Estimating the burden of vitiligo: a systematic review and modelling study

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Summary

Background Vitiligo is a chronic autoimmune disease characterised by depigmented skin patches, which can pose substantial psychosocial challenges particularly in individuals with dark skin tones. Despite its impact on quality of life, there is an absence of standardised global epidemiological data. We sought to address this gap with the present study.

Methods In this study we did a systematic review and modelling analysis to estimate the global, regional, and national prevalence and incidence of vitiligo. We did a comprehensive search of nine digital libraries (PubMed, Embase, Web of Science, Scientific Electronic Library Online, KCI Korean Journal Database, Russian Science Citation Index, Western Pacific Region Index Medicus, Informit, and Health Research and Development Information Network) from inception up to May 25, 2023. We included cross-sectional or cohort studies reporting the incidence rate or prevalence of vitiligo, or data from which incidence rate or prevalence could be calculated, in the general population of a country or area of a country. Summary estimate data were extracted. A main outcome was to estimate the worldwide, regional, and country-specific lifetime prevalence of vitiligo diagnosed by physicians or dermatologists among the general population and in adults and children (as per age groups defined in included studies). We used a Bayesian hierarchical linear mixed model to estimate prevalence, and calculated number of affected individuals using the UN population structure in 2022. In estimating lifetime prevalence, studies reporting point or period prevalence were excluded. Our other main outcome was to estimate incidence rates of vitiligo, but due to a small number of studies, the data on incidence were presented in a descriptive summary. This study was registered on PROSPERO, CRD42023390433.

Findings Our search identified 22 192 records, of which 90 studies met our inclusion criteria. Of these studies, six focused on the incidence of vitiligo, 79 reported on the prevalence of vitiligo, and five provided data on both incidence and prevalence. 71 studies reported on lifetime prevalence. In the most recent years studied, incidence rates in the general population ranged from 24·7 cases (95% CI 24·3–25·2) per 100 000 person-years in South Korea in 2019, to 61·0 cases (60·6–61·4) in the USA in 2017. In individual studies, incidence rates showed an increasing trend over the periods studied. The global lifetime prevalence of vitiligo diagnosed by a physician or dermatologist was estimated at 0·36% (95% credible interval [CrI] 0·24–0·54) in the general population (28·5 million people [95% CrI 18·9–42·6]), 0·67% (0·43–1·07) in the adult population (37·1 million adults [23·9–58·9]), and 0·24% (0·16–0·37) in the child population (5·8 million children [3·8–8·9]). Vitiligo prevalence was higher in adults than in children across all regions. Central Europe and south Asia reported the highest prevalence (0·52% [0·28–1·07] and 0·52% [0·33–0·82], respectively, in the general population).

Interpretation This study highlights the need for standardised epidemiological data collection globally to inform public health policies and improve vitiligo diagnosis and management. Emphasis on the impact on individuals with darker skin tones is crucial to reducing stigma and improving quality of life. Furthermore, our study highlights the need to conduct more research in regions and populations that have been historically under-represented, to effectively address the worldwide burden of vitiligo.

Funding None.

Introduction

Vitiligo is a chronic autoimmune disease characterised by depigmented white patches on the skin caused by the depletion of melanocytes.[1,2] The resulting depigmentation can be traumatic, especially when it involves the face, hands, and genitals, and particularly among people with dark skin tones, leading to a substantial emotional and psychosocial burden for patients with vitiligo.[3]

At present, epidemiological data on vitiligo are limited to specific areas globally, and data collection is not standardised. Most studies are concentrated in Europe, south Asia, and regions of the USA, necessitating a

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Research in context

Evidence before this study

We systematically searched nine electronic databases (PubMed, Embase, Web of Science, Scientific Electronic Library Online, KCI Korean Journal Database, Russian Science Citation Index, Western Pacific Region Index Medicus, Informit, and Health Research and Development Information Network) from inception until May 25, 2023. No language restriction was applied. The search terms used were: "vitiligo", "prevalence", "epidemiology", "incidence", and "population-based study". Our search indicated that the prevalence of vitiligo is not well studied, and no published data on a worldwide or regional level were available. In addition, there is no standardisation of data collection. In 2023, the International League of Dermatological Societies and WHO called for improved understanding of the epidemiology of vitiligo.

Added value of this study

To our knowledge, our systematic review and modelling study provide the first global, regional, and country-specific estimates of vitiligo prevalence, incorporating data from 32 countries. Our study also provides a descriptive synthesis of recent studies reporting incidence rates of vitiligo on a global scale. This systematic review emphasised the low availability of epidemiological data on the incidence and prevalence of vitiligo. Our study also found a discrepancy in prevalence when based on self-report versus physician or dermatologist report, with markedly higher prevalence estimated from self-report. The results highlight a need to improve the quality and increase the amount of data on the epidemiology of vitiligo.

Implications of all the available evidence

Estimation of global, regional, and national prevalence and incidence is important to develop adequate public health policies. With these data, we can understand the extent of vitiligo across various populations and regions, allowing health policy makers to allocate resources and initiate plans to ensure that individuals in high prevalence areas can receive adequate support. This knowledge is also pivotal for developing targeted interventions, providing effective patient support, and promoting health equity. Moreover, tracking the global prevalence and incidence of vitiligo provides valuable insights into disease pathogenesis, and might aid the implementation of preventive measures, particularly in regard to environmental interventions. Finally, understanding the global impact of a disease elevates public awareness and can drive policy changes and funding priorities, both at national and international levels.

centralised global resource for vitiligo's epidemiological data. Thus, a comprehensive and up-to-date estimation of the prevalence of vitiligo is crucial for cross-population assessment and for understanding the global burden of the disease.

