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Review

Vitamin D deficiency in Sri Lankan adults: A scoping review

De Silva S T[1,2], Herath N J[1]

[1]*Colombo North Teaching Hospital, Ragama, Sri Lanka*
[2]*Faculty of Medicine, University of Kelaniya, Sri Lanka*

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ABSTRACT

Background: Vitamin D deficiency (VDD) is a major global public health problem. Sri Lanka, a tropical island nation located between 6–9°N latitude and receiving year-round ultraviolet B solar radiation, paradoxically has a high burden of VDD, driven by sun-avoidance behaviour, low dietary intake of vitamin D-rich foods, and the absence of national food fortification or supplementation policies.
Objectives: To map published data on vitamin D status in Sri Lankan adults, describe the prevalence, determinants, and reported health associations of VDD, compare findings with regional and global data, and identify evidence gaps and locally grounded public health priorities.
Methods: A scoping review was conducted following the Arksey and O'Malley framework, using PubMed, Google Scholar, and the Sri Lanka Journals Online database. Studies reporting serum 25-hydroxy vitamin D [25(OH)D] concentrations in Sri Lankan populations were included. Regional and global systematic reviews and meta-analyses were used for comparative analysis. Consistent with scoping methodology, studies were charted descriptively without formal quality appraisal or quantitative synthesis.
Results: Reported vitamin D inadequacy ranges from 57.6% among premenopausal women to 90.2% in an urban cohort in Colombo. The most rigorous population-based study found VDD (<50 nmol/L) in 67.6% of adults in Colombo, with women more affected than men (72.6% vs 61.7%). Key determinants included sun avoidance, Fitzpatrick skin types IV–V, low dietary vitamin D intake, and obesity. Sri Lanka reports the lowest pooled VDD prevalence (48%) in South Asia but remains highly deficient in urban settings. Countries with mandatory food fortification achieve substantially lower deficiency burdens.
Conclusions: VDD is highly prevalent in urban Sri Lanka, particularly among women and working-age adults. Based on the available evidence, population-level measures, including mandatory fortification of staple foods, promotion of safe sun exposure, public education, and a national surveillance strategy, are priorities in Sri Lanka.

*Corresponding Author: De Silva S T
Email address: shamiladp@kln.ac.lk
https://orcid.org/0000-0001-7241-0963

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Introduction

Vitamin D is a fat-soluble secosteroid with a unique dual origin. It is synthesised endogenously in the skin upon exposure to solar ultraviolet B (UVB) radiation (wavelength 290–315 nm) and is also acquired through the diet.[1,2,3] Despite this dual source, vitamin D deficiency (VDD) has emerged as one of the most prevalent nutritional deficiencies worldwide. A pooled analysis of 7.9 million participants from 308 population-based studies reported that globally approximately 40% of the population had serum 25(OH) D concentrations below 50 nmol/L, the widely accepted threshold for insufficiency.[4,5]

Sri Lanka lies between 6–9° North latitude and experiences intense, year-round solar irradiance. The expectation that this geographic position would confer near-universal vitamin D sufficiency has repeatedly been contradicted by empirical evidence. Multiple studies have documented high rates of VDD and insufficiency across diverse Sri Lankan populations, with cumulative inadequacy rates ranging from approximately 57% to over 90%.[6,7,8]

Consequences of VDD range from osteomalacia and osteoporosis[1,9] to type 2 diabetes, cardiovascular disease, impaired immune function, and adverse pregnancy outcomes.[10,11,12] In Sri Lanka, which faces a mounting non-communicable disease burden, unaddressed VDD is a potentially modifiable and neglected risk factor.

This scoping review maps the available evidence on vitamin D status in Sri Lankan adults, describes the prevalence and determinants of VDD, compares these findings with regional and global data, and identifies evidence gaps and locally grounded public health priorities.

Methods

This scoping review was conducted in line with the Arksey and O'Malley framework, by searching PubMed/ MEDLINE, Google Scholar, and the Sri Lanka Journals Online (SLJOL) from 1990 to February 2026, using the following terms individually and in combination: "vitamin D," "25-hydroxyvitamin D," "25(OH)D," "cholecalciferol," "deficiency," "insufficiency," "Sri Lanka," "Sri Lankan," "South Asian," and "tropical." Reference lists were hand-searched for additional publications.

