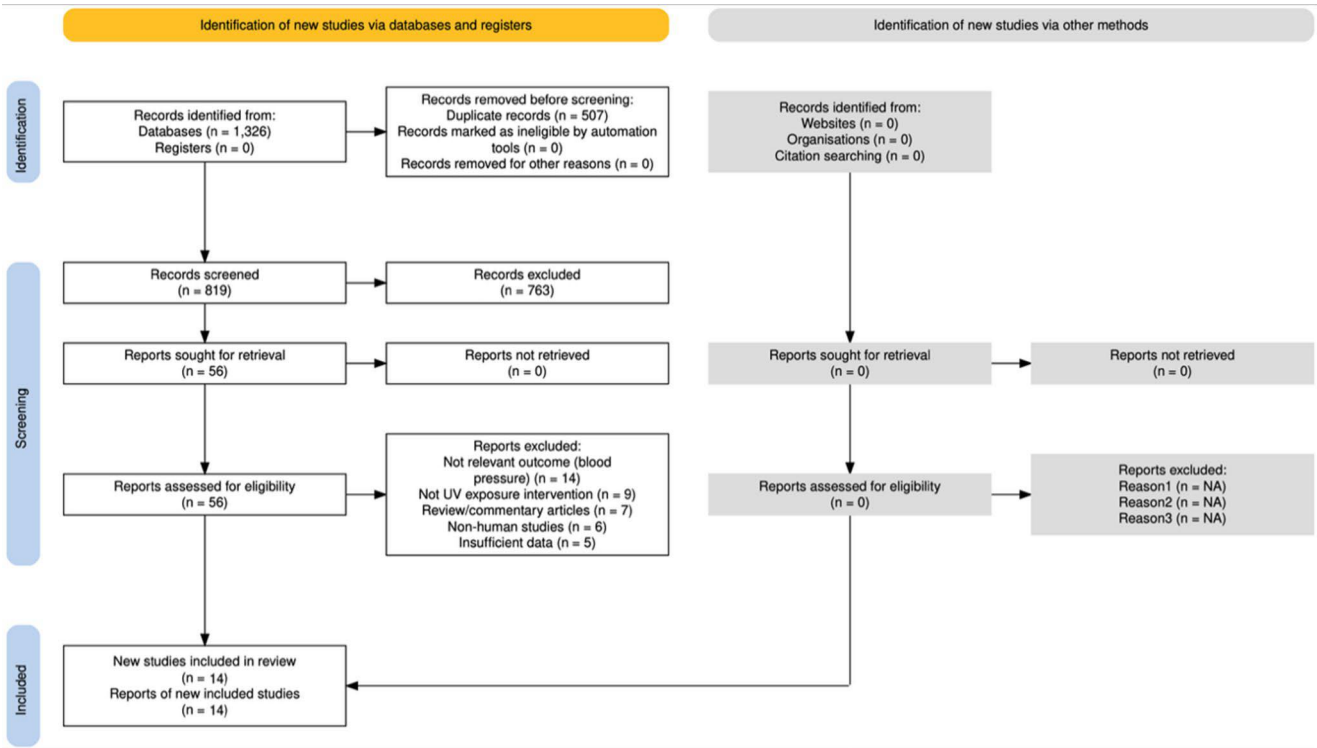

Fig. 1 PRISMA 2020 flow diagram of study selection

Table 1 Characteristics of included studies and UV exposure protocols

Author (year)	Country	Study design	Population/ sample size	Spectrum	Dose	Exposure protocol	Comparator	Outcomes	Main findings	Risk of bias
Yovanovich et al. [16]	USA	Observational cohort	Hemodialysis patients (n = ~2000+)	Ambient solar UV, wavelength-specific analysis	No administered dose	Observational hemodialysis study; environmental UV only	Low vs. high UV exposure	Systolic BP	Higher UV associated with lower BP	Moderate
Weller et al. [17]	UK	RCT	Mild hypertension ($n = 24$)	UVA 320–410 nm	5 J/cm²	Full-body UVA daily ×14 days; sham light > 500 nm	No UV exposure	Clinic BP, 24-h BP	↓ SBP and DBP after UVA	Low
Weller et al. [18]	International	Observational cohort	Hemodialysis cohort ($n > 10{,}000$)	Ambient solar UVA + UVB	No administered dose	342,457 patients from 2178 US dialysis centers over 3 years	Seasonal variation	SBP	Inverse association UV-BP	Moderate
Weber et al. [19]	USA	Experimental	Healthy adults (n = ~10–20)	Suberythemal UV, spectrum not specified	Dose not specified	Single UV exposure	Baseline	BP	Acute BP reduction	Moderate
Meffert et al. [20]	Germany	Controlled intra-individual clinical study	Patients, including individuals with arterial hypertension	IR and combined UV-IR	Repeated irradiation sessions	Prospective intra-individual comparison	Placebo/ control irradiation	Mean arterial BP; well-being; pain; fitness	Mean arterial BP reduction of approx. 8 mmHg	Moderate
Veleva et al. [21]	Netherlands	RCT	Nursing home residents ($n = 79$)	Mixed UV with UVB-dominant spectrum	1 SED/ session	Half-body irradiation, 2×/week for 6 months, 8 min/session	Vitamin D supplementation	BP	UV reduced BP independently of vitamin D	Low
Suschek et al. [22]	Germany	Experimental	Healthy volunteers ($n \approx 20$)	Whole-body UVA	Dose not specified	Whole-body UVA irradiation study investigating NO release	Baseline	BP, NO metabolites	↓ BP via NO release	Moderate
Scragg et al. [23]	New Zealand	RCT	Adults ($n = 109$)	UVB vs. UVA	Dose not specified	RCT, UVB intended to synthesize vitamin D vs. UVA control	Control	BP, CV risk	No significant effect	Low
Opländer et al. [24]	Germany	Experimental	Healthy volunteers ($n = 24$)	UVA 320–410 nm; peak approx. 351 nm	20 J/cm²	Single whole-body UVA irradiation using Waldmann UVA source	Baseline	BP, NO	Significant BP decrease via NO	Low
Monaghan et al. [25]	UK	Experimental	Healthy adults ($n = 18$)	UVA; light source max 351 nm	10 J/cm² vs. 20 J/cm²	Acute dose-comparison exposure	Dose comparison	NO metabolites, BP	Dose-dependent NO increase	Moderate
