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Prevention of Diabetic Foot Complications in Winter: Special Considerations for Jammu and Kashmir

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Abstract

Background: Diabetes mellitus prevalence in Jammu and Kashmir has risen sharply. The ICMR-INDIAB survey found overall prevalence of 18.9% specifically in the Jammu region (not the Union Territory as a whole), while separate, Union Territory-wide NFHS-6 data show elevated blood glucose—not a clinical diagnosis of diabetes—in 11.3% - 13% of adults; both sources point to a large undiagnosed burden. Diabetic foot disease is among the most disabling complications of diabetes, and international evidence indicates that its risk intensifies in cold climates through mechanisms distinct from those emphasized in temperate or tropical guidelines. **Objective:** To synthesize the epidemiological, pathophysiological, and culturally specific literature on winter-related diabetic foot risk in Jammu and Kashmir, and to translate international prevention frameworks into regionally appropriate recommendations. **Methods:** A narrative review of peer-reviewed literature, international guideline documents (International Working Group on the Diabetic Foot, 2023), and regional epidemiological reports was conducted, focusing on diabetic peripheral neuropathy, peripheral arterial disease, frostbite, thermal burn injury (including the regionally described "kangri ulcer"), classification and staging of diabetic foot lesions, and seasonal variation in foot-related outcomes. **Results:** The Kashmiri winter compounds the classical triad of neuropathy, ischaemia, and impaired wound healing through cold-induced vasoconstriction, loss of protective sensation to both cold and heat, dry and fissured skin, restrictive

footwear, and widespread traditional use of open-ember heating devices. A distinct chronic cutaneous entity, the kangri ulcer, is well described in regional dermatological literature and carries a recognised risk of malignant transformation over years of repeated exposure; this is mechanistically and clinically separate from the acute thermal burns that diabetic neuropathy also predisposes to, which instead carry an immediate risk of infection and limb loss. Health-system barriers, seasonal isolation, workforce shortages, and low awareness further delay presentation and worsen outcomes. **Conclusion:** A structured, evidence-based, and culturally sensitive prevention strategy, aligned with IWGDF 2023 guidance but adapted to local heating practices, terrain, and health-system access, and supported by telemedicine and community screening models already piloted elsewhere in India, could meaningfully reduce the winter-associated burden of diabetic foot disease in this high-risk, high-altitude population, pending region-specific prospective research to confirm the magnitude of the winter effect.

Keywords

Diabetic Foot, Frostbite, Kangri Ulcer and Ischaemia

1. Introduction

Diabetic foot disease is defined by the International Working Group on the Diabetic Foot (IWGDF) as infection, ulceration, or destruction of tissues of the foot associated with neuropathy and/or peripheral arterial disease in the lower extremity of a person with diabetes [1]. It remains one of the most feared complications of diabetes: globally, diabetic foot ulcers (DFUs) affect an estimated 15% - 25% of people with diabetes during their lifetime and precede over 80% of diabetes-related lower-limb amputations, with five-year post-amputation mortality reported to rival that of many malignancies. Beyond mortality, DFU imposes profound morbidity: recurrent hospitalisation, prolonged immobility, loss of livelihood, and, in a study of amputees, a fear of limb loss rated by patients as comparable to or exceeding their fear of death.

In India, the burden is substantial and well documented. Systematic evidence synthesis indicates that roughly a quarter of the country's diabetic population develops a foot ulcer, of whom half require hospitalisation for infection and a fifth ultimately require amputation [2]; diabetes-related lower-limb amputation is estimated at 45,000 - 100,000 procedures annually nationally, accounting for approximately 80% of all non-traumatic amputations [2] [3]. A community-based study from urban India found amputation in over 15% of patients presenting with DFU, with poor glycaemic control (HbA1c > 7%) significantly associated with amputation risk, and patients with a history of DFU carrying a roughly 40% higher ten-year mortality than those without [4] [5]. These are national-level figures and should be read as indicative rather than directly applicable to Jammu and Kashmir, for which no dedicated registry data yet exist (Section 9); the DFU-burden and amputation-rate esti-

mates above are drawn in part from an evidence-synthesis conference abstract [2] rather than a full peer-reviewed study, and are presented here with that caveat. These figures nonetheless situate diabetic foot disease as a leading, largely preventable, driver of disability in the Indian diabetic population, and one whose downstream costs—direct medical expenditure, lost productivity, and long-term rehabilitation—fall disproportionately on households with limited capacity to absorb them.