Inclusion criteria were,

(1) original studies reporting serum 25(OH)D concentrations or VDD prevalence in Sri Lankan adults (≥18 years)
(2) studies conducted in Sri Lanka or in Sri Lankan migrant populations
(3) publications in peer-reviewed journals or government surveillance reports

Paediatric studies were included if they provided lifecycle context.[13] For comparative analysis, systematic reviews and meta-analyses on vitamin D status in South Asian and global populations published after 2015 were preferentially selected. Diagnostic thresholds are reported as defined in the original studies.[14] Consistent with scoping review methodology, included studies were charted and summarised descriptively. A formal risk-of-bias appraisal and quantitative pooling were not conducted. The review is therefore exploratory, maps rather than grades the evidence, and is subject to selection, language, and interpretation biases inherent in a non-systematic design.

Vitamin D status in Sri Lankan adults

Community-based studies

The most methodologically rigorous Sri Lankan dataset is the population-based cross-sectional study by Seneviratne et al. (2024),[6] which recruited 1,260 adults aged 35–74 years from 63 administrative divisions of the Colombo District using probability-proportionate-to-size cluster sampling. Using the Endocrine Society cut-off of 25(OH)D <50 nmol/L, 67.6% of participants were deficient. Among those deficient, 53.9% had mild VDD (25–50 nmol/L), 12.8% had moderate VDD (<25 nmol/L), and 0.8% had severe VDD (<12.5 nmol/L). VDD was significantly more prevalent in women (72.6%) than men (61.7%; $p < 0.01$) and was highest in the 35–44-year age group, decreasing with advancing age, a pattern inverse to that seen in Northern Europe, where the elderly are most affected.

Subasinghe et al. (2019)[7] reported combined VDD and insufficiency rates of 90.2% in an adult urban cohort in Colombo, with particularly high rates among young adults and obese individuals, confirming the significant inverse association between body mass index and serum 25(OH)D. Rodrigo et al. (2013)[8] found combined vitamin D inadequacy in 57.6% of 132 premenopausal women in the Southern Province (VDD 6.1%, insufficiency 51.5%), with sun exposure and dietary intake as significant independent predictors.

Special populations

Suganthan et al. (2020)[15] found that among 105 postmenopausal osteoporotic women in Jaffna, Northern Sri Lanka, only 36.2% had sufficient vitamin D levels (>75 nmol/L), 44% were insufficient, and 19% were deficient (<50 nmol/L). Musculoskeletal symptoms were highly prevalent (bone pain 55.2%, myopathy 40.0%), but no significant differences were found between vitamin D-sufficient and deficient groups, underscoring the non-specificity of clinical symptoms and the need for laboratory screening.

In the maternal-infant context, Anusha et al. (2019)[16] documented a mean infant 25(OH)D of 28.1 nmol/L at a tertiary care centre in the Western Province, with low maternal vitamin D status during pregnancy conferring a sixfold increase in odds of infant VDD (OR 6.0, $p < 0.05$). Most exclusively breastfed infants were deficient, regardless of maternal sufficiency, highlighting the inadequacy of human breast milk as a sole source of vitamin D.

Migration and comparative data

Sri Lankan migration data provide compelling evidence that sun exposure is the dominant driver of vitamin D status. Meyer et al.[17] compared 196 Sri Lankans resident in Kandy (7° N) with 242 Sri Lankan migrants in Oslo (60° N). The mean serum 25(OH)D was 54.2 nmol/L in Sri Lanka versus 31.5 nmol/L in Norway, with severe VDD (<25 nmol/L) being 9.3 times more prevalent in Oslo. This study also carries important clinical implications for the growing Sri Lankan diaspora in high-latitude countries.

Table 1
Published studies on Vitamin D status in Sri Lankan populations.