Megaw et al. [15]	UK	Pilot study	Pregnant women ($n = 20$)	Environmental UV in pregnancy literature	No administered dose	Systematic review, not intervention phototherapy	Baseline	BP	Trend toward BP reduction	High

Table 1 (continued)

Author (year)	Country	Study design	Population/ sample size	Spectrum	Dose	Exposure protocol	Comparator	Outcomes	Main findings	Risk of bias
Liu et al. [26]	UK	Experimental	Healthy volunteers ($n=24$)	UVA 320–410 nm, max 351 nm	20 J/cm² = 2 SED/ session	Waldmann GH-8 ST; active UVA over 22 min	Baseline	Vaso-dilation, BP	↓ BP independent of NOS	Low
Krause et al. [27]	Germany	Experimental	Adults ($n=18$)	UVB vs. UVA	Dose not specified	Full-body UVA or UVB for 6 weeks	Baseline	BP	UVB influences BP	Moderate
Cabrera et al. [4]	Chile	Cross-sectional	General population ($n=5200+$)	Ambient solar radiation	No administered dose	Population-based Chilean survey	Latitude gradient	BP	Lower BP with higher sunlight	Moderate
Avilés García et al. [28]	Kyrgyzstan	Clinical study	Women with RA ($n\approx40$)	Phototherapy, spectrum not specified	Dose not specified	Women with RA; chronic phototherapy	Baseline	BP, hemodynamics	Improved BP parameters	High

RCT randomized controlled trial, *BP* blood pressure, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *UV* ultraviolet, *UVA* ultraviolet A, *UVB* ultraviolet B, *SED* standard erythemal dose, *NO* nitric oxide, *NOS* – nitric oxide synthase, *CV* cardiovascular, *RA* rheumatoid arthritis

Table 2 Risk of bias assessment

Author (year)	Study design	Selection bias	Confounding	Outcome assessment	Other bias	Overall risk of bias
Yovanovich et al. [16]	Observational cohort	Moderate	High	Low	Moderate	Moderate
Weller et al. [17]	RCT	Low	Low	Low	Low	Low
Weller et al. [18]	Observational cohort	Moderate	High	Moderate	Moderate	Moderate
Weber et al. [19]	Experimental	Moderate	Moderate	Moderate	High	Moderate
Meffert et al. [20]	Clinical interventional study	Moderate	Moderate	Moderate	Moderate	Moderate
Veleva et al. [21]	RCT	Low	Low	Low	Low	Low
Suschek et al. [22]	Experimental	Moderate	Moderate	Low	Moderate	Moderate
Scragg et al. [28]	RCT	Low	Low	Moderate	Low	Low
Opländer et al. [24]	Experimental	Low	Moderate	Low	Low	Low
Monaghan et al. [25]	Experimental	Moderate	Moderate	Moderate	Moderate	Moderate
Megaw et al. [15]	Pilot study	High	High	Moderate	High	High
Liu et al. [26]	Experimental	Low	Low	Low	Low	Low
Krause et al. [27]	Experimental	Moderate	Moderate	Moderate	Moderate	Moderate
Cabrera et al. [4]	Cross-sectional	Moderate	High	Moderate	Moderate	Moderate
Avilés García et al. [28]	Clinical study	High	High	Moderate	High	High