Jammu and Kashmir presents a distinctive epidemiological and environmental profile within this national picture. Two separate data sources describe this picture and should not be conflated: the ICMR-INDIAB survey reports diabetes prevalence specifically for the Jammu region (18.9% overall; 26.5% urban, 14.5% rural; 10.8% prediabetic; roughly 40% of cases undiagnosed) [6], whereas NFHS-6 (2023-24) separately reports elevated blood glucose—a screening measure, not a clinical diagnosis of diabetes—across the whole Union Territory, in 13% of women and 11.3% of men [7], both figures having risen substantially since NFHS-5. Superimposed on this rising diabetic population is a prolonged, severe winter, including the traditional 40-day period of most intense cold (Chillai Kalan), and a set of cold-climate exposures—thermal, vascular, neurological, and behavioural—that are rarely addressed in diabetic foot literature developed for temperate Western or tropical South Asian settings. The region also faces structural health-system challenges common to hilly and border areas: dispersed rural populations, seasonal road closures, a relative shortage of podiatry and vascular-surgical expertise outside tertiary centres in Srinagar and Jammu, and reduced clinic attendance during the harshest winter months. This narrative review integrates international prevention guidelines [1] [8] with cold-climate and region-specific literature to construct an evidence-based approach to winter diabetic foot care in Jammu and Kashmir, spanning epidemiology, pathophysiology, clinical classification, prevention, and health-system strategy.

2. Methods

A narrative literature review was conducted using PubMed, Google Scholar, and grey-literature sources (health-system reports, national survey data, and IWGDF guideline publications) to identify material relevant to: (i) Diabetes and diabetic foot epidemiology in Jammu and Kashmir/India; (ii) Pathophysiology, classification, and prevention of diabetic foot ulceration, per the 2023 IWGDF guideline series [1] [8]-[12]; (iii) Cold-climate-specific foot pathology, including frostbite and thermal/burn injury relevant to traditional Kashmiri heating practices; (iv) Health-system and technology-enabled models (telemedicine, community screening) with plausible applicability to remote and high-altitude regions. Given the narrative (non-systematic) design, the review prioritizes breadth and regional relevance over exhaustive quantitative synthesis and should be read as a scoping synthesis to orient regional clinicians, nurses, and public-health planners rather than as a formal systematic review or meta-analysis. No formal quality appraisal or risk-of-bias scoring was performed, consistent with standard narrative-review methodology; this is stated explicitly as a limitation in Section 9.

3. Epidemiological Context

3.1. Diabetes Prevalence in Jammu and Kashmir

Recent surveys converge on a picture of rapidly rising diabetes prevalence across Jammu and Kashmir. The ICMR-INDIAB study of 1520 participants reported diabetes prevalence of 18.9% overall in the Jammu region (26.5% urban, 14.5% rural), prediabetes of 10.8%, and high rates of coexisting hypertension (27.1%), generalized obesity (41.7%), and abdominal obesity (62.7%) [6]. NFHS-6 data show elevated blood glucose in 13% of women and 11.3% of men aged 15 and above, up from 8.7% and 8% respectively in NFHS-5 (2019-21), with a pronounced urban-rural gradient (17% urban versus 11.9% rural women; 14.6% urban versus 10.3% rural men) [7]. These two figures are not directly comparable: the ICMR-INDIAB estimate is a clinically ascertained diabetes prevalence confined to the Jammu region, while the NFHS-6 figure is a screening-level elevated-blood-glucose prevalence reported for the Union Territory as a whole; they are presented together here only to indicate overall direction and magnitude, not as a single combined statistic. Both surveys highlight a large undiagnosed pool, roughly 40% of cases in the ICMR-INDIAB sample, which has direct implications for foot-complication prevention, since undiagnosed patients receive no structured foot screening, glycaemic counselling, or footwear advice until a complication, sometimes a foot ulcer itself, brings them to medical attention.