Study (Year)	Population	N	Region	Prevalence Finding	Key Determinants Identified
Meyer et al. (2007)	Adults (LKA vs Norway)	438	Kandy vs Oslo	Mean 25(OH)D: 54.2 nmol/L (LKA) vs 31.5 nmol/L (Norway). Severe VDD 9.3× more prevalent in Oslo	Latitude, sun exposure
Rodrigo et al. (2013)	Premenopausal women, 20–40 yr	132	Southern Province	VDD 6.1%; Insufficiency 51.5%; Combined 57.6%	Sun exposure, dietary vitamin D intake
Anusha et al. (2019)	Pregnant/lactating mothers & infants	NR	Tertiary care, Western Province	Infant mean 25(OH)D: 28.1 nmol/L. Low maternal VD: OR 6.0 for infant VDD ($p < 0.05$)	Maternal status, infant sun exposure
Subasinghe et al. (2019)	Adults ≥18 yr	NR	Colombo (urban)	Combined VDD + insufficiency: 90.2%. Higher in young adults and women	Age, sex, obesity
Suganthan et al. (2020)	Postmenopausal women with osteoporosis	105	Teaching Hospital Jaffna	VDD 19%; Insufficiency 44%; Sufficient only 36.2%	Not systematically assessed
Jayatissa et al. (2019)	Children & adolescents, 10–18 yr	NR	National	VDD 13.2%; Insufficiency 45.6%; Combined 58.8%	Sun exposure, diet
Liyanage et al. (2022)	Healthcare undergraduates	482	University of Sri Jayewardenepura	Mean VD knowledge score: 31.3%. 59.3% used ≥1 sun avoidance measure	Knowledge deficit linked to sun avoidance
Seneviratne et al. (2024)	Adults 35–74 yr (population-based)	1260	Colombo District (urban)	VDD (<50 nmol/L): 67.6%. Female > male (72.6% vs 61.7%, $p < 0.01$). Highest in 35–44 yr group	Sex, age, skin type, diet, sun avoidance

LKA: Sri Lanka; NR: not reported; VDD: vitamin D deficiency (<50 nmol/L by Endocrine Society criteria unless otherwise specified); 25(OH)D: 25-hydroxyvitamin D; OR: odds ratio.

Knowledge and behaviour

Liyanage et al. (2022)[18] surveyed 482 healthcare undergraduates and found a mean vitamin D knowledge score of only 31.3%, with fewer than 18% scoring above 50%. A total of 59.3% of participants used at least one sun-avoidance measure, and lower knowledge scores were significantly associated with greater sun-avoidance behaviours. The knowledge deficit among future health professionals is particularly concerning because it perpetuates inadequate clinical recognition, screening, and management of VDD.

Table 1 summarises published studies on vitamin D status in Sri Lanka.

Determinants of Vitamin D deficiency in Sri Lanka

The principal determinants of VDD in Sri Lanka are summarised in Table 2. A unifying theme is that geographic solar advantage is systematically negated by behavioural, biological, and policy factors.

Sun avoidance behaviour is the primary driver. Cultural preferences for lighter skin tones, particularly prevalent among women, motivate routine umbrella use, protective clothing, and topical sunscreens.[8,18] This cosmetically motivated behaviour effectively eliminates the theoretical advantage of tropical residence. Superimposed on this are occupational trends; the rapid growth of indoor, formal-sector employment in urban Sri Lanka means that large segments of the working-age population spend most daylight hours in offices and vehicles with negligible UVB exposure.

Fitzpatrick skin types IV–V, which are predominant in Sri Lankans, require up to five times longer sun exposure than lighter skin types to produce equivalent amounts of cutaneous vitamin D3.[6,19] This inherent biological characteristic means that even moderate sun avoidance readily tips the balance towards deficiency.

The Sri Lankan diet provides minimal vitamin D: a rice-dominant staple devoid of vitamin D, low per capita consumption of fatty fish and dairy, and no mandatory food fortification render dietary compensation for reduced cutaneous synthesis virtually impossible.[8,20] Phytate in rice additionally impairs calcium absorption, increasing the physiological demand for calcitriol and its substrate.

Obesity, which is increasing rapidly in urban Sri Lanka,[21] compounds deficiency by sequestering 25(OH)D in adipose tissue, thereby reducing its systemic bioavailability. The significant inverse association between BMI and serum 25(OH)D in the Colombo urban study[7] is consistent with this mechanism. In the Moor Muslim community (approximately 9% of the population), veiling practices substantially restrict cutaneous UVB exposure, further widening the gender and ethnoreligious disparity.[7,22]

Sri Lanka has no mandatory vitamin D food fortification, no national supplementation programme, and no clinical guidelines on VDD screening or management as of 2024.[23]

Health consequences

The skeletal consequences of VDD, osteomalacia and osteoporosis, are directly relevant to Sri Lanka. Suganthan et al.[15] found a high burden of musculoskeletal symptoms in postmenopausal women with osteoporosis in the Northern Province. Secondary hyperparathyroidism consequent to VDD accelerates bone resorption and contributes to the substantial osteoporosis burden among postmenopausal Sri Lankan women. Meta-analyses have demonstrated that vitamin D supplementation reduces the risk of non-vertebral fractures,[9] a benefit with clear implications for a country where fragility fractures carry high morbidity.

