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Review Article

An Assessment of the Ethnomedicinal Properties of Endemic Flowering Plants of the Western Ghats, India

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ABSTRACT

Western Ghats is a global biodiversity hotspot in India with 7,402 species of flowering plants, of which 1,426 species are endemic. About 40 indigenous tribal communities live in these hill ranges, and they possess several plant-based traditional knowledge practices. This study is a comprehensive review of the ethnomedicinal uses of the plant species endemic to Western Ghats. The ethnomedicinal data of endemic flowering plants were collected from authentic sources such as journals, books, floras, Google Scholar, Scopus, PubMed, biodiversity portals, institutional reports, and grey literature. These traditional uses were classified into standard disease categories, and their significance as leads towards systematic phyto-pharmacological-nutritional studies is evaluated. The total number of traditional uses documented for 126 endemic plant species under 39 categories is 508. The major categories are Food and Nutraceuticals 8.9%, Traditional, Folk Medicines 8.1%, and General Health 6.5%. Our results infer that the native tribal communities of Western Ghats are prioritizing the use of the endemic species for their primary needs of food, nutrition and medicine. Of these time-tested leads only very few have been scientifically investigated so far, and efforts in these lines could result in new drug precursors, flavours, and nutritional additives.

Keywords: Western Ghats, Endemic plants, Ethnomedicinal uses, Traditional-folk medicines, Food and nutraceuticals, General health.

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INTRODUCTION

The Western Ghats refers to the hill chain running roughly in a north-south direction parallel to the Arabian sea coast, for about 1500 Km (area ~ 1,64,280 Km^2), from the river Tapti down to Kanyakumari at the tip of the Indian peninsula (Figure 1).[1,2] Nayar and co-workers enumerated 7,402 species of flowering plants in Western Ghats, of which 5,588 are indigenous and 1,273 species are endemic.[3] This mountain range is one of the global biodiversity hotspots. UNESCO has declared Western Ghats as a World Heritage Site for its rich biological diversity and endemism.[1] There are over 40 indigenous tribal communities in Western Ghats (Table S1),[1,4] and they hold fine knowledge of the local forests, plants and other natural resources. Most of these tribal communities have limited access or less preference to modern medicine;[5] instead, over centuries they evolved plant-based traditional knowledge practices. The World Health Organization (WHO) has defined traditional medicine as "the sum total of the knowledge, skill, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness."[6]

It has been estimated that over 2500 plant species are used in India for the preparation of traditional medicines;[7] the major reason for this high demand is the surge in the use of medicinal plants in *Ayurveda* and other traditional systems.[8,9] Ethnomedicine and traditional knowledge are crucial for the health and nutrition of local people, and is conveyed through generations by customs, oral or written accounts, songs, cultural values, local languages, healing arts and agricultural practices.[10,11] WHO recognizes the benefits of traditional, complementary and alternative medicines, and stimulates an evidence-based approach. Over 80% of the world's population in more than 170 WHO member countries use some form of traditional medicine.[12] Moreover, around 40% of pharmaceutical products have a natural product basis, and

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landmark drugs (examples: quinine, aspirin, artemisinin) have been derived from traditional medicines.[13,14] Further, exploring the particulars of ethnomedicine could unravel the history and co-evolution of nature and humans, and re-emphasize the need for sustainable utilization of nature's resources.[15-17]

In fact, there is a long history of herbal medicine being translated into effective treatments for health conditions; this means that new natural product sources and advanced methodologies are crucial in development of drugs of the future. Ethnomedicinal data, derived from longstanding practices, are reliable indicators prompting systematic studies towards establishing their chemistry and biology as well as evaluating their drug, nutraceutical and flavour prospects.[18] The ethnomedicinal data on the endemic species of Western Ghats in the literature are sporadic, and has not been scrutinized. The objective of this study is the systematic analysis of the ethnomedicinal reports of the endemic flowering plants of Western Ghats.

METHODOLOGY

Study area

Western Ghats, which runs parallel to the Western coastal area of India covering six states *viz.*, Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa, Gujarat, is the study area (Figure 1).