Integration and estimation of global, regional, and national prevalence and incidence is important with regard to public health responses. Vitiligo, often under-represented in public health discourse, deserves attention due to its impact on individuals and communities. The Global Vitiligo Atlas aims to raise awareness about vitiligo and its socio-environmental determinants, and foster informed strategies for health-care professionals and policy makers. This knowledge is pivotal for developing targeted interventions, providing effective patient support, and promoting health equity. With comprehensive epidemiological data, we can understand the extent of vitiligo across various populations and regions, allowing health policies to allocate resources and plans to ensure the patients in high prevalence areas can receive adequate support. Furthermore, tracking global prevalence and incidence provides valuable insights into disease pathogenesis and might allow for the implementation of preventive measures, in particular with regard to environmental interventions. Finally, understanding the global impact of the disease can elevate public awareness and drive policy changes and funding priorities, both at national and international levels.

In this paper, we aimed to estimate the prevalence and incidence of vitiligo across diverse populations through a systematic review and modelling study. We present modelled estimates of prevalence at the global, regional, and national levels, for the overall general population, and in adults and children. Although modelling of vitiligo incidence rates was planned, the number of studies was insufficient and we thus provide a descriptive summary of incidence rates.

Methods

Search strategy and selection criteria

The systematic review adhered to the PRISMA and GATHER guidelines. A comprehensive search was done to identify relevant studies reporting the prevalence or incidence rate of vitiligo. We systematically searched nine electronic databases (PubMed, Embase, Web of Science, Scientific Electronic Library Online, KCI Korean Journal Database, Russian Science Citation Index, Western Pacific Region Index Medicus, Informit, and Health Research and Development Information Network) from inception until May 25, 2023. No language restriction was applied. The search terms used were: "vitiligo", "prevalence", "epidemiology", "incidence", and "population-based study".

Two independent reviewers (HJJ and JYK) screened the titles and abstracts of the identified studies for potential inclusion. Studies were included if they reported the prevalence or incidence rate of vitiligo or data from which incidence rate or prevalence could be calculated in a representative population of a country or area of a country from cross-sectional or cohort studies. Studies

regarding other diseases but reporting epidemiological data on vitiligo were also included. We excluded non-human studies, studies in populations other than the general population (ie, population from dermatology clinics or specific subgroups), and studies that did not provide sufficient information to calculate prevalence or incidence rate. Articles in foreign languages were translated and study authors were contacted by email when information was unclear. Trial registries and unpublished studies were not included. Summary estimates were extracted.

Full-text evaluation was done by three authors (JJJ, Y-WH, and SL). Eligible papers were critically appraised, and those meeting inclusion criteria were selected for data extraction.

Data extraction and quality assessment

The following information was extracted from each included study: study characteristics (author, year, country), study design, population characteristics (age, sex, ethnicity), sample size (when available), method of diagnosis (physician, dermatologist, or self-reported), prevalence or incidence rate of vitiligo (or both; as the number of vitiligo cases, total population, and person-time data, when available), and any relevant additional findings. At least two among three authors (JJJ, Y-WH, and SL) reached consensus on the estimates in case of disagreement.

All included studies were assessed for risk of bias with the Appraisal tool for Cross-Sectional Studies (AXIS).[4] The tool comprises 20 items pertaining to the identification of research aims, appropriateness of study design, use of valid measures and statistical analyses and consideration of bias, relevant for both cross-sectional and cohort studies included in this systematic review. Questions in the AXIS tool assessment are shown in the appendix (pp 41–42). Studies were classified as having high, medium, or low risk of bias or unclear (if there was insufficient information) according to the overall quality of the study design, methods, and reporting of the results.

Data analysis

A main outcome was to estimate the worldwide, regional, and national lifetime prevalence of vitiligo diagnosed by physicians or dermatologists among the general population. A preplanned secondary outcome was to estimate self-reported lifetime prevalence. In estimating lifetime prevalence, studies reporting point or period prevalence were excluded; and in estimating point or period prevalence, studies reporting on lifetime prevalence were excluded.

We also intended to estimate incidence rates of vitiligo at the global, regional, and national levels as a main outcome. However, due to a small pool of studies providing data on the incidence rate of vitiligo, a descriptive summary was employed. Incidence rates per 100 000 person-years are presented. We directly extracted the incidence rate and 95% CI from the primary source. In studies in which the 95% CI was not available, we used the substitution method to estimate the 95% CI, using data on the number of vitiligo events and person-years. In cases in which these data were absent, 95% CIs were not shown. In cases in which numerical data could not be directly extracted from the study, datapoints were manually extracted from plots. The results are presented by country, age group (children, adults, or all ages), and sex (male and female) for the years that were studied, as reported or calculated from the studies. The age ranges for children and adults were as defined in the original studies. Incidence rates for individual years of study and the trends in incidence rates over time are reported when the data were available. When feasible, we examined variability in vitiligo incidence rates within each country and by specific age groups over the years studied. Similar descriptive summaries of prevalence of vitiligo as reported or calculated from original studies were presented. Although our protocol outlined that trends in prevalence over time were to be explored, such data were unavailable from the literature review.

We used a Bayesian hierarchical linear mixed model to calculate global, regional, and national prevalence of vitiligo (appendix p 2). In the Bayesian hierarchical model, estimates of vitiligo prevalence were informed by study data from the same country, if available, as well as study data from other countries. A concise description of the model is provided herein and more detailed information is provided in the appendix (p 2).

The outcome variable used in the model was the log-transformed prevalence of vitiligo. This transformation facilitated the use of a linear model and ensured predictions within the range of 0–100% when back-transformed. We categorised countries on the basis of the Global Burden of Disease classification: a total of 189 countries were nested within 21 regions, and these regions were further nested within seven super-regions (appendix p 7), following a hierarchical structure that is mainly based on geography and income. Substantial heterogeneity in the global prevalence of vitiligo was expected due to various factors, such as different age strata distributions, diagnostic methods (physician, dermatologist, or self-reported), and types of prevalence estimates (point, period, or lifetime prevalence). Therefore, the hierarchical model consisted of four levels (global, super-regions, regions, and countries) with four random intercepts and three fixed covariates: age strata, diagnostic method, and type of prevalence measure. Age strata included children, adults, or the overall population (children and adults combined). Although we also collected sex-stratified prevalence data from individual studies if available, the data were insufficient for a quantitative synthesis; therefore, we presented them descriptively.

