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Review

The global prevalence and correlates of skin bleaching: a meta-analysis and meta-regression analysis

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Abstract

Purpose To estimate and investigate the global lifetime prevalence and correlates of skin bleaching.

Methods A meta-analysis and meta-regression analysis was performed based on a systematic and comprehensive literature search conducted in Google Scholar, ISI Web of Science, ProQuest, PsycNET, PubMed, and other relevant websites and reference lists. A total of 68 studies (67,665 participants) providing original data on the lifetime prevalence of skin bleaching were included. Publication bias was corrected using the trim and fill procedure.

Results The pooled (imputed) lifetime prevalence of skin bleaching was 27.7% (95% CI: 19.6–37.5, $I^2 = 99.6$, $P < 0.01$). The highest significant prevalences were associated with: males (28.0%), topical corticosteroid use (51.8%), Africa (27.1%), persons aged ≤30 years (55.9%), individuals with only primary school education (31.6%), urban or semiurban residents (74.9%), patients (21.3%), data from 2010–2017 (26.8%), dermatological evaluation and testing-based assessment (24.9%), random sampling methods (29.2%), and moderate quality studies (32.3%). The proportion of females in study samples was significantly related to skin bleaching prevalence.

Conclusion Despite some limitations, our results indicate that the practice of skin bleaching is a serious global public health issue that should be addressed through appropriate public health interventions.

Introduction

Skin bleaching (also known as skin lightening, skin toning, skin whitening, etc.) refers to the cosmetic misuse of toxic agents (e.g., mercurials) or abuse of skin lightening agents (e.g., topical corticosteroids) primarily to change one's normal and natural skin color. Many skin bleaching practitioners report experiencing benefits such as perceived increase in attractiveness, confidence and self-esteem, relief from bodily blemishes, and better appreciation from spouses.[1–3] Conversely, long-term skin bleaching and the use of toxic and highly potent agents has been associated with various harmful outcomes varying from dyschromia to more worrisome systemic side effects including diabetes and hypertension.[4–8] As a result of these associated harms, the practice of skin bleaching is a public health concern,[4,9,10] and the importation and marketing of skin bleaching products has consequently been banned or is strongly regulated in many African, Asian, European, and North American countries.[10]

Besides summarizing available literature on a topic, a meta-analytic review has other advantages in terms of statistical methods for combining results from included studies and presenting overall findings, as well as investigating factors that account for between-study variance through a meta-regression analysis.[11] Some previous reviews have been conducted on the skin bleaching literature.[4–9,12–15] However, with one exception,[8] past reviews have been merely narrative and unsystematic. Further, although several epidemiological investigations have been conducted on skin bleaching practice in various parts of the world,[4,5,8,9,12,14] to our knowledge, no previous review has quantified through a systematic and meta-analytic approach the global prevalence of skin bleaching.

The dearth of a systematic and quantitative review on the prevalence of skin bleaching is also inferably related to the

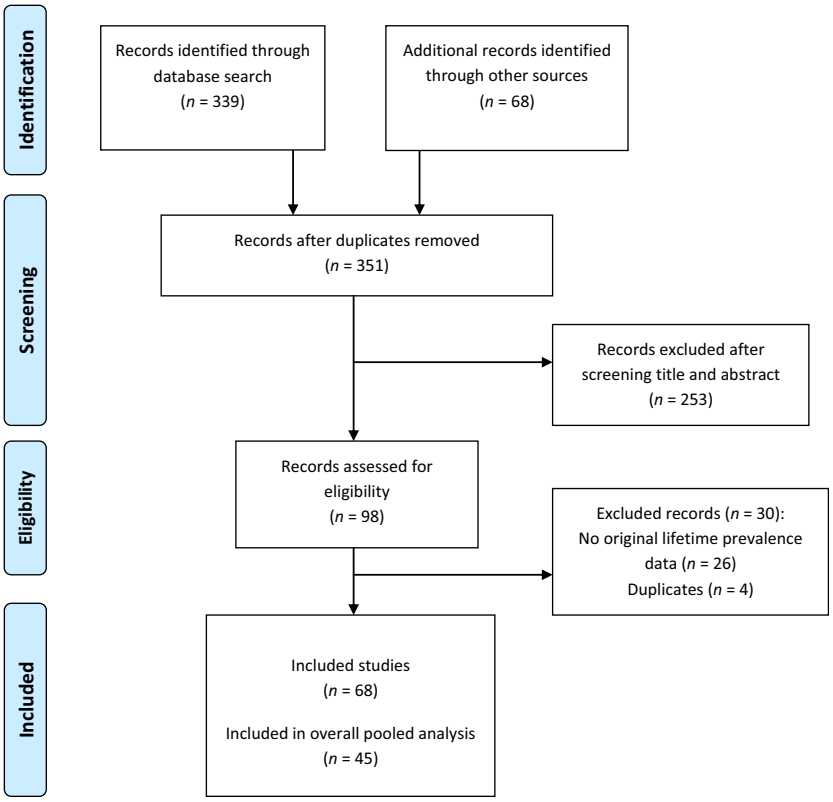

Figure 1 Flow diagram of systematic literature search on the lifetime prevalence of skin bleaching

paucity of systematic evidence on the correlates of skin bleaching prevalence. As a result of the above gaps in the literature, we conducted a meta-analysis and meta-regression analysis on the global lifetime prevalence of skin bleaching. The main research questions guiding the present systematic review were as follows: what is the (a) global lifetime prevalence of skin bleaching? (b) global lifetime prevalence of skin bleaching in females and males? (c) most popular skin bleaching agent? (d) global lifetime prevalence of skin bleaching in terms of world regions, age groups, educational experience, relationship/marital status, employment status, area of residence, assessment method, and sampling method?; and (e) are various study characteristics related to the lifetime prevalence of skin bleaching?

Methods

Search strategy and inclusion criteria

We conducted a systematic and comprehensive literature search in Google Scholar, ISI Web of Science, ProQuest, PsycNET, and PubMed. The following keywords were used for the searches in ISI Web of Science, PsycNET, and PubMed: "preval* skin bleach*", "preval* skin depigment*", "preval* skin lighten*", and "preval* skin toning". Owing to the generation of a high number of superfluous hits using the above key words, they were merged for the searches in Google Scholar and ProQuest: "preval* skin bleach* depigment* lighten* toning".

A total of 339 hits were identified from the database search. Also, a total of 68 additional records were identified through searches of related material such as reference lists of literature on skin bleaching and relevant websites. After removing duplicates, 351 records were available for screening. Of this pool of 351 records, 253 were removed after screening their titles and abstracts. Thus, 98 records were accessed for further evaluation. After screening the 98 records for eligibility, 68 were included in the analysis. The key inclusion criteria were that the study/literature: (a) was population or hospital/patient-based, and (b) presented original data on the lifetime prevalence of skin bleaching. No restrictions were made in terms of publication language and type (i.e., peer-reviewed or not). The literature search was conducted from February 23, 2017, to April 28, 2017.

We conducted the literature search and selection in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure,[16] and the guidelines of the Meta-analysis of Observational Studies in Epidemiology (MOOSE)[17] group. Figure 1 presents the literature search and selection process.

Data extraction

The first author (DS) independently conducted the literature search and selection of articles based on the aforementioned criteria. Articles published in French were translated using Google Translate (Google Inc.) with a plan for corroboration in case of ambiguity or uncertainty.[18,19] Using a standardized data extraction form, the following data were extracted from the identified studies and coded: first author name and publication year, data collection period, country and continent/region of research, type of sample, study setting, assessment method, sampling method, sample size (total, male, and female), participants' ages (range, mean, and standard deviation), response rate, and various reported lifetime prevalence of skin bleaching (overall, male, female, agents used, and by specific demographics) (see Table 1).