Endemic plants

A preliminary list of 1,273 endemic flowering plants of Western Ghats was made from the books, Flowering Plants of the Western Ghats, India (volumes I, II).[3,19] The list of endemic plants reported since 2024 were gathered through extensive search of literature such as taxonomy journals, books and annual reports (Table S1). Each of these names thus gathered was cross checked with Plants of the World Online (POWO; Kew Science),[20] to note their current names and also to underscore plants falling under the endemic category. Through revisionary studies the geographic distribution of plant species undergoes periodical changes. As a result, many of the taxa previously listed as endemic were later found to have extended distributions. The species listed (Table S1) are mostly endemic to the Western Ghats (Figure 1). In addition, those taxa previously listed as endemic in cited literature, but having extended distribution were also included due to their ethnomedicinal importance (marked @ in Table S1).

Ethnomedicinal data collection

Each endemic species listed was thoroughly searched for ethnomedicinal information in journals, floras, books, institutional reports, online sources such as Google Scholar, Scopus, PubMed, and biodiversity portals. Species names of endemic plants were used as keywords in data searches, and their ethnomedicinal data were gathered.

Classification of ethnomedicinal data

The medicinal uses of plants gathered were classified under standard disease categories (Tables 1, S1) based on the 9th and 11th versions of International Classification of Diseases (ICD). Additional disease classifications which are not coming under the ICD are listed as well.[21-23] Nutritional, flavour, cosmetic and other miscellaneous uses are also categorized (Tables 1, S1).

Data analysis

A chord diagram was used to illustrate the traditional uses of the 126 endemic species listed in Table S1 and the frequency of use of each species. The chord diagram was generated using the R software (Figure 2).

RESULTS

The number of endemic species in the Western Ghats enumerated up to 2014 is 1,273. Our literature survey from 2014 to 2024 resulted in adding another 153 species totalling 1,426 species. All these species were extensively searched, and only 126 of them recorded ethnomedicinal data. Of these 126 species 107 are endemic, and 19 species are previously recorded as endemic but have an extended distribution. The total number of ethnomedicinal reports for these 126 taxa of endemic flowering plants of Western Ghats under 39 disease categories is 508 (Table S1; Figure 2). The major ethnomedicinal uses (≥ 4%) of the 39 categories are Food and Nutraceuticals (FN) 8.9%, Traditional, Folk Medicines (TFM) 8.1%, General Health (GH) 6.5%, Skeleto-Muscular System Disorders (SMSD) 5.5%, Inflammation (In) 4.7%, Dermatological Infections/Diseases (DID) 4.7%, Digestive Problems (DP) 4.3%, Fever (Fr) 4.1%, and Microbial Infections (MI) 4.1%. The least mentioned ones (≤ 1%) are Kidney Problems (KP) 1.0%, Cancer (Cr) 1.0%, Abortion and Contraceptive (AC) 0.8%, Tumour (Tr) 0.6%, Tuberculosis (Ts) 0.6%, Circulatory System/Cardiovascular Diseases (CSCD) 0.6%, Hair Care (HC) 0.6%, Pregnancy and Postnatal Care (PPC) 0.4%, Mental Disorders (MD) 0.4%, and Gynaecological Disorders (GD) 0.2% (Table 1). Table S1 registered sixteen tribal communities, *viz.*, Kurumba (1), Kattunayaka (1), Kani (12), Paniya (3), Kuruma (1), Irula (1), Malavedan (1), Malappandaram (2), Malasar (2), Muthuvan (1), Palliyar (1), Kadar (1), Pulaiyar (1), Kudumbi (2), Gowli (1), Jenu Kuruba (1), with the Kani tribes (12) being the most frequently listed.