To plan for studies that used the same data resource, a filtering process was developed for the inclusion of

See Online for appendix

studies in the statistical model. We planned to select for studies with the most recent data on the variable of interest, followed by those with the most complete data on the variable, followed by those with the most robust methods per the AXIS assessment. Specifically, South Korea is a country where health-care use information for the entire population can be analysed for research purposes (via the National Health Information Database),[5] and a number of studies have been reported that used these data. Three such studies were identified in our review (appendix pp 29–30). Due to overlapping data among these studies, direct access to the database was sought to update with the most recent data to prevent duplication, whereby we calculated the number of patients who visited a medical institution for vitiligo (International Classification of Diseases, 10th Revision, code L80) at least once during the years covered by the studies (from Jan 1, 2003, to Dec 31, 2019), and included them in the analysis. This assessment was done under study approval by the Korean National Institute for Bioethics Policy (approval number NHIS-2021-1-143). Studies from South Korea that did not use this database were included in the analysis as independent datapoints.

Geographical clustering was incorporated in the model to generate estimates for countries with missing information. In such cases, the model relied on borrowed evidence from higher levels. For example, if no country-specific data were available, the estimate for the region was used, and if no data were available within a region, the estimate for the super-region was used. Of note, regional and super-regional estimates were always obtained from studies at the country level; therefore, no studies were conducted at the regional or super-regional levels. Super-region estimates differ from the region estimate for super-regions that include only one region as the estimate for the super-region was a preliminary value to derive the estimate for region.

The statistical model was fitted with use of Bayesian inference, sampling from the posterior distribution of parameters with the Hamiltonian Markov chain Monte Carlo method. The model was run with four chains of 2000 iterations each. Posterior predictions were made for each country and age strata combination, providing prevalence estimates as a proportion with 95% credible intervals (CrIs). To estimate the number of individuals affected by vitiligo in each country, the country-specific prevalence estimate was multiplied by the population size, with use of the UN population structure for the year 2022.

For the **UN population data** see https://population.un.org/wpp/Download/Standard/Population/

Model fit was assessed by evaluating measures related to effective sample size, autocorrelation, and trace plots (appendix p 3). With fixed effects, the overall (all ages) population and adult population had increased prevalence compared with children. Self-reported diagnosis yielded increased prevalence compared with physician-diagnosed vitiligo, and lifetime prevalence was higher than point or period prevalence.

All analyses were done with R (version 3.6.1) and the RStanArm package (version 2.21.4), which relied on Stan for the Bayesian modelling approach.

This study was registered on PROSPERO, CRD42023390433.

Role of the funding source

There was no funding source for this study.

Results

We retrieved 22 192 records through our comprehensive database search. Among these, 123 full-text articles were critically appraised and assessed to establish their eligibility. Of these papers, 90 reported on the incidence rate or prevalence of vitiligo in the general population, or provided data from which incidence rate or prevalence could be calculated, and were included in our systematic review. Six studies focused on the incidence of vitiligo, 79 studies reported on the prevalence of vitiligo, and five studies provided data on both incidence and prevalence (appendix p 4).

The 11 studies that examined the incidence rate of vitiligo in the general population were conducted in South Korea (five studies), the USA (four studies), and the UK (two studies),[6–16] with data spanning from the year 2000 to 2019 (table, appendix pp 8–10). Ten (91%) of the included studies reported low risk of bias (appendix pp 8–10, 37–42). Among these studies, eight reported the incidence rate of vitiligo for the overall general population (all ages). In the most recent years of study, rates ranged from 24·7 cases (95% CI 24·3–25·2) per 100 000 person-years in South Korea (in 2019)[8] to 61·0 cases (60·6–61·4) per 100 000 person-years in the USA (in 2017).[6] Another study in the USA reported an incidence rate of 22·6 cases (21·5–23·8) per 100 000 person-years for the period 2015–19.[9] Studies reporting incidence rates over consecutive years showed an increasing trend in the incidence rate of vitiligo in the overall general population during the period of study. The most recent study by Kang and Lee[8] reported an increase in the incidence rate of vitiligo in South Korea from 10·5 cases (95% CI 10·2–10·7) per 100 000 person-years in 2003 to 24·7 cases (24·3–25·2) per 100 000 person-years in 2019. Ray and colleagues[6] also reported an increase in the incidence rate of vitiligo in the USA, from 7·0 cases (6·9–7·2) per 100 000 person-years in 2013 to 61·0 cases (60·6–61·4) per 100 000 person-years in 2017.

Three studies investigated the incidence rate of vitiligo in the child population, in South Korea (one study) and the USA (two studies; table). One study from the USA reported an incidence rate of 20·8 cases (95% CI 18·5–23·4) per 100 000 person-years in children, and 23·3 cases (22·1–24·6) per 100 000 person-years in adults for the period 2015–19.[9] The other study from the USA documented an incidence rate of 46·0 cases (45·3–46·8) per 100 000 person-years in children compared with 65·0 cases (64·5–65·5) per 100 000 person-years in adults

in the most recent year of study (2017).[6] Overall, slightly lower rates were observed in children than in adults. However, a range of incidence rates were reported: from 46·0 cases (45·3–46·8) per 100 000 person-years (in 2017, USA[6]) to 50·7 cases (48·9–52·5) per 100 000 person-years (in 2018, South Korea[7]) in children; and 21·5 cases (21·2–21·7) per 100 000 person-years (in 2005–08, South Korea[12]) to 65·0 cases (64·5–65·5) per 100 000 person-years (in 2017, USA[6]) in adults.