RCT randomized controlled trial

3.3 UV exposure protocols

There was substantial heterogeneity in UV exposure protocols across studies, including differences in wavelength (UVA vs. UVB), irradiation dose, duration, frequency, and body surface area exposed. Interventions ranged from single-session experimental exposures to repeated treatments over several weeks. This variability limits comparability across studies and complicates the identification of optimal therapeutic protocols. Standardization of UV exposure parameters will be essential for future clinical translation.

3.4 Effects of UV exposure on blood pressure

The majority of included studies demonstrated a blood pressure-lowering effect following UV exposure, particularly with UVA radiation.

Additional support for sustained hemodynamic effects of light exposure is provided by earlier controlled interventional studies. Meffert conducted a prospective, placebo-controlled intra-individual study investigating the effects of infrared (IR) and combined UV-IR irradiation in patients, many of whom had arterial hypertension. The authors reported a persistent reduction in mean arterial blood pressure of approximately 8 mmHg following repeated exposures, with effects lasting for at least one week after the final irradiation session [20].

3.5 Interventional and observational studies

Weller et al. reported significant reductions in both systolic and diastolic blood pressure after controlled daily UVA phototherapy over two weeks in individuals with mild hypertension, with clinically meaningful changes in both clinic and 24-hour ambulatory measurements [17]. Similarly, experimental studies involving whole-body UVA irradiation [22, 25-27] showed acute decreases in systemic blood pressure. Observational and cohort-based studies, including large hemodialysis cohorts [16, 18], reported consistent associations between higher ambient UV exposure or seasonal sunlight and lower blood pressure levels. Cross-sectional data [4] further supported lower blood pressure in regions with higher solar radiation.

3.6 Mechanistic evidence

Several studies provided strong evidence supporting a NO-mediated mechanism. UVA exposure was shown to mobilize NO and related metabolites from cutaneous stores, leading to vasodilation of the systemic arterial vasculature and subsequent reductions in blood pressure. These effects occurred independently of vitamin D synthesis. Experimental studies demonstrated dose-dependent increases in NO metabolites [22, 25], reinforcing the biological plausibility of this pathway.

3.7 Comparative and special population studies

Some studies compared UV irradiation with oral vitamin D supplementation in elderly nursing home residents [21], showing BP reduction with UV but not fully replicated by vitamin D alone. Clinical studies in women with rheumatoid arthritis [28] suggested potential benefits, although interpretation is limited by small sample size and methodological constraints.

3.8 Studies reporting no significant effect

Not all studies demonstrated a beneficial effect. Scragg et al. [23] reported no significant changes in blood pressure or cardiovascular risk factors. These discrepancies likely reflect differences in study design, UV dose, exposure duration, participant characteristics, and baseline cardiovascular risk.

3.9 Safety reporting in included studies

None of the included studies systematically assessed adverse effects related to UV exposure. While most interventional studies reported no immediate clinically relevant side effects, formal safety monitoring was generally lacking. This represents an important limitation, particularly in light of the well-established long-term risks of UV radiation, including skin aging and carcinogenesis. Future studies should incorporate structured safety assessments and standardized reporting of adverse events.

3.10 Summary of findings

Overall, the included studies suggest that UV exposure, particularly UVA radiation, is associated with reductions in blood pressure in a variety of populations. However, the magnitude and consistency of these effects vary across studies due to methodological differences.

4 Discussion

4.1 Principal findings

This systematic review demonstrates that UV radiation, particularly UVA exposure, is associated with reductions in blood pressure across a range of human populations. The majority of included studies reported decreases in systolic and diastolic blood pressure, observed in both experimental settings [24, 26, 27] and clinical cohorts [17]. These findings support the concept that UV radiation may represent a modifiable environmental factor influencing cardiovascular regulation. However, the magnitude, consistency, and clinical relevance of these effects remain uncertain due to heterogeneity in study design and exposure protocols.

4.2 Risk-benefit considerations

Despite the observed blood pressure-lowering effects, a careful risk-benefit assessment is essential. UV radiation is a well-established risk factor for skin malignancies, including basal cell carcinoma, squamous cell carcinoma, and melanoma [10, 11]. Importantly, the absence of systematically reported adverse effects in the included studies should not be interpreted as evidence of safety, as most studies were not designed to assess long-term outcomes.