Statistical analysis

Software and computational model

The meta-analysis and meta-regression analysis were conducted using Comprehensive Meta-Analysis 3.0.[20] We used a random-effects model to combine estimates from relevant studies. We preferred a random-effects model as it permits higher external validity or generalizability of findings, and is also recommended when included studies are assumed to represent different populations of studies.[21]

Estimation of prevalences

We estimate two main types of lifetime prevalences. *Population prevalences* apply to the general population or sample types. These are the overall/pooled estimate, sex-specific, world region, sample type, data/study period, assessment method, sampling method, and study quality/risk of bias. On the other hand, *skin bleacher-specific prevalences* refer to the demographic characteristics of skin bleachers and hence apply specifically to skin bleaching practitioners (agents used, age groups, educational level, relationship/marital status, employment status, and residential area). In order to avoid potential inflation of population prevalences, studies presenting data on purposively sampled skin bleachers (lifetime prevalence $\approx$100%)[22–44] were not included in estimating population prevalences. They were also omitted from the meta-regression analysis. However, we included their relevant data in the estimation of the skin bleacher-specific prevalences.

Assessment of study quality/risk of bias

We assessed study quality or risk of presenting biased prevalence estimates using a quality assessment checklist for prevalence studies.[45] The checklist comprises questions assessing nine characteristics of included studies: (a) sample representativeness, (b) the sampling frame, (c) random selection of sample, (d) nonresponse bias, (e) direct collection of data from participants, (f) operationalization, (g) instrument reliability and validity, (h) instrument consistency, and (i) availability of data for estimation of prevalence. Each question was scored "0" (low risk of bias) or "1" (high risk of bias). Hence, the total score ranged from 0 to 9 and was categorized as follows: high quality/low risk (0–3), moderate quality/risk (4–6), and low quality/high risk (7–9) (see Table 2).

Publication bias

We tested for publication bias both visually using the funnel plot and statistically using the trim and fill procedure.[46] Where necessary, we adjusted for publication bias and imputed missing studies using the trim and fill procedure. We also performed 14 separate subgroup analyses for significant subcategories based on the *Q*-statistic to assess the statistical significance of differences in prevalences between the subgroups using a random-effects model. Here, we adjusted the alpha level for statistical significance with Bonferroni correction (N subgroup comparisons = 14, Bonferroni $P = 0.004$).

Meta-regression analysis

We conducted a meta-regression analysis to identify correlates of the overall prevalence estimate. The following variables were included in the meta-regression analysis: region (Africa, Asia, Europe, Middle East, and North America), sample type (community, patients, high school students/adolescents, and tertiary/university students), study period (1970–1979, 1980–1989, 1990–1999, 2000–2009, 2010–2017), assessment method (dermatological evaluation and testing with or without interviews or questionnaires, interviews only, questionnaires only, both interviews and questionnaires), sampling method (nonrandom and random), the proportion of females in the sample (not provided, ≤50%, 51–75%, and >75%), the proportion of persons aged 30 years or younger in the sample (not provided, ≤50%, 51–75%, and >75%), and study quality/risk of bias (high quality/low risk, moderate quality/risk). With the exception of the proportions of females and those aged 30 years or younger in the sample (where we used the 'not provided' subcategories as reference), we used the subcategory with the highest number of studies as the reference for each of the variables (indicated in Table 4).

Results

Description of studies

Of the 68 included studies, the indicated data collection period ranged from 1974–1980[47] to 2015–2016[25] whereas publication years ranged from 1972[26] to 2017.[49,50] There was a nonwestern preponderance of included studies: Africa ($n = 40$), Asia ($n = 18$), Middle East ($n = 5$), North America ($n = 3$), and Europe ($n = 2$). The studies included a total of 67,665 participants (range: 40–25,968, mean = 995.1, SD = 3280.9). Of this sample, 15,571 were indicated as females whereas 2,487 were

Table 1 Characteristics of studies on the prevalence of skin bleaching

1st author, y	Data period	Country	Sample type	Study site/setting	Assessment	Sampling	*N*	*N* (M)	*N* (F)	Age range (y)	Age Mn	Age SD
Africa												
Adebajo 2002 [1]	1998	Nigeria	Traders	Market	IQ	R	450	130	320	18–65	30.8	8.18
Akakpo 2015 [22]	2009–2013	Togo	Patients	Hospital	Q	NR	150		150		32.1	9.9
Alebiosu 2002 [83]		Nigeria	Community	Hospital	Q	NR	415	192	223	15–54	34.2	9.7
Amankwa 2016 [84]		Ghana	Community	Community	Q	NR	100		100	>18 (95)		
Atadokpédé 2015 [85]		Benin	High school students	High school	Q + DE	R	429	–	–	18–27[U]	18[U]	
Augou 2008 [24]	2006–2008	Cote d'Ivoire	Patients	Hospital	I + DE	NR	115	4	111	20–35		
Bantayehu 2015 [69]	2015	Ethiopia	Patients	Hospital	Q + DE	NR	927	176	751	18–65[U]	29.9[U]	8.56[U]
Barr 1972 [48]		Kenya	Patients	Hospital	I + DE + UA	NR	60	16	44	15–56		
Barr 1973 [26]		Kenya	Nurses	Hospital	I + DE + UA	NR	56		56	19–24		
Diongue 2013 [29]	2010	Senegal	Patients	Hospital	IQ + DE	NR	65		65	19–62	33	
Dlova 2015 [60]	2012	South Africa	Patients	Hospital	Q	NR	571		571	18–70		
Doe 2001 [86]	1995	Ghana	Patients	Hospital	Q + DE	NR	2254					
Gathse 2005 [30]	2002	Brazzaville, Congo	Patients	Hospital	Q + DE	NR	104		104	14–58	26.6	
Harada 2001 [87]	1998	Kenya	Community	Community	Q + HA	NR	65	30	35	7–87	27.8	
Hardwick 1989 [88]	1985–1986	South Africa	Patients	Hospital	I + DE	NR	195	53	142	14–73		
Kamagaju 2016 [68]	2010	Rwanda	Community	Community	Q	R	150	30	120	15–60		
Kane 2007 [89]	2002–2003	Senegal	Patients	Hospital	Q	NR	93	23	70	14–46	25.6	
Kombate′ 2012 [90]	2010	Togo	Patients	Hospital	Q + DE	NR	119	23	96	11–49	23.4	6.4
Kouotou 2015 [52]	2012–2013	Cameroon	Traders	Community	Q + DE	R	658		658	24–64	35.6	8.7
Kourouma 2016 [34]		Côte d'Ivoire	Patients	Hospital	Q + DE	NR	40		40	18–64	32.4	9.1
Kuffour 2014 [91]		Ghana	Community	Community	Q + DE	R	120		120	15–40		
Lartey 2016 [71]	2013	Ghana	Community	Community	Q + DE	R	555	12	543	18–90	41	14.1
Levang 2009 [53]	2007–2008	Mayotte	Community	Community	Q	R	163		163	15–64		
Lewis 2011 [3]		Tanzania	Community	Community	I	NR	355		355	13–51	25.2	9.1
Ly 2007 [37]	2005–2006	Senegal	Patients	Hospital	Q + DE	NR	86		86	16–49	29.3	
Mahé 2003 [92]	2000–2001	Senegal	Patients	Hospital	Q + DE	NR	368		368	16–70	31	11.4
Mahé 2007 [93]	2003	Senegal	Pregnant women	Hospital	Q + DE + BA	R	99		99	15–42	25.5	
Malangu 2006 [94]		South Africa	Pharmacy customers	Pharmacy	I	NR	225	38	187	20–60 (84)		
Ndiaye 2017 [50]	2014	Senegal	Patients	Hospital	I	NR	103	40	63	18–76	41.4	
Nnoruka 2006 [95]	2004	Nigeria	Patients	Hospital	Q + DE	NR	931	–	–	18–71[U]	29[U]	11.8[U]
Obuekwe 2004 [96]		Nigeria	University students	University	Q	R	200		200	17–26		
Okoye 2011 [97]		Nigeria	Community	Community	IQ + UA	R	520	–	–	18–90		
Oluyombo 2016 [98]		Nigeria	Community	Community	IQ	R	454	–	–	>18	45.8	19
Pitché 2005 [99]	1994–1995	Togo	Community	Community	Q + DE	R	910		910			
Rajaa 2016 [39]	1992–2008	Morocco	Patients	Health center	IQ + DE	NR	95	34	59	1–70	20	1.4
Raynaud 2001 [54]	1999	Senegal	Patients	Hospital	IQ + DE	R	147		147	15–60	37.5	

