

Aus der Abteilung für Zahnerhaltung und Präventivzahnmedizin des
CharitéCentrum 3 für Zahn-, Mund- und Kieferheilkunde
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DISSERTATION

“Inequality in utilization of dental services: Systematic Review
and meta-analysis”

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von

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1. Abstract

Deutsch

Erkrankungen der Zähne und des Zahnhalteapparates gehören zu den meistverbreiteten Erkrankungen, die jährlich Millionen von Menschen betreffen und in deren Lebensqualität beeinträchtigen. Einer der wichtigsten Faktoren in der Vermeidung von dentalen Erkrankungen ist der Zugang zu zahnärztlicher Versorgung - gerade hier herrscht jedoch global gesehen eine große Ungleichheit.

Das Forschungsziel dieser Arbeit ist die Einschätzung und Beurteilung dieser Ungleichheit; neben den Ursachen sollen auch etwaige Veränderungen über den Zeitraum der letzten zwölf Jahre untersucht werden.

Unter Verwendung von drei Datenbanken (Medline, Embase, Central) wurde eine systematische Überprüfung und Metaanalyse des Zeitraums von 01/2005 bis 04/2017 durchgeführt. Einbezogene Studien untersuchten die Assoziation zwischen regelmäßiger Nutzung zahnärztlicher Versorgung und Geschlecht, sowie Ethnizität, Lebensort, Bildungshintergrund, Einkommen und Beruf, sowie Versicherungsstatus.

Die Auswahl potenziell relevanter Studien wurde von zwei unabhängigen Prüfern durchgeführt. Der Ein- oder Ausschluss von Studien geschah in Übereinstimmung beider Prüfer. Nach sorgfältiger Evaluation wurden 117 Studien einbezogen und Ergebnisse auf der Basis von 7.380.810 Studienteilnehmern ausgewertet.

Nicht nur die Existenz, sondern vor allem das große Ausmaß der Ungleichheit im Bezug auf die Nutzung von zahnärztlicher Versorgung war das vorrangige Ergebnis dieser Auswertung.

Die Nutzung von zahnärztlicher Versorgung war geringer: bei männlichen Teilnehmern als bei weiblichen Teilnehmern (OR 0.85; 95% CI:0.74 to 0.95; $p < 0.001$); bei ethnische Minderheiten oder Immigranten als bei Mehrheiten oder Einheimischen (0.71; 0.59 zu 0.82; $p < 0.001$); bei Bewohnern von ländlichen Gegenden als bei Stadtbewohnern (0.87; 0.76 to 0.97; $p = 0.011$); bei Teilnehmern mit geringerem als mit höherem Bildungshintergrund (0.61; 0.55 to 0.68; $p < 0.001$) oder geringerem als höherem Einkommen (0.66; 0.54 to 0.79; $p < 0.001$) und bei unversicherten Teilnehmern verglichen mit versicherten Teilnehmern (0.58; 0.49 to 0.68; $p < 0.001$). Stellung im Beruf (0.95; 0.81 to 1.09; $p = 0.356$) hatte keine signifikante Auswirkung auf die Nutzung zahnärztlicher Versorgung. Die beobachtete Ungleichheit veränderte sich über den untersuchten Zeitraum von zwölf Jahren nur unwesentlich und war allgemein gegenwärtig.

Schlussfolgernd sind Ungleichheiten in der Nutzung von zahnärztlicher Versorgung weltweit vorhanden und über den Zeitraum der letzten zwölf Jahre konstant.

1. Abstract

Englisch

Among the most prevalent diseases, globally affecting billions of people, are dental diseases. One of the most important factors in preventing dental diseases is gaining access to dental services. However there remains a global inequality in access to dental service utilization.

Our study aimed to assess the extent of inequality on a global scale and examine the factors underlying the inequality of dental service utilization. Furthermore we aimed to evaluate the changes in inequality over a period of twelve years.

Using three databases (Medline, Embase, Central), a systematic review and meta-analysis was performed covering a time period from 01/2005 up to 04/2017. Included studies investigated associations between regular dental service utilization and sex, ethnicity, place of living, educational or income or occupational position, or insurance coverage status.

Screening of relevant studies was performed by two independent reviewers and in- or excluded upon consensus. The primary outcome for the study was presence and extent of inequality in dental service utilization, being measured as relative estimates (usually Odds Ratios) comparing the different groups between high utilization and low utilization.

Random-effects meta-analysis and subgroup analysis by region was then performed and meta-regression was performed to assess if and how associations changed during this time period.

After careful evaluation 117 studies were included and results obtained based on 7,830,810 participants.

Dental services utilization was lower in: males than females (OR 0.85; 95% CI:0.74 to 0.95; $p<0.001$); ethnic minorities or immigrants than majorities or natives (0.71; 95% CI = 0.59, 0.82; $p<0.001$); those living rurally rather than urban (0.87; 0.76 to 0.97; $p=0.011$); those with lower than higher educational position (0.61; 0.55 to 0.68; $p<0.001$) or income (0.66; 0.54 to 0.79; $p<0.001$), and among those without insurance coverage status than those with such status (0.58; 0.49 to 0.68; $p<0.001$). Occupational status (0.95; 0.81 to 1.09; $p=0.356$) had no significant impact on utilization. The observed inequalities did not significantly change over the assessed 12-year period, and were universally present.

In conclusion inequality in dental service utilization are present world-wide and consistent during the past 12-year period.

2. Eidesstattliche Versicherung

„Ich, Sophie Franziska Reda, versichere an Eides statt durch meine eigenhändige Unterschrift, dass ich die vorgelegte Dissertation mit dem Thema: „Inequality in utilization of dental services: Systematic Review and meta-analysis“ selbstständig und ohne nicht offengelegte Hilfe Dritter verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel genutzt habe.