The most traditionally listed plants (≥ 5%) belong to the families *Apocynaceae* (15.8%), *Acanthaceae* (11.0%), *Fabaceae* (6.3%), and *Araceae* (5.5%) (Table S1). *Apocynaceae* is one of the largest families in flowering plants, and they are known for several medicinal activities. They are also consumed as food by tribals, and few species are used as poison. Members of *Apocynaceae* family are rich in terpenoids, steroids, alkaloids, flavonoids, phenols, glycosides, lactones, and hydrocarbons.[24] Similarly, *Acanthaceae* species are traditionally used for various ailments; phytochemical

studies proved the presence of secondary metabolites such as glycosides, flavonoids, alkaloids, triterpenoids, fatty acid methyl esters and fatty acids in them. They also displayed various biological effects.[25,26] *Fabaceae* species have been used for medicinal purposes in Asia, Europe, and North America, and they are rich in proteins and phytochemicals such as saponins, alkaloids, flavonoids, phenolic acids, lectins, and carotenoids. Various *Fabaceae* species are also known to reduce the risk of cancer and other diseases.[27] *Araceae* species are widely used as food sources, mainly their starchy tubers. They also demonstrated medicinal properties against various ailments.[28] The Western Ghats endemics belonging to these four families provide good leads on their uses in traditional medicine (Table S1).

This study found that the tribal communities of Western Ghats are using plants in *Acanthaceae, Anacardiaceae, Apiaceae, Apocynaceae, Araceae, Arecaceae, Cucurbitaceae, Dipterocarpaceae, Fabaceae, Primulaceae, Sapotaceae*, and *Meliaceae* families for food and nutritional purposes. Flavour and fragrance components are reported only in three families, *viz., Apiaceae, Dipterocarpaceae*, and *Zingiberaceae*, whereas *Apiaceae, Apocynaceae* and *Myristicaceae* species are traditionally recorded as spice components. Again, indigenous communities in the forest areas of Western Ghats are using plants in *Acanthaceae, Apocynaceae, Araceae, Aristolochiaceae, Bignoniaceae, Fabaceae, Gentianaceae, Malvaceae* and *Rutaceae* families for treating snake and other poisonous bites.

The ten most listed endemic species in Table S1 are *Vateria indica* L. (*Dipterocarpaceae*), *Piper nigrum* L. (*Piperaceae*), *Symplocos macrophylla* subsp. *rosea* (Bedd.) Noot. (*Symplocaceae*), *Myristica malabarica* Lam. (*Myristicaceae*), *Andrographis stellulata* C. B. Clarke (*Acanthaceae*), *Decalepis nervosa* (Wight and Arn.) Venter (*Apocynaceae*), *Bonnaya veronicifolia* (Retz.) Spreng. (Linderniaceae), *Atalantia racemosa* Wight and Hook. (*Rutaceae*), *Humboldtia sanjappae* Sasidh. and Sujanapal (*Fabaceae*), and *Humboldtia brunonis* Wall. var. *brunonis* (*Fabaceae*). The woody species *V. indica* (common names: White Damar, Indian Copal Tree, Malabar Tallow tree, Piney Varnish-Tree) has proven uses in Ayurvedic drugs and in several other medicinal applications.[29] Its resin has been used as a traditional medicine for chronic bronchitis, sore throat, diarrhoea and rheumatism.[30] Phytochemical studies isolated terpenoids, polyphenols and other biologically active metabolites from *V. indica*.[30,31] *P. nigrum* is 'black pepper' or the 'King of spices'. It is used in traditional medicines in several countries, and its phytochemical composition and biological and spice potentials are well established.[32,33] *S. macrophylla* subsp. *rosea* (*S. racemosa*) is used in *Ayurveda* and Unani. Its phyto-pharmacology has been widely studied.[34]

Most Poaceae plants (commonly known as grasses) are used as green herbage, dried fodder, and cereal crops by animals and humans,[35] and in this study, the only two endemic Poaceae species of Western Ghats (listed in Table S1) *viz., Eriochrysis rangacharii* C.E.C.Fisch., *Ochlandra wightii* (Munro) C.E.C.Fisch., are registered for their use as fodder. Again, *Ardisia sonchifolia* Mez (*Primulaceae*) leaves are used as a food additive for livestock. *Strobilanthes integrifolia* (Dalzel) Kuntze (*Acanthaceae*) is known for its honey at Mahabaleshwar in Maharashtra. *Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb. (Bignoniaceae) leaves are traditionally used for treating maniacal cases, and *Elaeocarpus blascoi* Weibel (*Elaeocarpaceae*) is utilized for improving mental stability. Five endemic species, *viz., Andrographis stellulata* C.B. Clarke, *Tetrataenium grande* (Dalzell and A. Gibson) Manden., *Paphiopedilum druryi* (Bedd.) Stein, *Piper nigrum* L., and *Symplocos macrophylla* subsp. *rosea* (Bedd.) Noot. are used as aphrodisiacs by the native tribes. Again, a significant number of endemics are used for treatment of sexually transmitted diseases and as cooling agents (refreshing drink, regulate thirst and body temperature) (Table S1). Endemic plants are used as whole plants or as plant parts (roots, tubers, rhizomes, bark, leaves, flowers, pith, spines, fruits, seeds) or their combinations in a variety of forms (decoctions, powders, tinctures etc.) by the tribal