Table 1 Continued

1st author, y	Data period	Country	Sample type	Study site/setting	Assessment	Sampling	*N*	*N* (M)	*N* (F)	Age range (y)	Age Mn	Age SD
Schulz 1982 [47]	1974–1980	South Africa	Patients	Hospital	Q + DE	NR	5000					
Traoré 2005 [100]	2013	Burkina Faso	Community	Community	I + DE	R	1008		1008	15–55	25.2	
Wone 2000 [51]		Senegal	Community	Community	IQ	R	600		600	15–55		
Yousif 2014 [101]	2010	Sudan	High school	High school students	Q	R	1187		1187	16–19		
Asia												
Ambika 2014 [23]	2010–2011	India	Patients	Hospital	I + DE	NR	200	58	142	16–60 (88)		
Askari 2013 [102]		Pakistan	Community	Community	Q	NR	61		61	20–40 (78.7%)		
Bains 2016 [25]	2015–2016	India	Patients	Hospital	Q + DE	NR	100	24	76	6 m–51 y		
Bhat 2011 [27]	2007–2008	India	Patients	Hospital	I + DE	NR	200	56	144	11–60		
Brar 2015 [28]	2013–2014	India	Patients	Hospital	I + DE	NR	100	32	68	15–55 (94%)		
Dey 2014 [103]	2010–2011	India	Patients	Hospital	Q + DE	NR	6723	80[U]	299[U]	–	–	
Inakanti 2015 [32]	2012–2014	India	Patients	Hospital	Q + DE	NR	130	40	90	13–42		
Jha 2016 [33]	2014–2015	India	Patients	Hospital	Q + DE	NR	410	104	306	10–59 (76%)		
Kumar 2015 [35]	2012–2014	Nepal	Patients	Hospital	IQ + DE	NR	95	21	74	14–67	35.8	10.3
Lu 2009 [36]	1996–1997	China	Patients	Hospital	Q + DE	NR	312	25	287	6 m–65 y	35.3	
Mahar 2016 [104]	2015	India	Patients	Hospital	Q + DE	NR	2174	100[U]	150[U]	10–49 (93.6%)		
Nagesh 2016 [105]		India	Patients	Hospital	I + DE	NR	1000	360	640			
Rathi 2011 [41]	2007–2008	India	Patients	Hospital	IQ + DE	NR	110	12	98	18–54		
Rathod 2015 [106]		India	Patients	Hospital	Q + DE	NR	4368	110[U]	257[U]	11–40 (86.9)		
Rusmadi 2015 [107]		Malaysia	University students	University	Q	NR	104		104	20–30	24	2
Sin 2003 [42]	2002	Hong Kong	Patients	Hospital	IQ + UA + BA	NR	314	1	313	15–76		
Sinha 2016 [43]	2013	India	Patients	Hospital	Q + DE	NR	50	24	26	12–44	24.2	
Sun 1987 [108]		Taiwan	Patients	Hospital	I + DE	NR	507	121	386			
Europe												
Cristaudo 2012 [74]	2011	Italy	Patients	Hospital	Q + DE	NR	82		82	18–60		
Petit 2006 [38]	2004–2005	France	Patients	Hospital	IQ + DE	NR	46	7	39	23–64		
Middle East												
Al-Dhalimi 2006 [109]	2001–2002	Iraq	Patients	Hospital	IQ + DE	NR	1780			1–49	18.7	
Awaji 2017 [49]		Saudi Arabia	Community	Community	Q	NR	605		605	20–50	35.8	6.6
Hamed 2010 [110]	2006	Jordan	Pharmacy customers	Pharmacy	Q	R	318		318	20–50 (81.1%)		
Hameed 2013 [31]	2011–2013	Iraq	Patients	Hospital	Q + DE	NR	110	21	89	16–60	28.3	6
Mansour 2010 [111]	2006/2008	Iraq	Patients	Hospital	I + DE	NR	25968			15–96	39.6[U]	14.1[U]
North America												
James 2016 [75]	2013	Jamaica, Barbados, Grenada	Undergraduates	University	Q	R	1226	449	777	18–30		
Rapaport 1999 [40]		USA	Patients	Hospital	IQ + DE + BA	NR	100	28	72			
Weldon 2000 [44]	1996	USA	Community	Patients	Q + UA	NR	330	13	317	14–79		

Table 1 Continued

1st author, y	Response rate (%)	Prevalence (T, %)	Prevalence (M, %)	Prevalence (F, %)	Agent (%)	PolyP (%)	Age groups, y (%)	Education	Residence	Relationship	Employment	PrL(%)
Africa												
Adebajo 2002 [1]		77.3[L]	73.8[L]	78.8[L]	Hydroquinone (64.4); TC (49.1); mercurials (47.1); local soaps/creams (26.4)		18–29 (78.5); 30–39 (78.8); 40–65 (70.5)	Illiterate (57.1); primary (75.7); secondary (82.4); > secondary (75.6)		Married (76.1); single (78.8); other (75)	Employed (100)	
Akakpo 2015 [22]		100[L]		100[L]							Employed (68.7); other (31.3)	
Alebiosu 2002 [83]	91.2	33.7[L]										
Amankwa 2016 [84]	100	90[L]		90[L]		100						
Atadokpédé 2015 [85]		36.6[L]	33.1[L]	66.9[L]	Hydroquinone (42); TC (22.3); mercurials (19.7); fruit acids (13.6); other (2.3)							
Augou 2008 [24]		100[L]	100[L]	100[L]	Hydroquinone (69.6); mercurials (22.6); TC (20.9)							
Bantayehu 2015 [69]		17[L]	–	–	TC (100)		18–24 (29); 25–31 (33); 32–38 (24.5); >38 (13.5)	Illiterate (9); primary (12.5); secondary (39); college/ university (39.5)	Urban (75); other (25)	Single (54.5); married (45.5)	Employed (56.5); other (43.5)	
Barr 1972 [48]		53[L]	73[L]	6.3[L]	Mercurials (100)		15–20 (52); 15–30 (88)					
Barr 1973 [26]		94.6[L]; 41.1[C]		94.6[L]; 41.1[C]	Mercurials (100)							
Diongue 2013 [29]		100[L]		100[L]	Hydroquinone and TC (39); hydroquinone (29); TC (26); unknown (6)	39					Employed (61); other (34)	
Dlova 2015 [60]	95.2	32.7[L]		32.7 [L]		Yes.	<30 (29.3); 31–50 (28.7); >50 (42.5)	< Grade 10 (39.4); grade 10 –12 (31.8); graduate (14.1)	Urban (25.8); suburban (35.2); rural and semi-rural (36)	Married (30.2); other (35.3)	Employed (28.6); other (34.4)	
Doe 2001 [86]		3.8[L]		3.8[L]	Hydroquinone; TC; mercurials							
Gathse 2005 [30]		100[L]		100[L]	TC (38.5); Hydroquinone (30.8); hydroquinone and dermocorticoids (30.8)	30.8						