The extra-skeletal consequences are equally important. The vitamin D receptor is expressed in pancreatic beta-cells, and 1,25(OH)2D stimulates insulin secretion and improves insulin sensitivity.[10] Given that urban Sri Lanka has one of the highest prevalence rates of type 2 diabetes in Asia (approximately 25%), the inverse association between VDD and insulin resistance documented in the Colombo urban study[7] is potentially clinically relevant. VDD has also been associated with dyslipidaemia, hypertension, and cardiovascular disease.[10]

In the immune domain, calcitriol induces the production of antimicrobial peptides (cathelicidin and defensins) in macrophages, and VDD is associated with increased susceptibility to respiratory infections and tuberculosis.[11] Vitamin D supplementation has been shown in a Cochrane-level meta-analysis to reduce the incidence of acute respiratory infections, particularly in those with baseline VDD.[11] Multiple systematic reviews reported associations between VDD and greater COVID-19 severity and mortality.[12]

VDD during pregnancy is linked to gestational diabetes, pre-eclampsia, and adverse birth outcomes.[16] The six-fold increased odds of infant VDD documented in Sri Lanka[16] demonstrate intergenerational transmission of deficiency in the absence of preventive intervention.

Table 2
Key Determinants of Vitamin D Deficiency in Sri Lankan Adults.

Determinant	Mechanism / Evidence in Sri Lanka	Supporting Reference
Sun avoidance behaviour	Cosmetic preference for lighter skin drives umbrella use, protective clothing, and sunscreen application. 59.3% of healthcare undergraduates used ≥1 avoidance measure	Liyanage et al. [18]; Rodrigo et al. [8]
Fitzpatrick skin types IV–V	Higher melanin content requires up to 5× longer sun exposure vs type I for equivalent cutaneous vitamin D synthesis	Seneviratne et al. [6]; Webb et al. [19]
Female sex	Women have significantly higher VDD in all Sri Lankan studies. Linked to greater sun avoidance, differential occupational exposure, and potentially hormonal factors	Seneviratne et al. [6]; Subasinghe et al. [7]
Low dietary intake	Rice-dominant diet devoid of vitamin D; low per capita dairy and fatty fish consumption; no mandatory food fortification in Sri Lanka	Rodrigo et al. [8]; Jayawardena et al. [20]
Obesity	Adipose sequestration reduces 25(OH)D bioavailability. Significant inverse association between BMI and 25(OH)D documented in Colombo urban study	Subasinghe et al. [7]; Katulanda et al. [21]
Indoor/sedentary lifestyle	Urban formal-sector employment, air-conditioned transport and offices, and limited outdoor recreation reduce cumulative UVB dose	Seneviratne et al. [6]
Veiling practices (Moor community)	Hijab/niqab markedly reduces skin UVB exposure. Lower 25(OH)D documented in Muslim women in the Colombo urban study	Subasinghe et al. [7]; Darling et al. [22]
Absence of fortification/ supplementation policy	No mandatory food fortification and no national supplementation programme for any age group in Sri Lanka as of 2024	Epidemiology Unit MoH [23]; Pilz et al. [24]

25(OH)D: 25-hydroxyvitamin D; BMI: body mass index; UVB: ultraviolet B.

Table 3
Comparative Vitamin D deficiency prevalence: Sri Lanka, South Asia, and selected global populations.