3.2. Historical Trends and Foot-Specific Burden

Foot problems were reported to affect more than half of patients with diabetes duration exceeding ten years [3], broadly consistent with the national pattern in which 15% - 25% of Indian diabetics develop a foot ulcer in their lifetime, half of these become infected and require hospitalisation, and a fifth require amputation [2]. Applied to Jammu and Kashmir, these remain national extrapolations rather than locally measured figures. Applied to a region with rising prevalence, a high proportion of undiagnosed disease, and a severe winter climate, these national figures imply a substantial and likely growing local burden of preventable foot complications, one that is not yet quantified by dedicated regional registries.

3.3. Economic Burden

The cost implications of allowing diabetic foot disease to progress rather than intervening early are considerable even in absolute terms. Indian cost analyses [2] have estimated ambulatory treatment of an uncomplicated neuropathic ulcer at roughly $56 per episode, rising to approximately $165 for an infected neuropathic foot, $1080 for advanced limb-salvage care, $960 for amputation alone, and as high as $2650 when salvage is followed by amputation (**Table 1**). As with the burden estimates above, these cost figures originate from a conference-abstract-level evidence synthesis [2]; they are presented as approximate, indicative figures pending confirmation from a full peer-reviewed cost-of-illness study. Given that around half of patients who undergo one amputation experience a second within two

years, the lifetime cost trajectory for a single preventable ulcer can escalate substantially, an argument that applies with particular force in a resource-constrained hill-state health system where such expenditure competes directly with other essential services.

Table 1. Approximate per-episode treatment costs for diabetic foot disease in India (USD).

Care pathway	Approximate cost per episode (USD)
Ambulatory care, uncomplicated neuropathic ulcer	~$56
Ambulatory care, infected neuropathic foot	~$165
Advanced diabetic foot (limb salvage)	~$1080
Limb amputation	~$960
Salvage followed by amputation	~$2650
Neuro-ischaemic foot requiring bypass	~$1960

4. Pathophysiological Basis: Why Winter Amplifies Diabetic Foot Risk

4.1. The Classical Triad, Revisited for Cold Climates

The 2023 IWGDF Prevention Guideline identifies loss of protective sensation (from peripheral neuropathy), peripheral arterial disease, foot deformity, and prior ulcer/amputation history as the principal determinants of foot ulcer risk, and recommends risk-stratified screening and integrated preventive foot care accordingly [1] [8]. Winter conditions interact with each element of this triad rather than introducing an independent, unrelated hazard.

4.2. Cold-Induced Vasoconstriction and Ischaemia

Cold exposure triggers reflex peripheral vasoconstriction to conserve core temperature; in a foot with pre-existing peripheral arterial disease, itself markedly more prevalent in diabetic than non-diabetic populations, this can convert marginal perfusion into frank ischaemia [1] [8] [9]. Preliminary evidence from wearable in-shoe sensor technology is consistent with a seasonal effect on foot temperature, though this evidence is indirect and requires cautious interpretation. A 2026 feasibility study using wearable temperature and pressure sensors recorded a statistically detectable drop in foot temperature in December, which its authors described only as "potentially indicating reduced circulation or vasoconstriction due to colder weather"—a hypothesis-generating observation, not a confirmed physiological finding [13]. Critically, that study was conducted in healthy adult volunteers with no diabetes, neuropathy, or foot pathology, as a methodological baseline for future clinical work rather than a study of diabetic patients; its authors explicitly caution that the detected anomalies "should not be interpreted as clinically confirmed DFU-related pathology" [13]. It is cited here only as a possible risk indicator worth testing in diabetic cohorts, and should not be read as direct

evidence that winter vasoconstriction reduces perfusion or raises ulceration risk in people with diabetes—that remains a plausible, biologically grounded hypothesis extrapolated from general cold-physiology principles [1] [8] [9], not a demonstrated finding in this population. In practical terms, a foot that could tolerate a given degree of pressure or minor trauma in summer may be unable to do so once winter vasoconstriction has reduced its perfusion reserve, even without any change in the patient's underlying vascular disease; confirming this mechanism in diabetic patients specifically remains an important direction for regional research (Section 10).