Table 1 Continued

1st author, y	Response rate (%)	Prevalence (T, %)	Prevalence (M, %)	Prevalence (F, %)	Agent (%)	PolyP (%)	Age groups, y (%)	Education	Residence	Relationship	Employment	PrL(%)
Harada 2001 [87]		16.9[L]	0	31.4[L]	Mercurials (100)						Employed (81.8); other (18.2)	
Hardwick 1989 [88]		44.6[L]	15.1[L]	55.6[L]	Hydroquinone (100)							
Kamagaju 2016 [68]		35[L]	23[L]	38[L]	Kojic acid; hydroquinone; TC; other		16–24 (9.3); 25–34 (20.7); 35–44 (2.7); 45–55 (2)		Urban (100)			
Kane 2007 [89]		38.7[L]	–	–								
Kombate′ 2012 [90]		40.7[L]	8.7[L]	47.9[L]	Hydroquinone (54.2); TC (35.4); both (8.3)	8.3						
Kouotou 2015 [52]		43.6[L]	–	43.6[L]	Hydroquinone (62.7); unknown composition (54.7); mercurials (28.4); TC (25.8); fruit (21.2); vitamin C (13.6); vitamin A (7.2)	x: 2.7 ± 1.3 products; Majority (3 products)				Married (46.2); single (53.8)		
Kourouma 2016 [34]	24.2	100[L]; 47.5[C]		100[L]; 47.5[C]		50	20–40 (80)	≤ Secondary (42.5); > secondary (27.5)	Urban (87.5)	Unmarried (57.5)	Employed (57.5)	
Kuffour 2014 [91]		39.2[L]		39.2[L]								
Lartey 2016 [71]		65.2[L]	–	–	Hydroquinone (75.6); TC (63.8); mercurials (12.2); caustic agents (5); unknown (5.7)	76; 2 (44.4); ≥3 (31.5)	<40 (55.8); ≥40 (44.2)	Illiterate (20.2); educated (79.8)	Urban (100)	Married (35.9); other (4.1)	Employed (75.4); other (24.6)	72.4
Levang 2009 [53]		33[L]; 24[C]		33[L]; 24[C]	TC; salicylic acid; diproson (betamethasone dipropionate); pandalao	(63)	15–24 (21); 25–34 (40); 35–44 (59); 45–54 (29); 55–64 (14)				Employed (38.9); other (61.1)	
Lewis 2011 [3]		11.8[L]		11.8[L]								
Ly 2007 [37]		100[L]		100[L]	TC (78); hydroquinone (56); vegetable extracts (31.7); caustic products (8.5); unknown (41.4)	86.5		Primary (48.8); secondary (18.3); tertiary (8.5); illiterate (22)				

Table 1 Continued

1st author, y	Response rate (%)	Prevalence (T, %)	Prevalence (M, %)	Prevalence (F, %)	Agent (%)	PolyP (%)	Age groups, y (%)	Education	Residence	Relationship	Employment	PrL(%)
Mahé 2003 [92]		62.8[L]; 52.7[C]		62.8[L]; 52.7[C]								81[P]; 87[LAC]
Mahé 2007 [93]		72.7[L]; 68.7[C]		72.7[L]; 68.7[C]	Hydroquinone (94.1); TC (50); caustics (2.9); unknown (11.8)							100
Malangu 2006 [94]	18.3	35.6[L]	21.1[L]	38.5[L]	TC (100)		<20 (20); 20–40 (40); 41–60 (37.5); >60 (2.5)	Primary (20); high school (51.3); tertiary (28.7)		Married (46.3); other (53.7)	Employed (47.5); other (52.5)	
Ndiaye 2017 [50]		25.2[L]										
Nnoruka 2006 [95]		58.7[L]	24.3[L]	75.7[L]	TC (57.2); hydroquinone (43.7); mercurials (6.8); kojic acid (2.1); alphahydroxy acids/glycolic acids (1.6); unknown (5.7)	61.3	18–28 (23.9); 29–39 (40.8); 40–50 (21.6); 51–61 (12.6); 62–72 (1.1)				Employed (61.1); other (38.9)	Yes.
Obuekwe 2004 [96]	66.7	20[L]		20[L]	Hydroquinone (17); mercuric iodide (13)			University (100)				
Okoye 2011 [97]		7.6[L]	–	–								
Oluyombo 2016 [98]		2.3[L]	3.3[L]	4[L]								
Pitché 2005 [99]		58.9[L]		58.9[L]	Mercurials (30.9); hydroquinone (24); TC (18.5); unknown (25.6)	42.5	<40 (65.9); ≥40 (3.8)	Literate (68.7); illiterate (47.6)		Single (82.9); married (43.3)		
Rajaa 2016 [39]		100[L]	100[L]	100[L]			1–4 (16.8); 5–14 (10.5); 15–19 (26.3); 20–50 (46.3)		Urban (88.3); rural (11.7)			
Raynaud 2001 [54]		27.9[L]		27.9[L]								
Schulz 1982 [47]		6.5[L]			Hydroquinone (82); monobenzone (18)							
Traoré 2005 [100]		44.3[L]		44.3[L]	Phenolics (35.8); TC (26.6); mercurials (1.6); combinations (15.2); unspecified (20.8)	15.2	<30 (78.3); 20–24 (53.3)	literate-secondary (74); illiterate (23.5); tertiary (2.5)	Urban (100)	Married (42.1); other (57.9)	Employed (51.5); other (48.5)	
Wone 2000 [51]		67.2[L]		67.2[L]	Hydroquinone (61); TC (37); other (2)							

Table 1 Continued

1st author, y	Response rate (%)	Prevalence (T, %)	Prevalence (M, %)	Prevalence (F, %)	Agent (%)	PolyP (%)	Age groups, y (%)	Education	Residence	Relationship	Employment	PrL(%)
Yousif 2014 [101]	79.1	55.4[L]		55.4[L]	TC (10.2); mercurials (28.4); hydroquinone (3.3); TC + mercurials (13.7); TC + hydroquinone (2.7); mercurials + hydroquinone (8.1); 3 components (11.1); other (19.1)	35.6		High school (100)				
Asia												
Ambika 2014 [23]		100[L]	100[L]	100[L]	TC		1–15 (12); 16–30 (55); 31–45 (25); 45–60 (8)					
Askari 2013 [102]	70	59[L]		59[L]								
Bains 2016 [25]		100[L]	100[L]	100[L]	TC (100)	27	<10 (7); 11–20 (23); 21–30 (49); 31–40 (19); >40 (2)	Illiterate (9); 5th class (19); 6–10th class (48); 11–12th class (8); university (16)	Rural (58); urban (42)			
Bhat 2011 [27]		100[L]	100[L]	100[L]	TC (100)		11–20 (18); 21–30 (58); 31–40 (16); 41–50 (5.5); 51–60 (2.5)		Rural (58); urban (42)			
Brar 2015 [28]		100[L]	100[L]	100[L]	TC (100)		15–25 (23); 2–35 (36); 36–45 (22); 46–55 (13); >55 (6)					
Dey 2014 [103]		5.6[L]	100[U L]	100[U L]	TC (100)	39.9	1–9 (8.7); 10–19 (30.3); 20–29 (37.7); 30–39 (12.1); 40–49 (9.2); ≥50 (1.9)	Illiterate/primary (18.7); high school (50.9); tertiary (30.34)		Married (40.4); other (59.6)	Employed (21.1); other (78.9)	
Inakanti 2015 [32]		100[L]	100[L]	100[L]	TC (100)		21–30 (65.4); 11–20 (25.4); 31–40 (7.7)		Rural (majority)		Employed (27.6); other (70)	
Jha 2016 [33]		100[L]	100[L]	100[L]	Only TC (43.4); TC, hydroquinone and tretinoin (30.2); TC, antibiotic, and/or antifungal (26.3)	56.6	1–9 (5.9); 10–19 (24.9); 20–29 (33.7); 30–39 (19); 40–49 (9.8); 50–59 (6.8)					