We evaluated incidence rates according to specific age groups reported in individual studies (appendix pp 115–120). In the USA (2015–19),[9] among the adult population, the highest incidence rates occurred in adults in their 30s, 40s, 50s, and 60s (ranging between 24·7 cases [95% CI 21·4–28·2) and 25·3 cases (95% CI 22·2–28·6) per 100 000 person-years). In South Korea, incidence rates were highest in the youngest (age <20 years) and oldest (≥50 years) age groups from 2005 to 2019.[8] Specific child age groups were also reported in the US study,[9] with data showing the incidence rate of vitiligo to be similar across age groups, ranging from 20·2 cases (17·2–23·5) per 100 000 person-years in children aged 0–9 years to 21·9 cases (18·3–26·0) per 100 000 person-years in those aged 10–17 years, during 2015–19.

The incidence rate of vitiligo was similar between sexes in most of the studies. For example, for the overall general population, Mastacouris and colleagues reported an incidence rate of 21·9 cases (20·5–23·4) per 100 000 person-years for the female population and 23·4 cases (21·7–25·3) per 100 000 person-years for the male population (2015–19, USA).[9] Similarly, Kang and Lee reported an incidence rate of 27·5 cases (26·9–28·2) per 100 000 person-years for the female population and

	Diagnostic method	Age of population, years	Number with vitiligo	Incidence rate per 100 000 person-years (95% CI)		
				Total population	Female population	Male population
Children						
Lim et al (2022),[7] South Korea						
2010–18	Physician	0–12	27 864	50·3 (49·7–50·8)*	50·6 (49·8–51·4)*	50·1 (49·3–50·9)*
2010	..	..	2781	45·6 (43·9–47·3)*	44·4 (42·0–46·9)*	46·7 (44·3–49·2)*
2011	..	..	2805	46·0 (44·3–47·7)*	47·3 (44·9–49·9)*	44·7 (42·4–47·1)*
2012	..	..	2849	46·7 (45·0–48·5)*	47·1 (44·7–49·6)*	46·3 (44·0–48·7)*
2013	..	..	2863	47·0 (45·3–48·8)*	48·3 (45·8–50·9)*	45·6 (43·3–48·0)*
2014	..	..	3323	54·5 (52·7–56·4)*	56·0 (53·3–58·8)*	53·0 (50·5–55·6)*
2015	..	..	3123	51·2 (49·4–53·0)*	52·0 (49·4–54·7)*	50·5 (48·1–53·0)*
2016	..	..	3486	57·1 (55·2–59·0)*	57·7 (55·0–60·5)*	56·6 (54·0–59·3)*
2017	..	..	3543	58·1 (56·2–60·1)*	58·0 (55·3–60·8)*	58·2 (55·6–60·9)*
2018	..	..	3091	50·7 (48·9–52·5)*	49·2 (46·7–51·8)*	52·0 (49·5–54·6)*
Ray et al (2023),[6] USA						
2013	Physician	<18	1592	6·0 (5·7–6·3)*	NA	NA
2014	..	..	2252	9·0 (8·6–9·4)*	NA	NA
2015	..	..	7369	27·0 (26·4–27·6)*	NA	NA
2016	..	..	13 540	49·0 (48·2–49·8)*	NA	NA
2017	..	..	14 869	46·0 (45·3–46·8)*	NA	NA
Mastacouris et al (2023),[9] USA						
2015–19	Physician	0–17	293	20·8 (18·5–23·4)*†	NA	NA
Adults						
Lee et al (2020),[11] South Korea						
2009–12	Physician	≥20	22 811	22·7 (22·4–23)‡	27·7 (27·3–28·2)*	17·8 (17·4–18·2)*
Lee and Kim (2021),[12] South Korea						
2005–08	Physician	≥20	29 196	21·5 (21·2–21·7)‡	26·6 (26·2–27·1)*	17·0 (16·7–17·3)*
Ray et al (2023),[6] USA						
2013	Physician	≥18	6727	7·0 (6·8–7·2)*	NA	NA
2014	..	..	9644	11·0 (10·8–11·2)*	NA	NA
2015	..	..	32 571	33·0 (32·6–33·4)*	NA	NA
2016	..	..	65 294	65·0 (64·5–65·5)*	NA	NA
2017	..	..	70 952	65·0 (64·5–65·5)*	NA	NA
Mastacouris et al (2023),[9] USA						
2015–19	Physician	≥18	1312	23·3 (22·1–24·6)*†	NA	NA

(Table continues on next page)

	Diagnostic method	Age of population, years	Number with vitiligo	Incidence rate per 100 000 person-years (95% CI)		
				Total population	Female population	Male population
(Continued from previous page)						
All ages						
Dunlap et al (2017),[15] USA						
2000–12	Physician	NA	271	NA	32·4 (28·7–36·5)*	NA
Gandhi et al (2022),[14] USA						
2013	Physician	NA	NA	7·0*	NA	NA
2014	..	..	..	10·0*	NA	NA
2015	..	..	..	32·0*	NA	NA
2016	..	..	..	62·0*	NA	NA
2017	..	..	..	61·0*	NA	NA
Subramanian et al (2021),[16] UK						
2006–16	Physician	NA	4965	22·5 (21·9–23·1)‡	NA	NA
Lee et al (2023),[10] South Korea						
2006	Physician	0–89	10 673	20·5 (20·1–20·9)*†	NA	NA
2007	..	..	11 472	22·3 (21·9–22·7)*†	NA	NA
2008	..	..	11 600	23·4 (23·0–23·8)*†	NA	NA
2009	..	..	12 154	23·5 (23·1–23·9)*†	NA	NA
2010	..	..	12 169	24·4 (24·0–24·8)*†	NA	NA
2011	..	..	12 599	24·3 (23·9–24·7)*†	NA	NA
2012	..	..	13 013	25·0 (24·6–25·4)*†	NA	NA
2013	..	..	14 028	25·5 (25·1–25·9)*†	NA	NA
2014	..	..	13 461	27·4 (26·9–27·9)*†	NA	NA
2015	..	..	9713	26·2 (25·7–26·7)*†	NA	NA
Conrad et al (2023),[13] UK						
2000–19	Physician	NA	27 638	NA	NA	NA
2000–02	..	..	NA	13·6*	NA	NA
2000	..	..	NA	NA	12·7§	10·6§
2001	..	..	NA	NA	15·5§	12·9§
2002	..	..	NA	NA	15·8§	13·3§
2003	..	..	NA	NA	20·2§	16·2§
2004	..	..	NA	NA	20·3§	14·7§
2005	..	..	NA	NA	21·0§	17·1§
2006	..	..	NA	NA	19·5§	16·8§
2007	..	..	NA	NA	17·4§	16·3§
2008	..	..	NA	NA	19·7§	17·1§
2009	..	..	NA	NA	21·4§	20·5§
2010	..	..	NA	NA	20·7§	17·6§
2011	..	..	NA	NA	18·7§	16·4§
2012	..	..	NA	NA	17·6§	16·5§
2013	..	..	NA	NA	19·7§	19·0§
2014	..	..	NA	NA	19·5§	18·1§
2015	..	..	NA	NA	19·1§	16·5§
2016	..	..	NA	NA	20·0§	18·3§
2017	..	..	NA	NA	19·9§	17·8§
2018	..	..	NA	NA	20·4§	18·0§
2019	..	..	NA	NA	14·6§	15·7§
2017–19	..	..	NA	18·4*	NA	NA