4.3. Neuropathy: Loss of the Warning System, in Both Directions

Sensorimotor neuropathy is the pathway through which cold climates most directly threaten the diabetic foot, because it removes the protective withdrawal response to both extremes of temperature. Frostbite scoping reviews identify diabetes and neuropathy as recognized predisposing factors, since impaired cold-induced pain perception delays recognition of freezing injury [14] [15]; frostbite pathophysiology itself progresses through extracellular ice nucleation, microvascular thrombosis, and reperfusion injury on rewarming, producing long-term sequelae—chronic pain, cold hypersensitivity, vasomotor disturbance, and reduced sensation—in 63.3% of patients in one scoping review that pooled outcome data across included studies [16], alongside frostbite arthritis resembling osteoarthritis and, in children, growth-plate damage [14] [16]. Systematic review evidence further identifies personal and psychosocial predisposing factors for frostbite and frostbite-related amputation, including impaired judgement of cold exposure duration and delayed protective behaviour, factors plausibly compounded by neuropathic sensory loss [15]. Conversely, the same sensory loss removes the pain response that would normally prevent prolonged contact with a heat source, the mechanism underlying kangri- and bukhari-related thermal burns discussed below. Cold weather has also been separately reported to intensify neuropathic pain itself, through cold-allodynia mechanisms involving transient receptor potential (TRP) channels, independent of any injury [17], meaning patients may simultaneously experience heightened pain from intact nerves at rest while retaining dangerously reduced protective sensation to acute injury.

4.4. Thermal Injury from Traditional Warming Practices: The Kangri Ulcer

The kangri, an earthenware pot of hot embers woven into a wicker casing and carried beneath the pheran, is a centrally important traditional Kashmiri warming device, particularly in rural households and during the frequent winter power outages that sustain its continued use; the bukhari (wood/coal stove) and hot-water bottles serve related purposes.

Chronic kangri ulcer and malignant transformation. Kashmiri dermatological literature describes a distinct chronic cutaneous entity, the "kangri ulcer" (also

termed "Kangri cancer" when malignant change has occurred), arising from years of repeated, low-grade ember contact against the abdomen and thighs rather than from a single exposure. Hospital-based histopathological series from Srinagar have documented a spectrum of Kangri-associated skin change—erythema ab igne, Bowen's disease, and squamous cell carcinoma—in patients with long-standing Kangri use [18], and larger retrospective series describe Kangri-cancer squamous cell carcinoma with a substantial risk of loco-regional metastasis [19]. This chronic, cumulative pathway to malignancy is a regional variant of the broader phenomenon of heat-contact-associated Marjolin's ulcer, also described as "kairo burn cancer" in Japan and "kang ulcer" in China [20] [21]. It is mechanistically and clinically distinct from the acute thermal burns discussed next: the chronic kangri ulcer develops over years in the general Kashmiri population independent of diabetes status, carries a cancer risk rather than an immediate limb-threat, and is managed primarily by dermatological surveillance and biopsy of suspicious lesions, whereas acute diabetic foot burns, described below, present within hours to days, carry an immediate risk of infection and amputation, and are managed as acute wounds.

Acute thermal burns in the diabetic foot. In diabetic patients, neuropathy compounds the hazard of direct-contact heat sources acutely: case literature has documented diabetic individuals sustaining severe thermal burns after using direct heat therapy to relieve neuropathic discomfort, resulting in secondary infection and extensive debridement despite the absence of pain during the causative exposure [22]. Burn-registry evidence corroborates the disproportionate impact of thermal injury on diabetic feet specifically: diabetic patients with foot burns present later (delayed recognition due to reduced sensation), and single-institution and comparative retrospective studies report significantly higher rates of amputation, longer hospitalisation, more frequent regrafting, and reduced functional status at discharge among diabetic versus non-diabetic foot-burn patients, with one comparative study reporting 33% amputation in the diabetic group versus 0% in controls, and significantly fewer diabetic patients prescribed pressure garments despite comparable need [23] [24]. Regarding treatment, a single regional burn centre's retrospective comparison reported that its patients managed with local wound care had less morbidity, shorter wound-closure times, and better functional outcomes than those managed operatively, and that centre has accordingly adopted a non-operative-first institutional protocol [23]. This is a single-institution, abstract-level retrospective comparison in which treatment was not randomly allocated—patients selected for surgery may have had more severe injuries at baseline—so it should not be read as establishing a general preference for non-operative care. The more defensible clinical message is that every diabetic foot burn warrants prompt specialist (burns or diabetic-foot multidisciplinary) assessment, with the choice between operative and non-operative management individualised according to burn depth, presence of infection, and limb perfusion, rather than defaulting to either approach [23] [24].