Table 1 Continued

1st author, y	Response rate (%)	Prevalence (T, %)	Prevalence (M, %)	Prevalence (F, %)	Agent (%)	PolyP (%)	Age groups, y (%)	Education	Residence	Relationship	Employment	PrL(%)
Kumar 2015 [35]		100[L]	100[L]	100[L]	TC (100)		0–35 (52.6); 35–50 (37.9); >50 (9.5)		Rural (10.5); semiurban (71.6); urban (17.9)		Employed (54.7); other (45.3)	
Lu 2009 [36]		100[L]	100[L]	100[L]	TC (100)	91.7 [2 (21.8); ≥3 (69.9)]						
Mahar 2016 [104]		11.8[L]	100[U L]	100[U L]	TC (100)		0–9 (2); 10–19 (28); 20–29 (38); 30–39 (16.4); 40–49 (11.2); >50 (4.4)	Illiterate (20); primary (24); high school (41.6); tertiary (14.4)			Employed (24); other (76)	
Nagesh 2016 [105]		61.2[L]	58.9[L]	62.5[L]	TC (100)							
Rathi 2011 [41]		100[L]	100[L]	100[L]	TC (100)							
Rathod 2015 [106]		8.4[L]	100[L]	100[L]	TC (100)		11–20 (15.5); 21–30 (40.3); >40 (13.1)			Married (42.2); other (57.8)		
Rusmadi 2015 [107]		60.6[L]; 51.9[C]		60.6[L]; 51.9[C]				University (100)				
Sin 2003 [42]		100[L]	100[L]	100[L]	Mercurials							
Sinha 2016 [43]		100[L]	100[L]	100[L]				≤ Standard 10 (30); > standard 10–12 (54); university (16)		Married (38); other (62)	Employed (16); other (84)	
Sun 1987 [108]		4.1[L]	0.01[L]	5.2[L]								
Europe												
Cristaudo 2012 [74]		39[L]		39[L]	Hydroquinone; TC		<35 (43.9); ≥35 (35.9)	University (53.8); middle school (36.7); high school (37.1)				
Petit 2006 [38]		95.6[L]; 54.3[C]			Hydroquinone; TC	94.3						
Middle East												
Al-Dhalimi 2006 [109]		7.9[L]	32.2[L]	67.8[L]	TC (100); mixed (>1; 10)	10	1–9 (12.1); 10–19 (49.3); 20–29 (27.1); 30–39 (8.6); 40–49 (2.9)	Illiterate-secondary (63.6); > secondary (7.2)				
Awaji 2017 [49]		72.4[L]; 65[C]		72.4[L]; 65[C]			L: 16–25 (74.3); 26–35 (71.4); 36–45 (65.1); >45 (79.2)	≤ High school (73.4); ≥ university (72.1)		Single (74); married (71.7); divorced/separated (54.5); widowed (60)	Student (73.7); other (71.1); housewife (74.4); employee (71.9); other (55)	6.8[P]; 15.9[LAC]

Table 1 Continued

1st author, y	Response rate (%)	Prevalence (T, %)	Prevalence (M, %)	Prevalence (F, %)	Agent (%)	PolyP (%)	Age groups, y (%)	Education	Residence	Relationship	Employment	PrL(%)
Hamed 2010 [110]		60.7[L]		60.7[L]	Hydroquinone (22.6); TC (1.9)	Face (81.9)	<20 (62); 20–30 (58); 31–40 (63); 41–50 (45); >50 (58)			Married (61); single (60); divorced (60); widow (58)	Employed (55); unemployed (45)	
Hameed 2013 [31]		100[L]	100[L]	100[L]	TC (100)		11–20 (8); 21–30 (54); 31–40 (31); 41–50 (3); 51–60 (1.8)	Illiterate (26.3); primary (44.5); secondary (23.7); university (6.3)				
Mansour 2010 [111]		2.6[L]; 1.4[C]	30.9[L]	69[L]	TC (100)					Ever married (83)	Employed (30.5); other (69.1)	
North America												
James 2016 [75]	58.5	13.6[L]	7.3[L]	17.9[L]				University (100)				
Rapaport 1999 [40]		100[L]	100[L]	100[L]	TC (100)							
Weldon 2000 [44]		100[L]	100[L]	100[L]	Mercurials (100)							

BA, blood analysis; C, current prevalence; DE, dermatological evaluation; F, female; HA, hair analysis; I, interview; IQ, interview with questionnaire; LAC, lactation; L, lifetime prevalence; M, male; m, month; Mn, mean; y, year; NR, non-random; OTC, over-the-counter; P, pregnancy; PolyP, polypharmacy; PrL, pregnancy/lactation; Q, questionnaire; R, random; SD, standard deviation; T, total; TC, topical corticosteroids; U, users; UA, urine analysis; xd, times daily; y, year.

Table 2 Risk of bias/methodological quality [45] of included studies

Study	1. Sample representativeness	2. Sampling frame	3. Randomization	4. Non-response bias	5. Primary data	6. Operationalization	7. Instrument	8. Consistency	9. Estimation	Total risk score	Risk category[a]
Africa											
Adebajo 2002 [1]	1	0	1	1	0	0	1	0	0	4	Moderate
Akakpo 2015 [22]	1	1	1	1	0	0	1	0	0	5	Moderate
Alebiosu 2002 [83]	1	1	1	0	0	0	1	0	0	4	Moderate
Amankwa 2016 [84]	1	1	1	0	0	0	1	0	0	4	Moderate
Atadokpédé 2015 [85]	1	0	0	1	0	0	0	0	0	2	Low
Augou 2008 [24]	1	1	1	1	0	0	0	0	0	4	Moderate
Bantayehu 2015 [69]	1	0	1	1	0	0	0	0	0	3	Low
Barr 1972 [48]	1	1	1	1	0	0	0	0	0	4	Moderate
Barr 1973 [26]	1	1	1	1	0	0	0	0	0	4	Moderate
Diongue 2013 [29]	1	1	1	1	0	0	0	0	0	4	Moderate
Dlova 2015 [60]	1	1	1	0	0	0	1	0	0	4	Moderate
Doe 2001 [86]	1	0	1	1	0	0	0	0	0	3	Low
Gathse 2005 [30]	1	1	1	1	0	0	0	0	0	4	Moderate
Harada 2001 [87]	1	1	1	1	0	0	0	0	0	4	Moderate
Hardwick 1989 [88]	1	1	1	1	0	0	0	0	0	4	Moderate
Kamagaju 2016 [68]	1	0	0	1	0	0	1	0	0	3	Low
Kane 2007 [89]	1	1	1	1	0	0	1	0	0	5	Moderate
Kombate′ 2012 [90]	1	0	1	1	0	0	0	0	0	3	Low
Kouotou 2015 [52]	1	1	0	1	0	0	0	0	0	3	Low
Kourouma 2016 [34]	1	0	1	1	0	0	0	0	0	3	Low
Kuffour 2014 [91]	1	1	0	1	0	0	0	0	0	3	Low
Lartey 2016 [71]	1	0	0	1	0	0	0	0	0	2	Low
Levang 2009 [53]	1	1	0	1	0	0	1	0	0	4	Moderate
Lewis 2011 [3]	1	1	1	1	0	0	1	0	0	5	Moderate
Ly 2007 [37]	1	0	1	1	0	0	0	0	0	3	Low
Mahé 2003 [92]	1	0	1	1	0	0	0	0	0	4	Low
Mahé 2007 [93]	1	1	0	1	0	0	0	0	0	3	Low
Malangu 2006 [94]	1	0	1	1	0	0	1	0	0	4	Moderate
Ndiaye 2017 [50]	1	0	1	1	0	0	1	0	0	4	Moderate
Nnoruka 2006 [95]	1	0	1	1	0	0	0	0	0	3	Low
Obuekwe 2004 [96]	1	1	0	1	0	0	1	0	0	4	Moderate
Okoye 2011 [97]	1	0	0	1	0	0	0	0	0	2	Low
Oluyombo 2016 [98]	1	0	0	1	0	0	0	0	0	2	Low
Pitché 2005 [99]	1	0	0	1	0	0	0	0	0	2	Low
Rajaa 2016 [39]	1	1	1	1	0	0	0	0	0	4	Moderate
Raynaud 2001 [54]	1	0	0	1	0	0	0	0	0	2	Low
Schulz 1982 [47]	1	0	1	1	0	0	0	0	0	3	Low
Traoré 2005 [100]	1	0	0	1	0	0	0	0	0	2	Low
Wone 2000 [51]	1	0	0	1	0	0	1	0	0	3	Low