Risk-benefit considerations should not be restricted to dermatological harm alone. Several population-based studies have suggested that higher habitual sunlight exposure is associated with lower all-cause mortality, with reductions in cardiovascular mortality contributing substantially to this association [29-33]. These observations suggest that an overly risk-focused interpretation of UV exposure may be incomplete. At the same time, these data are observational and cannot establish causality, and their generalizability may be limited by geography, ambient UV intensity, skin type, and exposure behavior. Moreover, the relationship between UV exposure and melanoma risk is complex and likely non-linear. Therefore, a balanced interpretation is required: controlled, suberythemal UV exposure may have cardiovascular benefits, but any clinical translation must define exposure thresholds that maximize vascular benefit while minimizing photoaging and skin cancer risks.

4.3 Potential mechanisms

The findings strongly support a NO-mediated mechanism. UVA radiation mobilizes NO and related photolabile derivatives from cutaneous stores, leading to systemic vasodilation and reductions in blood pressure [22, 24- 26]. This pathway appears to operate independently of NO synthase activity and vitamin D metabolism, as demonstrated in experimental studies [26].

4.4 UVA versus UVB and the role of vitamin D

Traditionally, cardiovascular effects of sunlight were attributed mainly to UVB-induced vitamin D synthesis [6]. However, the evidence synthesized in this review indicates that UVA plays a more immediate role in blood pressure regulation through NO mobilization. Comparative studies suggest that vitamin D supplementation alone does not replicate the hemodynamic effects observed with UV exposure [21], highlighting the importance of non-vitamin D pathways.

Some studies have suggested that UVB radiation may also contribute to blood pressure regulation and could potentially exert stronger or complementary effects under certain conditions. However, the mechanisms underlying UVB-associated cardiovascular effects are less clearly defined and are often attributed primarily to vitamin D synthesis. The relative contribution of UVB compared to UVA therefore remains an important area for future investigation.

4.5 Heterogeneity of findings

Despite an overall trend toward blood pressure reduction, findings across studies were heterogeneous. This variability is likely explained by differences in study design, population characteristics, baseline cardiovascular risk, and UV exposure parameters such as wavelength, dose, duration, and frequency [16, 18]. Small sample sizes and short intervention periods further limit the ability to detect sustained or clinically meaningful effects.

4.6 Clinical implications

The available evidence suggests that controlled UVA exposure may have modest blood pressure-lowering effects under experimental conditions. However, UV exposure cannot currently be recommended as a therapeutic intervention for hypertension outside controlled experimental or clinical trial settings. Future clinical translation will require standardized exposure protocols and a quantitative benefit-risk framework that evaluates cardiovascular effects, all-cause mortality-related outcomes, and dermatological safety together.

4.7 Strengths and limitations

Strengths of this review include adherence to PRISMA guidelines [12], prospective protocol registration, and the integration of mechanistic and clinical evidence across diverse study designs.

However, several limitations must be considered. Substantial heterogeneity in UV exposure protocols, study populations, and outcome measures precluded quantitative meta-analysis. Many included studies were small, short-term, and at moderate risk of bias. Residual confounding in observational studies cannot be excluded. Importantly, a dose–response relationship between UV exposure and blood pressure reduction cannot be established based on the available data.

Importantly, the absence of systematically reported adverse effects should not be interpreted as evidence of safety.

4.8 Future directions

Future research should prioritize well-designed RCTs with standardized UV exposure protocols, long-term follow-up,

dose-response evaluations, and a quantitative benefit-risk framework that evaluates cardiovascular outcomes, all-cause mortality-related outcomes, and dermatological safety together. Mechanistically related non-UV light interventions, including photobiomodulation, may be relevant to future research but require separate evaluation and were outside the scope of the present UV-focused review [34–36, 36, 37].

5 Conclusion

This systematic review indicates that UV radiation, particularly UVA exposure, is associated with reductions in blood pressure across several human study settings. The evidence suggests that these effects are largely mediated through NO-dependent mechanisms rather than solely through vitamin D pathways [35–38]. However, the evidence base remains heterogeneous and is limited by small sample sizes, short-term interventions, and variability in study design and UV exposure protocols. Clinical translation should therefore not be framed only as a question of UV-related skin risk, but as a broader quantitative risk-benefit assessment that also considers cardiovascular outcomes and all-cause mortality evidence. Large-scale, well-designed randomized controlled trials with standardized exposure protocols and long-term safety follow-up are required before UV-based interventions can be recommended for cardiovascular prevention or hypertension management.

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Declarations

Conflict of interest None.

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