4.5. Dermatological Barrier Breakdown

Low ambient humidity outdoors and drying indoor heating reduce skin moisture; diabetic skin, already prone to autonomic-mediated reduced sweating, becomes more prone to fissuring, particularly over the heel, in winter. Fissures constitute a portal of entry for pathogens in a population already documented to have high rates of polymicrobial and multidrug-resistant diabetic foot infection in Indian case series [9] [25], raising the stakes of any skin breach; one Indian cohort found multidrug-resistant organisms in 69% of bacterial isolates from diabetic foot infections, with methicillin-resistant Staphylococcus aureus accounting for over 80% of resistant Gram-positive isolates [25], underscoring how quickly a minor winter fissure could seed a difficult-to-treat infection.

4.6. Footwear, Mobility, and Health-Seeking Behaviour

IWGDF guidance identifies appropriate footwear and structured self-care education as core pillars of ulcer prevention for at-risk patients [8]. Winter footwear—heavy socks, insulated boots, layered wrappings—can increase in-shoe pressure and friction while simultaneously making daily visual foot inspection more cumbersome. Snow and ice add mechanical and frostbite risk to exposed or thinly covered toes, and reduced daylight, difficult terrain, and seasonal isolation in high-altitude areas of the Union Territory plausibly delay care-seeking for early lesions, compounding the known association between diagnostic delay and adverse diabetic foot outcomes documented across Indian tertiary-care cohorts [4] [5].

5. Risk Synthesis

Table 2 summarizes the principal winter-specific mechanisms by which the Kashmiri climate and its associated cultural practices intersect with the established pathophysiology of diabetic foot disease.

Table 2. Winter-specific risk domains for diabetic foot disease in Jammu and Kashmir.

Risk domain	Winter-specific mechanism	Representative evidence
Vascular	Cold-induced peripheral vasoconstriction reduces perfusion in a foot already compromised by peripheral arterial disease; preliminary wearable-sensor data (non-diabetic cohort) show a seasonal decline in foot temperature, proposed as a possible risk indicator	IWGDF PAD guideline [1] [8] [9]; feasibility sensor study [13]
Neurological	Loss of protective sensation prevents recognition of cold injury, pressure, or burns; cold weather intensifies neuropathic pain and cold allodynia	Frostbite scoping reviews [14]-[16]; cold-allodynia narrative review [17]
Thermal/ traumatic	Chronic, repeated kangri/bukhari contact causes a distinct cutaneous entity with malignant potential; separately, acute contact burns occur in an insensate foot; frostbite from cold/snow exposure	Kangri-ulcer histopathology [18] [19]; Marjolin's ulcer literature [20] [21]; diabetic foot-burn cohort studies [22]-[24]
Dermatological	Low ambient humidity and indoor heating dry and fissure skin, creating portals for infection	Diabetic foot infection case series [9] [25]
Behavioural/ systemic	Heavy footwear, reduced mobility, delayed care-seeking in remote/high-altitude terrain; seasonal drop in clinic attendance	IWGDF prevention guideline [8]; regional health-access reports