Table 2 Continued

Study	1. Sample representativeness	2. Sampling frame	3. Randomization	4. Non-response bias	5. Primary data	6. Operationalization	7. Instrument	8. Consistency	9. Estimation	Total risk score	Risk category[a]
Yousif 2014 [101]	1	1	0	0	0	0	1	0	0	3	Low
Asia											
Ambika 2014 [23]	1	1	1	1	0	0	0	0	0	4	Moderate
Askari 2013 [102]	1	1	1	1	0	0	1	0	0	5	Moderate
Bains 2016 [25]	1	1	1	1	0	0	0	0	0	4	Moderate
Bhat 2011 [27]	1	1	1	1	0	0	0	0	0	4	Moderate
Brar 2015 [28]	1	1	1	1	0	0	0	0	0	4	Moderate
Dey 2014 [103]	1	1	1	1	0	0	0	0	0	4	Moderate
Inakanti 2015 [32]	1	1	1	1	0	0	0	0	0	4	Moderate
Jha 2016 [33]	1	1	1	1	0	0	0	0	0	4	Moderate
Kumar 2015 [35]	1	1	1	1	0	0	0	0	0	4	Moderate
Lu 2009 [36]	1	1	1	1	0	0	0	0	0	4	Moderate
Mahar 2016 [104]	1	1	1	1	0	0	0	0	0	4	Moderate
Nagesh 2016 [105]	1	0	1	1	0	0	0	0	0	3	Low
Rathi 2011 [41]	1	1	1	1	0	0	0	0	0	4	Moderate
Rathod 2015 [106]	1	0	1	1	0	0	0	0	0	3	Low
Rusmadi 2015 [107]	1	1	1	1	0	0	1	0	0	4	Moderate
Sin 2003 [42]	1	1	1	1	0	0	0	0	0	4	Moderate
Sinha 2016 [43]	1	0	1	1	0	0	0	0	0	3	Low
Sun 1987 [108]	1	0	1	1	0	0	0	0	0	3	Low
Europe											
Cristaudo 2012 [74]	1	1	1	1	0	0	0	0	0	4	Moderate
Petit 2006 [38]	1	1	1	1	0	0	0	0	0	4	Moderate
Middle East											
Al-Dhalimi 2006 [109]	1	1	1	1	0	0	0	0	0	4	Moderate
Awaji 2017 [49]	1	1	1	1	0	0	1	0	0	5	Moderate
Hamed 2010 [110]	1	1	0	1	0	0	1	0	0	4	Moderate
Hameed 2013 [31]	1	1	1	1	0	0	0	0	0	4	Moderate
Mansour 2010 [111]	1	1	1	1	0	0	0	0	0	4	Moderate
North America											
James 2016 [75]	1	1	0	1	0	0	1	0	0	4	Moderate
Rapaport 1999 [40]	1	1	1	1	0	0	0	0	0	4	Moderate
Weldon 2000 [44]	1	1	1	1	0	0	0	0	0	4	Moderate

Item score: (0: low risk, 1: high risk).

[a]Total quality/risk score: [range (0–9): high quality/low risk (0–3), moderate quality/risk (4–6), poor quality/high risk (7–9)].

indicated in the studies as males (some studies did not present the sex distribution of participants).

Data from only the abstracts of two studies[24,51] were used as neither full texts nor author contacts were available for consultation. Sixty articles (89.2%) were published in English with eight (10.8%) published in French.[24,29,30,34,50,52–54] Table 1 presents further characteristics of included studies. A total of 23 (33.8%) studies (lifetime prevalences ≈100%) were not included in estimating the population prevalences (overall, sex-specific, world region, sample type, data/study period, assessment method, sampling method, and study quality/risk of bias) and the meta-regression analysis.[22–44]

Assessment of study quality/risk of bias

A total of 25 (36.8%) studies were categorized as being of high quality/low risk of bias whereas 43 (63.2%) were categorized as having moderate quality/risk of bias. No study met the criteria of poor quality/high risk of bias (see Table 2).

Prevalence estimates, subgroup comparisons, and heterogeneity testing

Table 3 presents results of the crude and adjusted (trim and fill) meta-analysis and subgroup comparisons. Indicated are the total number of studies (*N*), the lifetime prevalences (p%) and corresponding confidence intervals (95% CI) as well as the heterogeneity statistics (*Q* and I^2).

Overall

The overall lifetime prevalence obtained after imputing (trim and fill procedure) three studies was 27.7% ($N = 48$; 95% CI: 19.6–37.5, $I^2 = 99.6$, $P < 0.01$) compared to the original (from identified studies) 31.0% ($N = 45$; 95% CI: 22.1–41.6, $I^2 = 99.6$, $P < 0.01$).

Sex specific

The prevalence for females did not reach statistical significance (imputed: 43.8%, $P = 0.707$). The prevalence for males after imputing 2 studies (trim and fill procedure) was 35.2%.

World regions

Africa had an estimated prevalence of 27.1% after imputing six studies whereas Asia had a prevalence of 23.1%. The difference between the prevalences for the two regions did not reach statistical significance ($Q_{bet} = 1.4$, $P = 0.241$).

Sample type

Patients had a prevalence of 21.3%.

Study/data collection period

Studies using data collected or published between 2010 and 2017 had a prevalence of 26.8%.

Assessment method

Studies using dermatological evaluation and testing in addition to other methods (e.g., interviews, questionnaires, or both) reported a prevalence of 24.9% whereas studies that used only interviews had a prevalence of 22.6%. The difference between the two assessment methods was not significant ($Q_{bet} = 0.1$, $P = 0.822$).

Sampling method

Studies based on random sampling methods had a prevalence of 29.2% whereas studies based on nonrandom sampling reported a prevalence of 27.0% ($Q_{bet} = 1.8$, $P = 0.176$).

Study quality/risk of bias

Studies of high quality/low risk had a prevalence of 29.7% while those of moderate quality had a prevalence of 32.3% ($Q_{bet} = 0.1$, $P = 0.790$).

Agents used

Topical corticosteroids (TC) were the most popular agent (51.8%) followed by mercurials (mercury and its derivatives; 34.4%) ($Q_{bet} = 20.8$, $P < 0.001$) and other agents containing caustic substances (e.g. 10% salicylate preparations), glycolic or fruit acids, herbal derivatives, kojic acid, vitamins (e.g. A and C), and other products of unknown composition (32.7%) (TC vs. other agents: $Q_{bet} = 27.5$, $P < 0.001$). The difference between the prevalences of use of mercurials and other agents did not reach statistical significance ($Q_{bet} = 1.1$, $P = 0.298$).

Age groups

Persons aged 30 or younger were associated with the highest prevalence (55.9%) followed by those aged 31–49 years (25.9%) ($Q_{bet} = 39.8$, $P < 0.001$) and those aged ≥50 years (6.1%) (≤30 vs. ≥50 [$Q_{bet} = 54.0$, $P < 0.001$]; 31–49 vs. ≥50 [$Q_{bet} = 16.9$, $P < 0.001$]).

Educational level

Individuals with no formal education (illiterates) had a prevalence of 17.8%. Additionally, individuals with only primary school education had a prevalence of 31.6%, whereas tertiary educated persons had a prevalence of 22.8%. However, subgroup comparisons showed that these differences were not significant (illiterates vs. primary only [$Q_{bet} = 54.0$, $P = 0.020 >$ Bonferroni $P = 0.004$]; illiterates vs. tertiary [$Q_{bet} = 0.3$, $P = 0.595$]; primary only vs. tertiary [$Q_{bet} = 1.6$, $P = 0.203$]).

Relationship/marital status

The prevalences for relationship or marital status were not significant (ever married: 50.4% [$P = 0.915$], never married: 56.7% [$P = 0.153$]).