Population / Country	VDD Prevalence (cut-off used)	Mean/Median 25(OH)D	Source
Sri Lanka – urban adults, Colombo	67.6% (<50 nmol/L)	NR	Seneviratne et al., 2024 [6]
Sri Lanka – urban adults, Colombo	90.2% (deficiency + insufficiency <75 nmol/L)	NR	Subasinghe et al., 2019 [7]
Sri Lanka – pooled (meta-analysis)	48% (95% CI: 41–55%)	~19 ng/mL	Siddiqee et al., 2021 [25]
Pakistan	73% (95% CI: 63–83%)	~16 ng/mL	Siddiqee et al., 2021 [25]
Bangladesh	67% (95% CI: 50–83%)	~18 ng/mL	Siddiqee et al., 2021 [25]
India	67% (95% CI: 61–73%)	~18 ng/mL	Siddiqee et al., 2021 [25]
Nepal	57% (95% CI: 53–60%)	~19 ng/mL	Siddiqee et al., 2021 [25]
South Asia – pooled	68% (95% CI: 64–72%)	19.15 ng/mL (weighted mean)	Siddiqee et al., 2021 [25]
Global (pooled)	~40% (<50 nmol/L)	Variable by region	Cui et al., 2023 [4]
USA / Canada	~20–30%	~28–30 ng/mL	Cashman, 2022 [28]
Europe (overall)	~30–50% (wide variation)	~20–26 ng/mL	Cashman, 2022 [28]
Finland (post-fortification)	<15% (after 2003–2010 mandatory fortification)	>20 ng/mL	Koskinen et al. [33]

VDD: vitamin D deficiency; NR: not reported. Cut-offs and definitions vary across studies as noted. Siddiqee et al. [25] used primarily <50 nmol/L for pooled analyses. 25(OH)D values expressed in ng/mL from source studies where reported; multiply by 2.5 to convert to nmol/L.

These extra-skeletal associations are largely based on observational data and cannot establish causation. With the partial exception of slowing progression from prediabetes to diabetes, randomised trials have not consistently shown that vitamin D supplementation prevents these clinical outcomes. The relevance of VDD to the non-communicable disease burden in Sri Lanka therefore remains a hypothesis requiring locally conducted interventional research rather than an established basis for treatment.

Regional and global comparison

The most comprehensive meta-analysis of VDD in South Asia, by Siddiqee et al. (2021),[25] synthesised 65 studies from 44,717 participants across five countries. The pooled VDD prevalence was 68% (95% CI: 64–72%), with a weighted mean serum 25(OH)D of 19.15 ng/mL. Country-specific estimates were: Pakistan 73%, Bangladesh 67%, India 67%, Nepal 57%, and Sri Lanka 48% (95% CI: 41–55%)[26,27]. Sri Lanka reports the lowest pooled VDD prevalence in South Asia, likely reflecting its southern latitude, but remains highly deficient, with urban studies reporting rates of 67.6–90.2%.[6,7]

Globally, Cui et al. (2023)[4] estimated that approximately 40% of the world population has 25(OH)D <50 nmol/L based on 308 population studies. Cashman (2022)[28] highlighted substantial geographic heterogeneity: North America (20–30%) and Scandinavia (<15% post-fortification) perform substantially better than South Asia, the Middle East (>70% in some studies), and Southern/Eastern Europe (30–50%).[29,30,31,32]

The success of mandatory fortification programmes is striking. Finland's mandatory fortification of dairy products and fats, initiated in 2003 and strengthened in 2010, reduced national VDD prevalence to below 15%,[33] a transformation achievable in Sri Lanka if similar policies were adopted. Comparative VDD data confirm two key points. Latitude alone is a poor predictor of vitamin D status. Fortification policy is the most powerful and equitable lever available to governments seeking to reduce population VDD (Table 3).[24]

Strengths and limitations of the reviewed evidence

There are certain gaps in the Sri Lankan research discussed, and the conclusions should be interpreted with caution. The literature is dominated by cross-sectional studies that establish prevalence and associations but cannot demonstrate causation or the direction of effect. The most informative data are geographically concentrated in the Colombo District and other urban centres. Rural, estate-sector, and Northern and Eastern populations are under-represented, limiting national generalisability. Studies also differ in their 25(OH)D assay methods, diagnostic thresholds (50 vs 75 nmol/L), sampling frames, and age ranges, which restricts direct comparison and pooling. Only one study used probability-based population sampling, while the others relied on convenience or clinic-based recruitment, which may overestimate deficiency rates.

As a scoping review, this work maps the available literature without formal quality grading and is itself vulnerable to selection, language, and interpretation bias. These limitations are the principal reason this review confines its recommendations to population-level measures of established safety and refrains from clinical prescriptions that the underlying studies cannot support.

Public health priorities and evidence gaps

Recommendations are confined to measures that follow directly from the Sri Lankan data reviewed above, together with population-level interventions of established safety and equity. The following priorities emerge from local data.