6. Classification and Clinical Assessment

Consistent staging of any foot lesion is essential both for clinical decision-making and for meaningful audit of outcomes, including any future region-specific study of seasonal variation. The IWGDF 2019/2023 classification guideline recommends the SINBAD system (Site, Ischaemia, Neuropathy, Bacterial infection, Area, Depth) for routine communication among healthcare professionals because of its simplicity [10] [26], and the WIfI (Wound, Ischaemia, foot Infection) system where assessment of perfusion and likely benefit from revascularisation is required, alongside continued, broadly externally validated use of the Meggitt-Wagner and University of Texas systems for predicting healing and amputation risk [27]-[29]. Comparative prospective cohort data indicate WIfI can outperform Wagner and University of Texas systems as a predictor of major amputation (area under the receiver-operating-characteristic curve up to 0.899 in one study), though a paired analysis in the same study found the differences between systems were not always statistically significant, and no single system has been universally adopted [27] [30] [31]. The Meggitt-Wagner system (**Table 3**), the most widely used historically, remains a practical bedside tool for regional clinicians without immediate access to vascular imaging [28].

Table 3. Meggitt-Wagner classification of diabetic foot lesions.

Grade	Description
0	Pre- or post-ulcerative site; intact skin, possible deformity or cellulitis
1	Superficial ulcer (partial- or full-thickness)
2	Deep ulcer extending to tendon, capsule, or bone, without abscess/osteomyelitis
3	Deep abscess, osteomyelitis, or joint sepsis
4	Partial-foot (forefoot) gangrene
5	Whole-foot gangrene

For a Kashmiri clinical setting, deliberate use of a shared, simple classification system, whether SINBAD for routine referral communication or Wagner for bedside triage, would allow future seasonal audits (see Section 9) to compare lesion severity across summer and winter presentations on a consistent basis, something not currently possible given the absence of dedicated regional data.

7. Prevention Strategies

The following recommendations translate IWGDF 2023 prevention principles [1] [8]—screening for loss of protective sensation and peripheral arterial disease, risk-stratified integrated foot care, appropriate footwear, and structured self-care education—into measures adapted for the regional winter context.

7.1. Risk Stratification and Structured Screening

- Screen all persons with diabetes at least annually for loss of protective sensa-

tion (10g monofilament and/or vibration perception) and pedal pulses, per IWGDF risk categories [1] [8], with more frequent review (every 1 - 3 months) for those at high risk and every 3 - 6 months for moderate risk, and continue this schedule through winter months when attendance often falls.

- Give special attention to patients with a prior ulcer or amputation, who IWGDF and Indian cohort data identify as being at the highest recurrence risk and among whom lifelong preventive foot care is warranted [5] [8].
- Record any new lesion using a consistent classification system (SINBAD or Wagner) to standardize communication between primary care, specialist, and referral centres [10] [26] [28].

7.2. Daily Foot Care and Inspection

- Inspect both feet daily, including soles and inter-digital spaces, using a mirror or the assistance of a family member when visual acuity or flexibility is limited.
- Wash feet daily in lukewarm water, verifying temperature with the elbow or a thermometer rather than the foot itself if sensation is impaired; dry thoroughly, especially between the toes.
- Apply moisturiser to soles and heels (avoiding web spaces) to counter winter-related dryness and fissuring.
- Refer corns, calluses, thickened or ingrown nails for professional podiatric management rather than self-treatment with blades, acids, or heat.

7.3. Safer Alternatives to Open-Ember and Direct-Contact Heating

- There is no cloth barrier or contact-time limit that makes direct contact between a kangri, hot-water bottle, heating pad, or bukhari and an insensate foot safe. Because impaired protective sensation prevents the patient from feeling developing tissue damage regardless of barrier or duration, direct or prolonged contact between any such heat source and the foot should be avoided altogether in patients with confirmed or suspected neuropathy, not merely minimised [22]-[24].
- Where feasible, prefer thermostatically controlled electric heaters with automatic shut-off over open-ember devices for individuals with confirmed neuropathy, while recognizing the cultural significance and continued necessity of the kangri during frequent winter power outages.
- Warm the room, not the foot directly: insulated footwear and warmed (not hot) bedding reduce reliance on direct-contact heat sources.
- Educate family members and caregivers of elderly or neuropathic patients to actively check for evolving burns, since the patient may not perceive the injury developing.
- Where a thermal injury does occur, seek prompt assessment by a burns or diabetic-foot specialist rather than assuming conservative management is preferred by default; the choice between operative and non-operative treatment should be individualised according to burn depth, presence of infection, and

limb perfusion, recognising that operative management is necessary for deep, infected, or poorly perfused wounds [23] [24].