(Table continues on next page)

	Diagnostic method	Age of population, years	Number with vitiligo	Incidence rate per 100 000 person-years (95% CI)		
				Total population	Female population	Male population
(Continued from previous page)						
Ray et al (2023),[6] USA						
2013	Physician	NA	8319	7·0 (6·9–7·2)*	NA	NA
2014	..	..	11 896	10·0 (9·8–10·2)*	NA	NA
2015	..	..	39 940	32·0 (31·7–32·3)*	NA	NA
2016	..	..	78 834	62·0 (61·6–62·4)*	NA	NA
2017	..	..	85 821	61·0 (60·6–61·4)*	NA	NA
Kang and Lee (2023),[8] South Korea						
2003	Physician	NA	5006	10·5 (10·2–10·7)*	11·7 (11·3–12·2)*	9·2 (8·8–9·6)*
2004	..	..	6765	14·1 (13·7–14·4)*	16·0 (15·5–16·6)*	12·1 (11·7–12·6)*
2005	..	..	8278	17·2 (16·8–17·6)*	19·3 (18·8–19·9)*	15·1 (14·6–15·6)*
2006	..	..	8620	17·8 (17·4–18·2)*	20·1 (19·5–20·7)*	15·5 (15·0–16·0)*
2007	..	..	9297	19·1 (18·7–19·5)*	21·6 (21·0–22·2)*	16·6 (16·1–17·2)*
2008	..	..	9961	20·3 (19·9–20·7)*	22·7 (22·1–23·3)*	18·0 (17·4–18·5)*
2009	..	..	10 024	20·3 (19·9–20·7)*	22·4 (21·8–23·0)*	18·3 (17·8–18·9)*
2010	..	..	10 420	21·0 (20·6–21·4)*	23·5 (22·9–24·1)*	18·5 (18·0–19·1)*
2011	..	..	10 474	21·0 (20·6–21·4)*	23·7 (23·1–24·3)*	18·3 (17·7–18·8)*
2012	..	..	10 616	21·2 (20·8–21·6)*	23·6 (23·0–24·3)*	18·7 (18·1–19·2)*
2013	..	..	10 910	21·6 (21·2–22·0)*	24·5 (23·9–25·1)*	18·8 (18·2–19·3)*
2014	..	..	11 541	22·7 (22·3–23·2)*	25·6 (25·0–26·2)*	19·9 (19·4–20·5)*
2015	..	..	10 892	21·4 (21·0–21·8)*	23·8 (23·2–24·4)*	18·9 (18·4–19·4)*
2016	..	..	12 600	24·6 (24·2–25·0)*	28·1 (27·4–28·7)*	21·2 (20·6–21·7)*
2017	..	..	12 871	25·1 (24·6–25·5)*	28·4 (27·8–29·1)*	21·7 (21·2–22·3)*
2018	..	..	12 188	23·6 (23·2–24·1)*	26·4 (25·8–27·0)*	20·9 (20·3–21·4)*
2019	..	..	12 801	24·7 (24·3–25·2)*	27·5 (26·9–28·2)*	22·0 (21·4–22·5)*
Mastacouris et al (2023),[9] USA						
2015–19	Physician	NA	1605	22·6 (21·5–23·8)*†	21·9 (20·5–23·4)*†	23·4 (21·7–25·3)*†

Incidence rates are applicable to the years of study as shown. The diagnostic method and age range are provided in the first row of data for each study. NA=not available. *Values reported from the study; 95% CIs not shown in cases where 95% CIs were not directly reported and values for the substitution method (eg, person-years) were unavailable. †Adjusted for age or sex, or both, in the original source. ‡Incidence rates and 95% CIs were calculated using a numerator (number of events) and denominator (total person-years). §Datapoints were manually extracted from a plot because the paper did not report incidence rates directly.

Table: **List of studies providing incidence rates in children, adults, and the overall population**

22·0 cases (21·4–22·5) per 100 000 person years for the male population (2019, South Korea;[8] table).

The 84 studies that reported on the prevalence of vitiligo in the general population were identified across 21 regions worldwide, with data spanning from the year 1971 to 2020 (appendix pp 11–27). No studies were excluded on the basis of duplicate data. Data from three studies originating from South Korea were directly extracted from the National Health Information Database and were treated as a single dataset (appendix pp 29–30). Thus, our statistical analysis included 82 independent datasets, derived from 32 (17%) of 189 countries globally, (figure 1). 71 studies (corresponding to 69 datasets) reported on lifetime prevalence and 13 studies (13 datasets) reported on point or period prevalence. The majority of studies included in the statistical analysis were categorised as having a low to medium risk of bias (77 [92%] of 84; appendix pp 11–27, 37–42). Tables in the appendix (pp 28–36) present the prevalence of vitiligo within each age group and by sex, categorised by diagnostic method (physician or dermatologist diagnoses or self-reported lifetime prevalence), as reported or calculated from the studies. We observed no sex predilection.