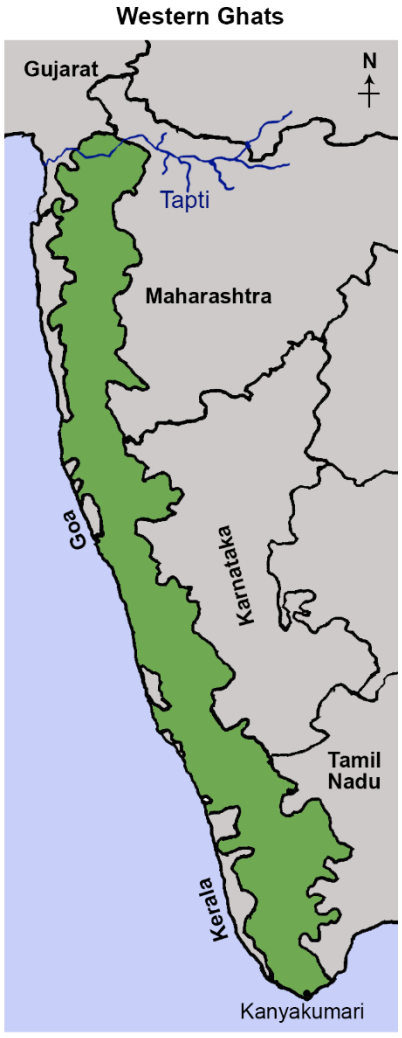

Figure 1: Study area of Western Ghats in India.

communities of Western Ghats. A few of these ethnomedical claims of Western Ghats endemics listed in Table S1 were subjected to phyto-pharmacological and nutritional studies, but most remain uninvestigated.

DISCUSSION

The number of endemic species in the Western Ghats is enumerated as 1,426. Of these, a total of 508 traditional uses of only 126 species (9.9%) are documented (Table S1, Figure 2). The most traditionally used categories are Food and Nutraceuticals (FN) 8.9%, Traditional, Folk Medicines (TFM) 8.1%, and General Health (GH) 6.5% (Table S1). This is a strong indication that the native tribal communities are using these endemic plant species for their primary needs of food, nutrition, and medicine. Our data further confirm the prevalence of major traditional systems, *viz.*, *Ayurveda*, Unani, Siddha, folk medicine, among the native tribals of Westen Ghats (Table S1).

Of the 7,402 species of flowering plants in Western Ghats only 19.3% are endemic, and only 126 (1.7%) are listed for their traditional uses. These limited number of plants used in traditional medicine are the outcome of the careful choices made by the native tribes based on their healing properties, availability (of the species or its useful parts), taste, smell and other parameters. For example, the Kani tribes of the southern Western Ghats are an ancient community living in the Agasthya Hills, where they coexist harmoniously with nature while preserving their indigenous wisdom and sustainable practices.[23,36] They have chosen these locally distributed endemic species for diverse purposes in their daily lives, *viz.*, for treatment of skin diseases, syphilis, peptic ulcer, cancer-like afflictions, nervous disorders, rheumatism, diabetes, headache, chickenpox, toothache, asthma, gastric complaints, digestive problems, giddiness, body pain, skin diseases, purification of blood, rejuvenating tonic, poisonous bites, and as mouth freshener and food. Traditional leads also provide insights on their toxicity, efficacy and safety.[37] Various plant parts of these promising species are used for preparing tinctures, powders, macerations, decoctions, teas, percolation products, infusions, inhalations and other medicinal preparations.[38]