7.4. Footwear and Protection from Cold Injury

- Wear well-fitting, insulated, waterproof footwear with adequate toe room; avoid constrictive boots or excessive sock layering that compresses the foot and impairs circulation.
- Inspect the interior of footwear for foreign objects, seams, or moisture before each use.
- Change damp socks promptly; avoid prolonged bare or thinly covered exposure to snow, ice, or cold flooring, which can cause unrecognized frostnip in an insensate foot.
- Never walk barefoot on cold stone or concrete floors indoors.

7.5. Glycaemic and Vascular Risk Optimization

- Maintain glycaemic control (targeting HbA1c ≤ 7% where individually appropriate), given the documented association between poor control and both DFU incidence and amputation in Indian cohorts [4] [5].
- Manage coexisting hypertension, dyslipidaemia, and tobacco use, all of which are prevalent regionally and compound peripheral arterial disease risk [6].
- Maintain diabetes clinic attendance through winter months despite travel and weather difficulty, recognizing the risk of care discontinuity in remote and high-altitude areas.

7.6. Early Recognition and Prompt Care-Seeking

- Treat any new redness, blister, discoloration, numbness, or wound as urgent regardless of pain, since neuropathic feet may not signal injury through pain.
- Avoid home remedies, hot compresses, or unsupervised topical treatment of any foot lesion, a documented precipitant of severe thermal injury in neuropathic patients [22].
- Ensure prompt referral pathways from primary care to specialist diabetic foot or wound services, given the strong association between delayed presentation and amputation demonstrated across Indian and international burn and DFU cohorts [4] [23] [24].

8. Health-System Strategy: Telemedicine, Workforce, and Community Models

Given the terrain and seasonal isolation of much of Jammu and Kashmir, technology-enabled and community-based care models piloted elsewhere in India offer a plausible template for extending foot-screening access through winter months. The Chunampet Rural Diabetes Prevention Project in Tamil Nadu demonstrated that a mobile van equipped with trained technicians, glucose meters, and satellite-linked tele-diabetology could deliver diabetes and complication screening, includ-

ing neuropathy and foot circulation assessment, to remote villages otherwise lacking specialist access [32]. A comparable customised-mobile-van model in urban-underprivileged Delhi combined point-of-care glucose testing with video-linked specialist consultation for diabetes complications, including foot assessment [33]. At primary-care level, a randomised crossover trial in rural India found frontline-worker-supported telemedicine achieved diagnostic concordance with face-to-face care [34], consistent with the provider-to-provider telemedicine model envisioned under India's Ayushman Bharat health and wellness centre network.

More directly relevant to wound follow-up, mobile-phone image-based assessment of diabetic foot ulcers has shown reasonable validity and reliability compared with in-person review in international studies [35], and an emerging evidence base on digital health technologies, smartphone imaging, remote monitoring, and mobile applications for diabetic foot ulcer care, points toward feasible, lower-cost options for interim monitoring between in-person visits [36], particularly relevant when road closures or heavy snowfall make weekly clinic attendance impractical for a wound requiring three months or more of active treatment. Applied to Jammu and Kashmir, an integrated model might combine: (i) ASHA/community health worker-led seasonal foot-risk screening using the 10g monofilament and simple visual inspection; (ii) Smartphone-photograph-based remote triage for suspected ulcers or burns during periods of road inaccessibility; (iii) Scheduled tele-consultation linking primary health centres to tertiary diabetic-foot or vascular-surgical expertise concentrated in Srinagar and Jammu, reducing the need for physically difficult winter travel while preserving specialist oversight.

This technology-enabled approach has an important limit that should be stated explicitly. The validation studies underlying mobile-phone ulcer assessment and remote monitoring demonstrate that such tools can support triage—deciding who needs to travel for in-person care—and interim follow-up of a wound already under active management [35] [36]; they do not demonstrate that remote images or video consultation can substitute for in-person clinical assessment where infection, ischaemia, or a significant burn is suspected. Signs such as spreading erythema, crepitus, systemic illness, absent pulses, or a burn involving more than superficial skin thickness warrant in-person evaluation regardless of travel difficulty, and any telemedicine protocol adopted in Jammu and Kashmir should build in explicit, low-threshold criteria for escalation to in-person care rather than defaulting to remote management of these presentations.