Table 3 Prevalence estimates, confidence intervals, and heterogeneity statistics, and subgroup comparisons of the crude and adjusted lifetime prevalence estimates of skin bleaching

		Crude				Adjusted (trim and fill)			
	N	p%	95% CI	*Q*	I^2	n_1	p%	95% CI	*Q*
Population prevalences									
Overall	45	31.0**	22.1–41.6	12370.4	99.6	3	27.7**	19.6–37.5	12774.0
Sex									
Female[a]	33	51.4[ns]	44.2–58.5	1511.7	97.9	6	43.8[ns]	36.6–51.3	2059.7
Male[a]	15	28.0**	16.7–43.0	386.4	96.4	2	35.2**	22.1–51.0	410.1
Region									
Africa	32	35.0**	26.3–44.8	3771.2	99.2	6	27.1**	19.5–36.3	5868.6
Asia	7	21.3*	8.5–44.2	1934.3	99.7	0			
Middle East	4	23.7[ns]	2.9–76.5	2918.3	99.9	0			
Sample type									
Patients	21	21.3***	12.5–33.9	6394.4	99.7	0			
Community	19	43.2[ns]	33.8–53.2	1022.5	98.2	3	35.6[ns]	26.0–46.5	1643.5
High school students/adolescents	2	46.0[ns]	28.6–64.4	43.8	97.7	–			
Tertiary/university students	3	28.0[ns]	10.0–57.8	110.3	98.2	0			
Pregnant women	4	54.9[ns]	19.9–85.6	239.3	98.7	1	44.5[ns]	14.3–79.3	407.8
Data/study period									
1970–1979	2	21.8[ns]	1.8–81.2	111.6	99.1	–			
1980–1989	2	15.8[ns]	1.1–76.7	121.5	99.2	–			
1990–1999	5	30.3[ns]	7.4–70.4	1016.3	99.6	0			
2000–2009	12	36.0[ns]	14.6–64.9	5372.4	99.8	2	29.8[ns]	13.0–54.5	5461.6
2010–2017	24	31.1**	21.2–43.1	4420.8	99.5	2	26.8**	18.0–38.0	4952.0
Assessment method									
DET ± other	26	24.9***	15.3–37.8	8920.1	99.7	0			
Interview only	3	22.6**	10.5–42.1	43.2	95.4	0			
Questionnaire only	13	46.1[ns]	33.5–59.3	815.2	98.5	0			
Interview and questionnaire	3	36.2[ns]	10.4–73.4	219.4	99.1	0			
Sampling method									
Random	18	37.9*	28.9–47.8	1254.4	98.6	4	29.2*	20.1–40.5	2771.8
Nonrandom	27	27.0**	16.9–40.2	7811.9	99.7	0			
Study quality/risk of bias[c]									
High quality/Low risk	22	29.7**	19.5–42.5	4773.0	99.6	0			
Moderate quality/risk	23	32.3*	19.5–48.4	5591.1	99.6	0			
Bleacher-specific prevalences									
Agent									
Topical corticosteroids[ab]	32	73.5***	63.7–81.4	997.1	96.9	9	51.8***	40.7–62.7	1157.8
Mercurials[a]	15	34.4*	23.3–47.7	497.3	97.2	0			
Other agents[b]	13	25.1**	15.0–38.9	672.4	98.2	2	32.7**	20.4–47.9	780.4
Hydroquinone	18	53.2[ns]	40.6–65.5	855.2	98.0	2	47.5[ns]	35.5–59.8	909.8
Polypharmacy	16	54.0[ns]	40.9–66.6	677.0	97.8	0			
Age groups									
≤30 years[a]	21	64.4*	53.6–73.9	1320.8	98.5	5	55.9*	45.6–65.7	1445.8
31–49 years[a]	13	25.9***	21.5–30.8	104.9	88.6	0			
≥50 years[a]	9	6.1***	2.9–12.2	173.2	95.3	0			
Educational level									
Illiterate	10	19.6***	13.8–26.9	143.5	93.7	1	17.8***	12.0–25.5	217.1
Primary school only	11	31.6***	24.6–39.6	83.1	88.0	0			
High school	14	46.6[ns]	40.7–52.7	124.9	89.6	3	42.1[ns]	35.3–49.3	328.4
Tertiary	18	22.8***	22.8–14.1	776.6	97.8	0			
Ever married									
Yes	15	50.4[ns]	42.5–58.3	343.8	95.9	0			
No	15	56.7[ns]	47.5–65.5	451.7	96.9	0			
Employed									
Yes	21	57.4[ns]	47.4–66.8	600.1	96.7	0			
No	21	51.8[ns]	43.0–60.4	548.6	96.4	0			

Table 3 Continued

		Crude				Adjusted (trim and fill)			
	N	p%	95% CI	*Q*	I^2	n_f	p%	95% CI	*Q*
Residence									
Urban/semiurban[a]	12	79.6**	63.4–89.8	450.6	97.6	1	74.9**	57.3–86.9	462.1
Rural[a]	6	25.6*	11.9–46.7	147.8	96.6	1	20.5*	8.2–42.7	275.3

Prevalences of subcategories sharing the same figure ([a] or [b]) are different ($P < 0.004$).
N, number of studies; p%, prevalence (%); 95% CI, (95% confidence interval). *Q*, heterogeneity statistic; I^2, heterogeneity index; n_f, number of imputed studies; DET, dermatological evaluation and test.
[c]Range (0–9): high quality/low risk (0–3), moderate quality/risk (4–6), poor quality/high risk (7–9).
***$P < 0.001$; **$P < 0.01$; *$P < 0.05$; [ns]not significant.

Employment status

The prevalences for employment status were not significant (employed: 57.4% [$P = 0.147$], unemployed: 51.8% [$P = 0.692$]).

Residential area

Persons resident in urban or semiurban areas (74.9%) were associated with a significantly higher prevalence compared ($Q_{bet} = 14.8$, $P < 0.001$) to persons living in rural areas (20.5%).

Correlates of skin bleaching prevalence

Results of the meta-regression analysis are presented in Table 4. The proportion of female participants was significantly associated with skin bleaching prevalence. Specifically, studies that did not report the proportion of female participants were associated with a lower overall prevalence compared to studies with female participants ranging from 51 to 75%, or more than 75%. Altogether, the predictor variables explained 57.0% of the variance in the overall prevalence estimate.

Discussion

We conducted, to our knowledge, the first ever meta-analysis and meta-regression analysis of the global lifetime prevalence of skin bleaching. The overall lifetime prevalence obtained after imputation (27.7%) provides empirical indication of a high global prevalence of skin bleaching practice, in line with suggestions from previous reviews[4–6,14] as well as estimates from fiscal and trend analysis of the skin bleaching market.[55] Even though males reported a high lifetime prevalence (35.2%), the sex difference in terms of lifetime prevalence did not reach statistical significance, suggesting that skin bleaching is a unisex practice. Additionally, the association of only the proportion of females in study samples with skin bleaching prevalence in the meta-regression analysis is consistent with the truism in the field.[4,5,56]

The prevalence of skin bleaching varied considerably across the globe, with Africa and Asia being the continents characterized by the highest practice in line with evidence from global market analysis, suggesting these regions to be the largest and fastest growing skin bleaching markets.[55] This result may also be a reflection of engrained cultural perceptions about skin color and the increasing use of light-skinned models for cosmetic products targeting black consumers.[57–59] Although prevalence for the Middle East did not reach statistical significance and there was a paucity of data from Europe, North America, South America, and Oceania, the broad range of countries presenting empirical evidence of skin bleaching prevalence suggests that the practice of skin bleaching is a global phenomenon.[5,6,9,56]

As previously noted, prolonged skin bleaching and the use of toxic and highly potent agents has been associated with various adverse consequences.[4,5,8,12] In line with the above, the high prevalence estimate for patients (21.3%) is reasonable. On the other hand, this cohort may be more likely to suffer from preexisting dermatoses for which skin bleaching agents may be required. In fact, individuals may first seek skin bleaching agents primarily to treat preexisting dermatoses, such as postinflammatory hyperpigmentation in the setting of acne, eczema, and papular urticarial and other inflammatory dermatoses. The misuse of these skin bleaching agents to lighten constitutive skin color may be a secondary phenomenon in some patients. Indeed, about 70% of the cohort in one study had underlying skin pigmentation disorder.[60] In addition, despite the increasing illegalization and regulation as well as public health campaigns against skin bleaching and its agents in many jurisdictions particularly in recent times,[10,12,15] recent prevalence (2010–2017) of 26.8% is high and should be of concern.