These traditional medicines function through synergism of various constituents within their plant source(s).[39] It is crucial to isolate and characterize the active entities from the mix, and towards this recent advances in chromatography, spectroscopy and metabolomics are being used.[14,37,40] This approach could unravel biologically active entities, which could be used for drug development with improved pharmacological effects. Otherwise,

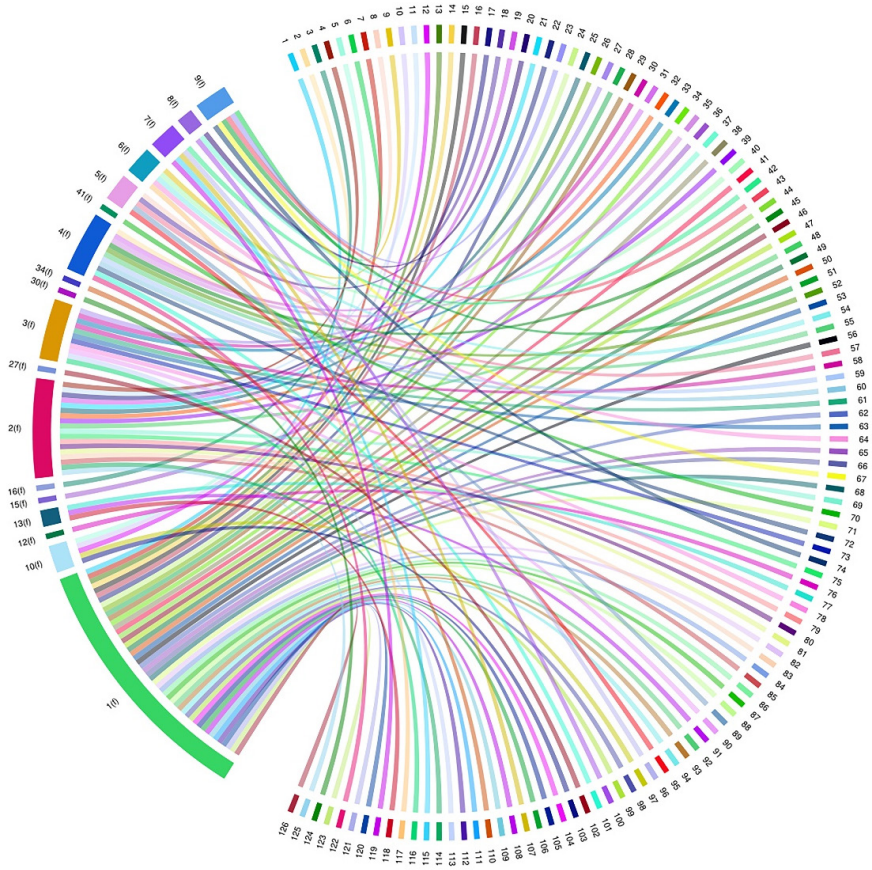

Figure 2: Chord diagram showing the ethnomedicinal uses of endemic plants of Western Ghats. Numbers 1-126 denote the plant species in the same sequence as listed in Table S1, and number(f) indicates the number of traditional uses of each of them.

Table 1: Disease categories and number of reports of traditional uses of endemic species of Western Ghats.