A) Mandatory food fortification is the most cost-effective and equitable single intervention[24] and is the measure most strongly supported by international experience. In Sri Lanka, the most suitable vehicles are edible oils (since coconut oil is the near-universal cooking medium), dairy products, powdered milk, wheat flour, and infant formula. As Finland, Canada, and the USA have demonstrated, mandatory fortification with modest levels of vitamin D3 (typically 5–10 μg/100 g) achieves sustained population-wide increases in 25(OH)D without meaningful risk of toxicity.[24,33]

B) Primary prevention through behaviour and lifestyle should be promoted, as these measures are safe, low-cost, and directly supported by the determinant data. Public messaging should encourage 15–30 minutes of midday sun exposure on the arms and legs three to four times per week, which substantially improves vitamin D status without meaningful skin cancer risk in a tropical population;[36] discourage routine practices that cover the entire body outdoors where culturally acceptable, and support weight reduction, given the documented inverse association between BMI and 25(OH)D. Dietary promotion of fatty fish, eggs, and sunlight-exposed mushrooms should be integrated into national dietary guidelines.[20,8]

C) Maternal and infant measures warrant particular attention because local data document high rates of maternal and infant deficiency and intergenerational transmission.[16] Antenatal and infant vitamin D supplementation are endorsed internationally and could be evaluated and, where appropriate, delivered through the existing government midwife, antenatal, and immunisation infrastructure. Because the clinical-outcome benefit of these measures has not been tested in the Sri Lankan setting, they should ideally be introduced alongside local effectiveness studies rather than as untested blanket policy.

D) Clinical guidelines and healthcare education are needed to define appropriate, limited indications for testing and treatment and to discourage indiscriminate screening. Sri Lanka should develop national guidance on screening indications, diagnostic thresholds, treatment protocols, and monitoring. Given the documented knowledge deficit even among healthcare undergraduates,[18] vitamin D education must be integrated into undergraduate and postgraduate health curricula.

E) All interventions should be underpinned by a nationally representative surveillance strategy for serum 25(OH)D, standardised to international quality schemes, to enable trend monitoring, impact evaluation, and the generation of the local interventional evidence currently lacking. This surveillance gap is itself a key research priority.

Conclusions

Vitamin D deficiency is a widespread and largely unrecognised public health problem in Sri Lanka. Between 57% and 90% of adults in the reviewed studies had sub-optimal vitamin D status, with concentrations among urban-dwelling women, working-age adults, and growing segments of the population affected by obesity and indoor lifestyles. This burden is paradoxical for a tropical country but is explicable by the convergence of cosmetically motivated sun avoidance, dark skin pigmentation, low dietary vitamin D intake, and the absence of a national fortification policy.

Sri Lanka has the lowest pooled VDD prevalence in South Asia, yet recent urban studies report rates of 67–90%, and the country has no policy to arrest these trends. In contrast, countries that have implemented mandatory food fortification have achieved dramatic and sustained reductions in population VDD.[24,33]

The evidence reviewed is predominantly urban, cross-sectional, and observational, and it supports a description of the problem more firmly than it supports specific clinical prescriptions. The priorities that follow from these data are population-level and include mandatory fortification of edible oils and dairy products, safe sun exposure and weight-reduction messaging, avoidance of complete bodily covering, dietary improvement, and a standardised national surveillance system. Sri Lanka eliminated iodine deficiency through salt iodisation, demonstrating the transformative power of food fortification. Recommendations for individual screening and supplementation for specific disease groups should await locally generated trial evidence. The solutions for population-level prevention are affordable and equitable. What is needed is political will to act and local research to refine clinical practice.

Author declaration

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Conflicts of Interest

The authors declare no financial conflicts of interest. As a scoping review built on a non-systematic, largely urban and cross-sectional evidence base, this work is also subject to selection and interpretation bias. Its conclusions should be read with that methodological limitation in mind.

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Author contributions

SDS and NH conceptualised and designed the study. SDS acquired, analysed, and interpreted the data with help from NH. SDS drafted the work, and both authors revised it critically. SDS and NH approved the final version and are accountable for all aspects of the work.

Use of artificial intelligence

Claude.ai was used for language editing and grammar correction, to improve clarity and structure of the text and for formatting references and tables. All AI-generated outputs were reviewed, verified, and validated by the authors.

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