The worldwide lifetime prevalence of vitiligo diagnosed by a physician or dermatologist was estimated at 0·36% (95% CrI 0·24–0·54) in the general population, affecting an estimated 28·5 million people (95% CrI 18·9–42·6) worldwide. The estimated lifetime prevalence was 0·67% (0·43–1·07) in the adult population (37·1 million adults [23·9–58·9]) and 0·24% (0·16–0·37) in the child population (5·8 million children [3·8–8·9]). In terms of regional distribution, the estimated lifetime prevalence of vitiligo among the general population showed variations, ranging from 0·23% (0·14–0·38) in east Asia, to 0·52% (0·33–0·82) in south Asia and 0·52% (0·28–1·07) in central Europe (figure 2, appendix pp 43–54). Notably, we observed substantial disparities in

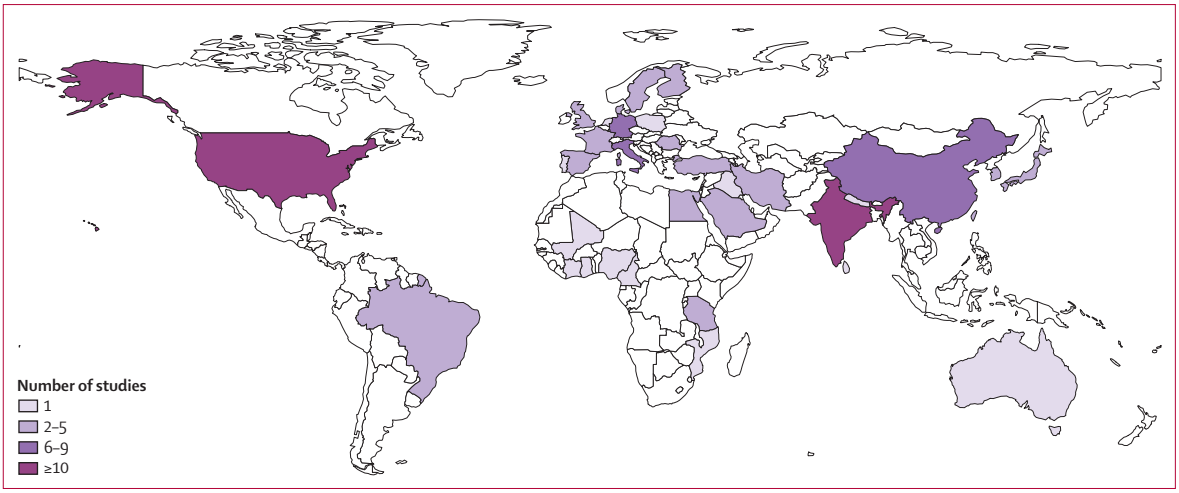

Figure 1: **Distribution of studies included in the analysis of vitiligo prevalence**

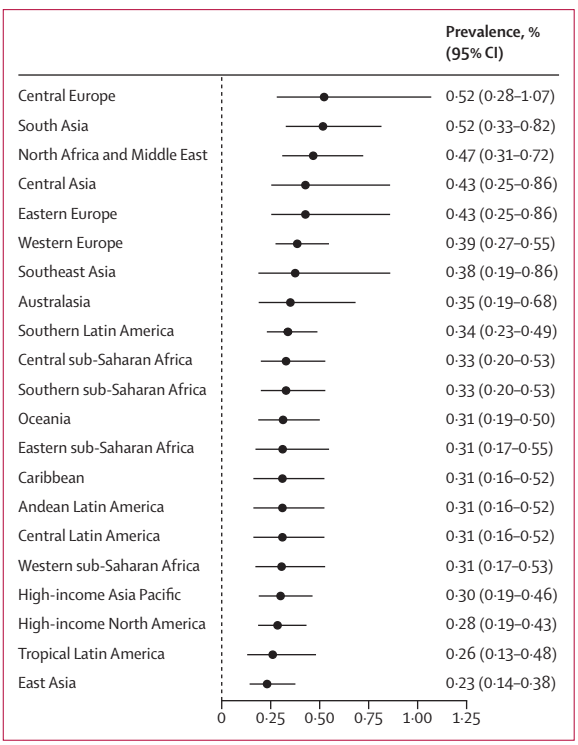

Figure 2: **Physician-diagnosed or dermatologist-diagnosed lifetime prevalence of vitiligo for the general population (all ages), by world region**
The error bars indicate 95% credible intervals. The regions for which data were extrapolated from super-region estimates were central Asia, eastern Europe, southern Latin America, Andean Latin America, the Caribbean, central Latin America, Oceania, central sub-Saharan Africa, and southern sub-Saharan Africa. Prevalence estimates by age groups and different diagnostic methods at the regional and national levels are presented in the appendix (appendix pp 5–6, 43–114).

the country-specific lifetime prevalence of vitiligo (figure 3). For the overall general population estimate, Romania (0·54% [0·29–1·11]), Poland (0·53% [0·28–1·11]), Nepal (0·53% [0·32–0·90]), and India (0·53% [0·36–0·81]) had the highest prevalence of vitiligo. Meanwhile, the estimated prevalence of vitiligo in countries from east Asia was considerably lower, with Taiwan and China having the lowest estimate worldwide (0·22% [0·13–0·36] and 0·22 (0·14–0·35), respectively; appendix pp 43–54).

The estimated lifetime prevalence of physician-diagnosed or dermatologist-diagnosed vitiligo was higher in adults than in children across all regions (appendix pp 5–6). In adults, the prevalence estimates varied from 0·43% (0·26–0·72) in east Asia to 0·98% (0·51–2·08) in central Europe (appendix pp 55–66). Among children, the prevalence of vitiligo varied from 0·16% (0·09–0·26) in east Asia to 0·35% (0·22–0·55) in south Asia and 0·35% (0·18–0·75) in central Europe (appendix pp 67–78).