Sl. No.	Disease categories (Codes)	Number of reports	% reports
1	Abortion and Contraceptive (AC)	4	0.8
2	Aphrodisiacs (As)	6	1.2
3	Burns and Ulcers (BU)	16	3.1
4	Cancer (Cr)	5	1.0
5	Circulatory System/Cardiovascular Diseases (CSCD)	3	0.6
6	Cooling Agents (CA)	12	2.4
7	Dental Care (DC)	6	1.2
8	Dermatological Infections/Diseases (DID)	24	4.7
9	Digestive Problems (DP)	22	4.3
10	Diseases of Blood and Blood-forming Organs (DBBO)	17	3.3
11	Ear, Nose and Throat problems (ENT)	8	1.6
12	Eye Diseases (ED)	6	1.2
13	Flavours, Fragrances and Cosmetics (FFC)	7	1.4
14	Fever (Fr)	21	4.1
15	Food and Nutraceuticals (FN)	45	8.9
16	Gastro-Intestinal Ailments (GIA)	15	3.0
17	General Health (GH)	33	6.5
18	Genito-Urinary Ailments (GUA)	15	3.0
19	Gynaecological Disorders (GD)	1	0.2
20	Hair Care (HC)	3	0.6
21	Inflammation (In)	24	4.7
22	Kidney Problems (KP)	5	1.0
23	Liver Problems (LP)	11	2.2
24	Mental Disorders (MD)	2	0.4
25	Metabolic Disorders (MDs)	12	2.4
26	Microbial Infections (MI)	21	4.1
27	Miscellaneous (Ms)	8	1.6
28	Miscellaneous (unclassified) (Misc)	10	2.0
29	Neurological Disorders (ND)	6	1.2
30	Open Wounds and Injury (OWI)	11	2.2
31	Parasites (PS)	12	2.4
32	Poisonous Bites (PB)	16	3.1
33	Pregnancy and Postnatal Care (PPC)	2	0.4
34	Respiratory System Diseases (RSD)	16	3.1
35	Sexually Transmitted Diseases (STD)	8	1.6
36	Skeleto-Muscular System Disorders (SMSD)	28	5.5
37	Traditional, Folk Medicines (TFM)	41	8.1
38	Tuberculosis (Ts)	3	0.6
39	Tumour (Tr)	3	0.6
Total		508	100.0

the synergistic traditional drugs could be used as 'multi-target drugs' with proper profiling and toxicity evaluations.[9,39] Similarly, systematic studies on the edible tubers, roots, rhizomes, and fruits of endemic species in the Western Ghats could uncover new sources of food and nutritional additives.[5,41]

In our literature survey, we found only less than 20% of the ethnomedicinal attributes on endemic species in Western Ghats are subjected to systematic studies so far. In one such study, the stem extracts of *Jatropha maheshwarii* Subram. and M.P. Nayar demonstrated activity against human pathogenic bacteria and fungal strains, and this provided scientific basis for its ethnomedicinal use against skin diseases and oral infections.[42] Similarly, *Lindernia ciliata* subsp. *sivarajanii* Tandyekk. and N. Mohanan, which is traditionally used for jaundice and liver complaints, has been studied for its hepatoprotective activity.[43] *Mucuna* spp. are used for the treatment of Parkinson's disease and for its nutritional components.[44] Patil and co-workers (2015) found high content of the drug L-dopa in *Mucuna sanjappae* Aitawade and S.R. Yadav, and validated its ethnomedicinal traits.[45]

We conducted phytochemical studies on species such as *Alpinia smithiae* M. Sabu and Mangaly, *Humboldtia unijuga* Bedd. var. *unijuga*, and *Ophiorrhiza shendurunii* A.E.S. Khan, E.S.S. Kumar and Pusp., which led to the discovery of new bioactive molecules and essential oil sources.[46-48] Again, we found endemic *Ophiorrhiza* species as sources of the anticancer drug, camptothecin.[49,50] But most of the ethnomedicinal leads on endemics of Western Ghats are unverified by modern phytochemical-pharmacological means.

CONCLUSION

The ethnomedicinal assessment of endemics of Western Ghats highlights the interconnection between plants and human life. Crucially, so far only a very low percent of the endemic species of Western Ghats are documented for their ethnomedicinal uses. Again, most of these recorded traditional uses are not validated by systematic scientific studies. Recent advances in phytochemistry, pharmacology and metabolomics allow us to isolate and characterize plant-based metabolites, even in traces, and study their drug prospects. These time-tested leads could lead us towards the discovery of new drugs and food/nutritional additives. Moreover, this study brings the rest of the endemic species, with no reported traditional uses, into the limelight, and they are also possible repositories of drug precursors, nutritional additives, and cosmetics. This study urges systematic studies on the leads presented in the ethnomedicinal data on the endemics of Western Ghats. These traditional records also reiterate the need to conserve these endemic species and preserve the indigenous wisdom.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

GRS: Concept, investigation, design, methodology, literature search, data acquisition, data analysis, manuscript preparation, manuscript editing. **RKSR:** Design, methodology, literature search, data acquisition. **KCK:** Concept, design, methodology, manuscript preparation, manuscript editing. **SB:** Concept, investigation, design, methodology, data analysis, manuscript preparation, manuscript editing.

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