Although self-reports have the advantage of generating data from large populations using ethical and relatively cheap methods, studies relying on self-reports have limitations such as false positive and false negative responses particularly when self-reports are not authenticated, using objective measures. Due to the stigmatization of skin bleaching in some countries, skin bleaching agents are marketed using various nomenclature such as "skin-evening creams, skin lighteners, skin-brighteners, skin-whiteners, skin-toners, fading creams, or fairness creams" (p. 148).[58] Hence, some practitioners do not admit engaging in skin bleaching and use some of the above euphemistic

Table 4 Meta-regression analysis of correlates of skin bleaching prevalence

Variable	*B*	SE (95% CI)	*Z*
Region			
Africa[a]			
Asia	−0.63	0.62 (−1.84 to 0.59)	−1.01[ns]
Europe	−0.04	1.38 (−2.75 to 2.66)	−0.03[ns]
Middle East	−0.94	0.69 (−2.30 to 0.42)	−1.35[ns]
North America	−2.08	1.62 (−5.26 to 1.11)	−1.28[ns]
Sample type			
Patients[a]			
Community	0.05	0.59 (−1.11 to 1.20)	0.08[ns]
High school students/adolescents	0.70	1.37 (−1.98 to 3.38)	0.51[ns]
Tertiary/university students	−0.75	1.13 (−2.96 to 1.46)	−0.67[ns]
Data/study period			
2010–2017[a]			
1970–1979	0.35	0.92 (−2.15 to 1.44)	−0.39[ns]
1980–1989	−1.69	0.95 (−3.54 to 0.16)	−1.79[ns]
1990–1999	−0.49	0.66 (−1.78 to 0.79)	−0.75[ns]
2000–2009	0.63	0.46 (−0.28 to 1.54)	1.36[ns]
Assessment method			
DET ± other[a]			
Interview only	−0.76	0.94 (−2.60 to 1.09)	−0.81[ns]
Questionnaire only	0.50	0.61 (−0.70 to 1.70)	0.81[ns]
Interview + questionnaire	0.13	0.77 (−1.39 to 1.64)	0.16[ns]
Sampling method			
Nonrandom[a]			
Random	−0.61	0.61 (−1.81 to 0.59)	−1.00[ns]
% females in sample			
Not provided[a]			
>75%	1.88	0.48 (0.94 to 2.81)	3.94*
51–75%	2.89	0.79 (1.35 to 4.44)	3.66*
% ≤30 years in sample			
Not provided[a]			
>75%	0.48	0.86 (−1.20 to 2.16)	0.56[ns]
51–75%	0.79	0.53 (−0.25 to 1.82)	1.49[ns]
≤50%	0.11	0.55 (−0.97 to 1.18)	0.20[ns]
Study quality/risk of bias[b]			
Moderate quality/risk[a]			
High quality/low risk	0.36	0.68 (−0.97 to 1.68)	0.53[ns]

R^2 = 57.0%. DET, dermatological evaluation and test.
[a]Reference category.
[b]Range (0–9): high quality/low risk (0–3), moderate quality/risk (4–6), poor quality/high risk (7–9).
*$P < 0.001$; [ns]not significant.

nomenclature in denying or rejecting their skin bleaching practice.[2,58,61] Thus, self-reports are vulnerable to reporting biases. In contrast, dermatological evaluation and testing may objectively provide valid prevalence estimates. Nonetheless, our findings show that studies including dermatological evaluation and testing as validation for self-reports (interviews and/or questionnaires) and those using only interviews are associated with similar prevalences.

Many substances were used for skin bleaching, of which topical corticosteroids were the most popular. Besides other previously delineated harms, this should be of concern with the accumulating evidence of topical corticosteroid dependence.[25,62–64] Mercury-containing skin bleaching agents were the second most popular agent despite the fact that such cosmetics are illegal or regulated in many parts of the world.[10,12] The present finding corroborates growing reports of the availability and use of high mercury-containing bleaching agents.[12,65] This trend is worrisome considering harms associated with the use of such agents including mercury poisoning, renal dysfunction, and neurological disorders.[8,66] We also found that a large proportion of skin bleachers (32.7%) resort to the use of other substances including acids, caustics, herbal derivatives, and products of unknown composition with potentially dangerous consequences. This study also provides global evidence of hydroquinone use and the practice of polypharmacy among skin bleaching practitioners although their respective prevalence estimates did not reach statistical significance.

Moreover, skin bleaching has been described as an element of the youth culture of persons from largely nonwestern contexts or of darker skin tone.[5,13,56,57] Our findings on age prevalence from the meta-analysis is in line with this perspective. In addition, obtaining social capital such as congeniality, esteem, and status and the chances of finding a spouse or employment are important motives for skin bleaching[2,3,9,67,68] which pertain more strongly to younger than to older individuals. In sum, our findings on educational experience, marriage, employment, and practice during pregnancy show that the practice of skin bleaching transcends academic, relationship/marriage, employment, and pregnancy boundaries.

Also, the present finding associating urban and semiurban residents with a higher prevalence compared to rural residents is in line with expert opinion[69] and other viewpoints[2,70]. It is tenable that urban and semiurban residents in nonwestern cultural contexts have higher exposure to western images of 'lighter beauty' and skin bleaching advertisements and products and are more exposed to the Internet as well as social media, activities, and festivities. It has been argued that this phenomenon is related to the high skin bleaching prevalence among urban and semiurban residents who aim at meeting 'lighter' standards of beauty and enhancing their perceived appearance at social events.[57,58,71] It has also been indicated that rural work such as farming exposes people to ultraviolet radiation with subsequent darkening of skin. Hence, rural-to-urban migrants tend to practice skin bleaching in order to enhance their skin color and disguise their rural origin[68] as a means to avoiding stigmatization and prejudice sometimes targeted at rural-to-urban migrants.[72,73]

Strengths and Limitations

Our study represents the first systematic and quantitative examination of the global prevalence of skin bleaching. Contemporarily, findings represent the best empirical basis for policymaking and planning. Other strengths of our study include the comprehensive search, the study's global scope, and the innovative data analysis minimizing the effect of extreme studies and combining both meta-analysis and meta-regression analysis. Nonetheless, our study has some limitations that should be considered when interpreting findings. First, as with all systematic reviews, it is reasonable that methodical limitations associated with included studies and their results may have influenced our results.

Also, most studies sampled persons from nonwestern cultural contexts (Africa, Asia, and the Middle East). Indeed, we did not find sufficient studies for estimation of generalizable prevalences for Europe, North America, Oceania, and South America despite reports of skin bleaching practice in Europe,[38,74] North America,[44,75] Oceania,[76,77] and South America.[78,79] Additionally, we examined lifetime prevalence which is typically higher than other prevalence estimates (e.g. past year, past month, and current) because of the possibility of abstinence and termination as well as susceptibility to recall bias.[80,81]

Conclusions and Future Directions

The results of our study have important implications for healthcare professionals, policymakers, and researchers. We provide evidence of a high global prevalence of skin bleaching transcending various geographic, demographic and socioeconomic boundaries. Hence, the practice of skin bleaching should be an issue of global public health concern. This practice and associated harms may be addressed through the regulation of dangerous skin bleaching products, massive consumer education about complications of skin bleaching, highlighting the benefits of melanin pigmentation against ultraviolet radiation and associated dermatoses, and targeted harm reduction and preventive interventions among others as discussed elsewhere.[5,8,9,15,82]

There is also the need for epidemiological studies in currently underrepresented regions such as Europe, the Middle East, North- and South America, and Oceania to elucidate the prevalence, correlates, and associated harms. This study provides a strong foundation that can be enhanced with the accumulation of additional epidemiological evidence especially from currently underrepresented regions. Further, self-report measures of skin bleaching practice varied across studies, and scientists are encouraged to move toward a standard self-report measure in order to facilitate comparisons of studies. With evidence of the various associated harms, quantitative investigations of exposure to skin bleaching agents and their potential health effects are also warranted.

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