Several factors such as the type of diagnostic method (self-reported or diagnosis by a physician or dermatologist) and the type of prevalence estimate (period, point, or lifetime prevalence) could have contributed to the heterogeneity in the prevalence estimates for vitiligo. The worldwide self-reported lifetime prevalence of vitiligo was estimated to be 0·55% (95% CrI 0·33–0·92) in the general population (43·6 million people [95% CrI 26·2–73·0]), 1·03% (0·62–1·69) in adults (56·8 million adults [34·2–93·5]), and 0·37 (0·22–0·63) in children (8·9 million children [5·2–15·2]). These estimates were notably higher than those based on physician or dermatologist report. Self-reported lifetime prevalence estimates for the 21 regions and 189 countries for the general population, adults, and children are presented in the appendix (pp 79–114).

Discussion

Our study provides a comprehensive and up-to-date evaluation of the global prevalence and incidence of vitiligo on the basis of available studies to date. In modelling analysis, we estimated the overall global

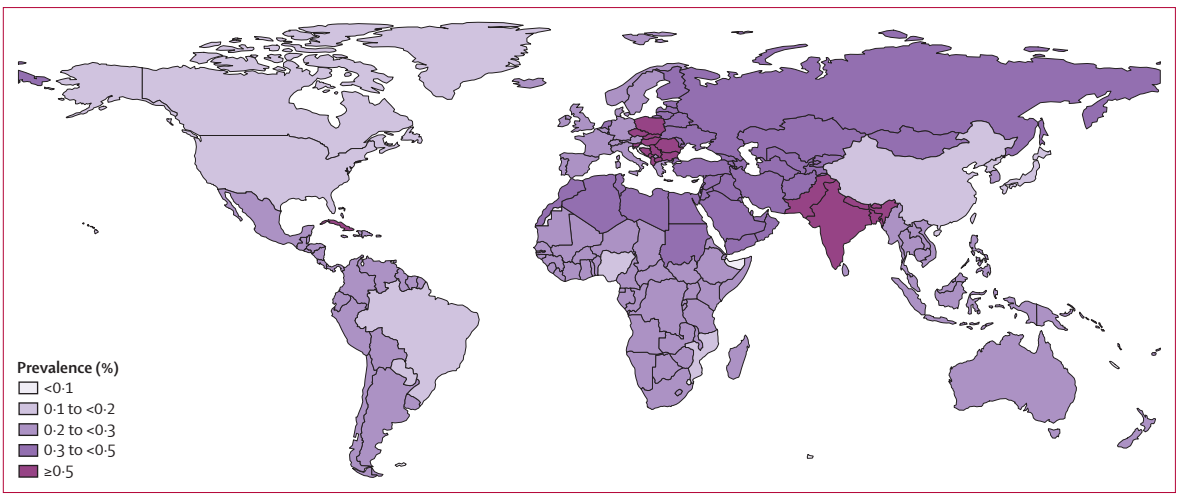

Figure 3: **Physician-diagnosed or dermatologist-diagnosed lifetime prevalence of vitiligo for the general population (all ages), by country**
Details about countries with observed or extrapolated data are given in the appendix (pp 43–114).

lifetime prevalence of vitiligo to be 0·36% (95% CrI 0·24–0·54), affecting an estimated 28·5 million people (95% CrI 18·9–42·6) worldwide. The highest lifetime prevalence was reported in central Europe and south Asia. Self-reported lifetime prevalence revealed that 43·6 million people (26·2–73·0) were affected, with a prevalence of 0·55% (0·33–0·92), indicating that many patients with vitiligo might be unable or unwilling to seek management or are not being diagnosed properly. Vitiligo was more prevalent in adults than in children. Based on descriptive summaries, we observed similar prevalence between males and females.

This systematic review used the same methodology and modelling to that of the Global Psoriasis Atlas,[17] and emphasises the limited accessibility of epidemiological data on the incidence of vitiligo. To date, large-scale epidemiological studies have only been conducted in east Asia, North America, and Europe. A discrepancy in the number of studies across regions was also observed, with most of the prevalence and incidence data available for vitiligo originating from European nations, Asia, and the USA.

Countries situated in the central European region were estimated to have a higher prevalence of vitiligo compared with other countries and regions. Several factors could explain this observed pattern. The disparity might arise from the health-care systems, increased awareness of the disease, and easier access to health-care systems in high-income countries (HICs) compared with low-income and middle-income countries (LMICs). In addition, data quality is more accurate and complete, as studies from these countries often rely on large population-based and nationally representative electronic health record databases. Furthermore, the ratio of dermatologists to patients is high in European countries,[18] hence increased patient contact and disease detection. Meanwhile, vitiligo is often not tracked by registries and the ratio of dermatologists to patients is lower in LMICs[19,20] than in HICs, which might lead to underestimation of vitiligo prevalence.

Another region with a high overall prevalence was south Asia, which comprises India, Bangladesh, Nepal, Pakistan, and Bhutan. One possible reason is that vitiligo is more visible in individuals with dark skin tone, for whom the contrast between unaffected skin and vitiligo patches is stark.[21] Increased awareness and need for active treatment in such areas could lead to heightened detection of vitiligo. Variation in the prevalence of vitiligo has been reported in large countries such as India[22,23] and one hypothesis is that the variation is attributable to pollution and chemical exposure. Thus, the pathophysiology of vitiligo is complex, with a link between chemical and hair dye exposure investigated in several studies.[24] In addition, an oxidative stress hypothesis has been proposed, linking vitiligo to the generation of free radicals, with pollution being a substantial contributor to the production of these free radicals,[25] which explains high prevalence in Gujarat,[26] an industrially-intensive state in India. The differences in prevalence in large countries such as India might also be linked to chemically-induced vitiligo in areas with elevated use of dyes and chemicals, including, but not limited to, household detergents, specific toothpastes, insecticides and pesticides, deodorants, and phenols.[27] Furthermore, stigmatisation remains in this region, negatively impacting on patients' quality of life. In India, derogatory terms contribute to social stigma, originating from misconceptions linking vitiligo to leprosy, beliefs around hereditary transmission, limited education, and deep-rooted superstitions.[28,29] This stigma leads to exclusion, impacting marriage prospects and causing abuse, job loss, and career impediments.[30,31] Additionally, because of stigma a diagnosis might be delayed, leading to missed treatment opportunities among the already limited

available options for vitiligo. Finally, central to our investigation, is the inadequate representation of individuals with darker skin tones in research on vitiligo. Historically, studies on vitiligo have predominantly included people with lighter skin of northern European ethnicities. This bias could result in a limited understanding of the distinct requirements and difficulties encountered by individuals with darker skin who are affected by vitiligo.