9. Limitations of the Current Evidence Base

Region-specific, quantitative data directly linking winter seasonality to diabetic foot ulcer incidence, thermal-burn incidence, or amputation rates in Jammu and Kashmir are limited; much of the mechanistic evidence cited here is drawn from international frostbite, burn, and diabetic-foot literature, extrapolated to the regional context, together with descriptive Kashmiri dermatological literature on kangri ulcers that substantially predates the current diabetes epidemic in the re-

gion [14]-[16] [18] [19]. As a narrative rather than systematic review, this synthesis did not apply formal risk-of-bias or certainty-of-evidence grading (e.g., GRADE, as used by IWGDF itself) to individual sources, and publication and availability bias cannot be excluded, since much of the accessible cold-injury and burn literature originates from high-income cold-climate settings whose health-system context (emergency response times, burn-unit access) differs from rural Jammu and Kashmir. A further limitation is that several cited sources (notably refs. [2] [13] and [23]) are conference abstracts or single-institution/feasibility studies rather than full peer-reviewed primary studies; these are flagged at first mention in the text and should be treated as hypothesis-generating rather than definitive. Prospective, season-stratified audits of diabetic foot presentations at regional tertiary centres, ideally using a consistent classification system as outlined in Section 6, are needed to quantify the magnitude of the winter effect precisely and to evaluate the impact of targeted preventive interventions, including the telemedicine and community-screening models proposed in Section 8.

10. Future Research Directions

- Prospective, multi-centre, season-stratified cohort studies of DFU and thermal-burn presentations across major hospitals in Srinagar, Jammu, and district-level centres, using a standardized classification system (SINBAD or Wagner).
- Case-control or cohort studies specifically examining kangri/bukhari-related thermal injury in diabetic versus non-diabetic patients within the region, to establish a contemporary, diabetes-era estimate of kangri ulcer incidence and its relationship to glycaemic control and neuropathy severity.
- Feasibility and cost-effectiveness evaluation of telemedicine-supported foot screening and wound monitoring adapted to Jammu and Kashmir's terrain and seasonal accessibility constraints, building on existing Indian rural telemedicine models.
- Qualitative research on patient and caregiver knowledge, attitudes, and practices regarding traditional heating devices and diabetic foot risk, to inform culturally acceptable safety messaging rather than messaging that dismisses a valued cultural practice outright.
- Prospective validation of wearable foot-temperature and pressure sensors specifically in diabetic patients in the region, to test directly whether the seasonal decline observed in a non-diabetic feasibility cohort [13] translates into a measurable perfusion or ulceration-risk signal in people with diabetes.

11. Conclusion

Diabetic foot disease is a highly preventable but potentially devastating complication of diabetes, and the literature reviewed here indicates that its risk is plausibly heightened by the winter conditions and traditional heating practices characteristic of Jammu and Kashmir, though the regional, diabetes-specific evidence base

for the size of this winter effect remains limited and is a priority for future research (Sections 9 - 10). With regional diabetes prevalence now approaching or exceeding national averages [6] [7], a high proportion of undiagnosed disease, and a well-established national burden of DFU-related amputation and cost [2]-[5], the anticipated winter-related contribution—through cold-induced ischaemia, frostbite, and kangri-associated thermal injury—warrants explicit incorporation into local diabetes care protocols. Aligning international IWGDF prevention and classification principles [1] [8] [10] with culturally grounded, season-specific education, safer heating alternatives, and improved access to structured foot screening, supported where feasible by telemedicine and community health-worker models already validated elsewhere in rural India [32]-[36], offers a feasible, low-cost pathway to reducing this burden, pending region-specific prospective research to refine and evaluate these measures.

Author Contributions

Resources, A.R., P.U.F.B., S.S., M.A., R.M. and S.M.; investigation and data curation, A.R. and R.M.; writing—original draft preparation, A.R. and R.M.; writing—review and editing, A.R. and R.M. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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