In the present study, the lowest prevalence of vitiligo was estimated in east Asia. This finding could be because most of the epidemiological studies from countries in the region were based on the national insurance claims databases of countries. Studies from South Korea[8] and Taiwan[32,33] covered almost the entire population and used strict definitions of vitiligo in order to minimise selection bias, which could have led to underestimation of the actual prevalence of the disease. Overall, the results indicate that increased epidemiological data, with use of uniform protocols and disease definition, need to be collected from all regions to estimate the prevalence and incidence with improved accuracy.

Our study also found a discrepancy in prevalence when based on self-report versus physician or dermatologist report. Although similar trends according to regions were observed between the diagnostic methods, self-reported prevalence was markedly higher than physician-reported prevalence. Many conditions mistaken for vitiligo, such as idiopathic guttate hypomelanosis, hypopigmented scarring, and post-inflammatory hypopigmentation, or poor accessibility to hospitals, could have misled the diagnosis of vitiligo in self-reported studies.

Studies on the epidemiology of vitiligo in the USA have reported variable prevalence, ranging from 0·004% to 2·28%.[14] This variability might have been due to multiple factors, including differences in study design, geographical location, and population characteristics. In other studies, vitiligo was found to be most prevalent in Africa (0·4–2·5%) and Asia (0·1–1·6%) compared with the Americas.[2] Meanwhile, at the country-level, the greatest incidence has been reported in India (8·8%) and Mexico (4·0%) among various countries.[22] Research in China has also indicated that incidence is similar in both urban regions (0·081%) and rural regions (0·099%).[34] There is a limited availability of research that has attempted to integrate such fragmented data.[2,3,35] Zhang and colleagues[2] previously provided prevalence estimates of vitiligo for six regions worldwide and a total of 30 countries. Kruger and colleagues[35] reported worldwide prevalence derived from high-income countries, such as EU countries, the UK, and the USA.

Our study has several strengths. First, our systematic review was comprehensive, incorporating a large number of the most recent studies, and encompassed the most extensive scientific literature available, compiled from nine electronic and regional databases. Second, our statistical model accounted for important factors of heterogeneity, such as the types of diagnostic methods and prevalence measure used. Lastly, we modelled self-reported vitiligo prevalence in addition to physician-reported prevalence for 189 countries.

Our findings also require some cautious interpretations due to limitations. First, the limited number of studies in many LMICs could have led to uncertain estimates. Second, the incidence rate data were insufficient to include in our statistical approach, and many studies did not provide detailed information about their sample, including age and sex, and therefore age-standardised and sex-standardised prevalence estimates were not modelled. A third limitation was that although we disaggregated incidence rate and prevalence data from individual studies by sex, these data were insufficient to do a sex-stratified quantitative synthesis, resulting in a descriptive presentation of the result. Finally, the most commonly studied countries were the USA and India, both of which are large countries with a high amount of published data. Unfortunately, the data are sparse in some regions, and data were absent in several countries and regions, for which we used the estimates of the regions or super-regions they were nested in, which requires caution in interpretation of the results. Nevertheless, estimates for nations without data can offer insight and guidance to policy makers, health-care professionals, and patients, and provides recognition of countries with no data.

Vitiligo is a complex disease that impacts multiple dimensions of an individual's life, including social activities, mental health, marriage, and occupation.[36] Research has shown a high prevalence of mental health disorders among people with vitiligo, notably anxiety, highlighting the condition's broader impact beyond physical appearance.[37] Furthermore, management of vitiligo is associated with substantial financial burdens, encompassing both direct and indirect costs, a majority of which are often borne by the individuals themselves.[38]

Over recent years, the availability of data on the incidence and prevalence of vitiligo has increased. However, substantial gaps persist, particularly in geographical areas with limited reporting, notably in low-income and middle-income countries. To our knowledge, this systematic review and modelling analysis is the most up-to-date comprehensive report to evaluate the incidence and prevalence of vitiligo on a global scale, notably including data from LMICs.

There is a clear imperative to enhance the quality and quantity of data regarding the epidemiology of vitiligo to allow better resource provision. Improving our understanding of the epidemiology of vitiligo is crucial for the effective allocation of resources towards reducing morbidity, disability, and stigmatisation associated with the disease. Increased research will also support efforts that are being made to improve awareness, diagnosis, and treatment options for vitiligo in individuals of all skin types.

Contributors

SL, HJJ, RP, JMB, and KE were responsible for study conception and design. SL did the analysis. All authors interpreted the findings and had access to the data. JJJ, Y-WH, and SL accessed and verified the underlying data. JA wrote the first draft of the manuscript. All authors were responsible for reviewing and editing the manuscript, approved the current version of the manuscript, and had final responsibility for the decision to submit for publication.

Declaration of interests

IH reports being a consultant for AbbVie, Pfizer, Bayer, Incyte, UCB, Boeringher Ingelheim, Estee Lauder, Ferndale Laboratories, L'Oréal, Arcutis, Avita Novartis, Gladerma, Janssen, Clinuvel, and Almirall. KE reports being a consultant for AbbVie, Incyte, La Roche-Posay, Pfizer, Pierre Fabre, Sanofi, and MSD. All other authors declare no competing interests.

Data sharing

The raw data collected during the systematic review, descriptions of the model structure, and the parameters included in the model are available in the appendix. The analysis code is available on request to rosa.parisi@manchester.ac.uk.

Editorial note: The Lancet Group takes a neutral position with respect to territorial claims in published maps and tables.

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