Alle Stellen, die wörtlich oder dem Sinne nach auf Publikationen oder Vorträgen anderer Autoren beruhen, sind als solche in korrekter Zitierung (siehe „Uniform Requirements for Manuscripts (URM)“ des ICMJE -www.icmje.org) kenntlich gemacht. Die Abschnitte zu Methodik (insbesondere praktische Arbeiten, Laborbestimmungen, statistische Aufarbeitung) und Resultaten (insbesondere Abbildungen, Graphiken und Tabellen) entsprechen den URM (s.o) und werden von mir verantwortet.

Mein Anteil an der ausgewählten Publikation entspricht dem, der in der untenstehenden gemeinsamen Erklärung mit dem/der Betreuer/in, angegeben ist. Sämtliche Publikationen, die aus dieser Dissertation hervorgegangen sind und bei denen ich Autor bin, entsprechen den URM (s.o) und werden von mir verantwortet.

Die Bedeutung dieser eidesstattlichen Versicherung und die strafrechtlichen Folgen einer unwahren eidesstattlichen Versicherung (§156,161 des Strafgesetzbuches) sind mir bekannt und bewusst.“

Datum

Unterschrift

Ausführliche Anteilserklärung an der erfolgten Publikation

Publikation 1: **Sophie Reda**, Seif Reda, William Murray Thomson, Falk Schwendicke, **Inequality in utilization of dental services: Systematic Review and meta-analysis**, American Journal of Public Health, published online ahead of print December 21 2017

Beitrag im Einzelnen:

Sophie Franziska Reda hatte folgenden Anteil an der erfolgten Publikation: Literaturrecherche und Datenerhebung, Interpretation der analysierten Daten, Mitarbeit bei der Verfassung des Artikels sowie endgültige Revision.

Unterschrift, Datum und Stempel des betreuenden Hochschullehrers/der betreuenden Hochschullehrerin

Unterschrift des Doktoranden/der Doktorandin

3. Auszug aus der Journal Summary List

Journal Data Filtered By: **Selected JCR Year: 2016** Selected Editions: SCIE,SSCI
 Selected Categories: **“PUBLIC, ENVIRONMENTAL and OCCUPATIONAL HEALTH”** Selected Category Scheme: WoS
Gesamtanzahl: 333 Journale

Rank	Full Journal Title	Total Cites	Journal Impact Factor	Eigenfactor Score
1	Lancet Global Health	2,649	17.686	0.015380
1	Lancet Global Health	2,649	17.686	0.015380
3	MMWR-MORBIDITY AND MORTALITY WEEKLY REPORT	23,370	11.483	0.084010
4	Annual Review of Public Health	4,974	10.228	0.008800
4	Annual Review of Public Health	4,974	10.228	0.008800
6	ENVIRONMENTAL HEALTH PERSPECTIVES	37,319	9.776	0.044780
7	INTERNATIONAL JOURNAL OF EPIDEMIOLOGY	19,327	7.738	0.046360
8	EUROPEAN JOURNAL OF EPIDEMIOLOGY	6,462	7.226	0.015900
9	EPIDEMIOLOGIC REVIEWS	3,282	7.160	0.003790
10	Clinical Epidemiology	1,625	7.056	0.007850
11	EPIDEMIOLOGY	11,965	5.986	0.020770
11	EPIDEMIOLOGY	11,965	5.986	0.020770
13	JOURNAL OF TOXICOLOGY AND ENVIRONMENTAL HEALTH-PART B-CRITICAL REVIEWS	1,475	5.815	0.001880
14	TOBACCO CONTROL	6,544	5.469	0.015930
14	TOBACCO CONTROL	6,544	5.469	0.015930
16	JOURNAL OF CLINICAL EPIDEMIOLOGY	22,958	4.978	0.034140
17	BULLETIN OF THE WORLD HEALTH ORGANIZATION	13,747	4.939	0.016290
18	AMERICAN JOURNAL OF EPIDEMIOLOGY	36,389	4.825	0.047280
19	INTERNATIONAL JOURNAL OF HYGIENE AND ENVIRONMENTAL HEALTH	3,702	4.643	0.006500
20	NICOTINE & TOBACCO RESEARCH	8,064	4.609	0.021280
20	NICOTINE & TOBACCO RESEARCH	8,064	4.609	0.021280
22	INDOOR AIR	3,914	4.383	0.005060
23	PALLIATIVE MEDICINE	4,309	4.220	0.007430
24	CANCER EPIDEMIOLOGY BIOMARKERS & PREVENTION	19,570	4.142	0.033440
25	SCANDINAVIAN JOURNAL OF WORK ENVIRONMENT & HEALTH	4,625	4.071	0.005620
25	SCANDINAVIAN JOURNAL OF WORK ENVIRONMENT & HEALTH	4,625	4.071	0.005620
27	AMERICAN JOURNAL OF PREVENTIVE MEDICINE	18,936	4.020	0.042310

Rank	Full Journal Title	Total Cites	Journal Impact Factor	Eigenfactor Score
28	JOURNAL OF ADOLESCENT HEALTH	12,728	3.974	0.026390
28	JOURNAL OF ADOLESCENT HEALTH	12,728	3.974	0.026390
30	OCCUPATIONAL AND ENVIRONMENTAL MEDICINE	7,949	3.912	0.010310
31	AMERICAN JOURNAL OF PUBLIC HEALTH	34,671	3.858	0.062750
31	AMERICAN JOURNAL OF PUBLIC HEALTH	34,671	3.858	0.062750
33	ENVIRONMENTAL RESEARCH	10,802	3.835	0.018070
34	Environmental Health	3,747	3.816	0.009760
35	JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH	12,671	3.608	0.019620
35	JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH	12,671	3.608	0.019620
37	INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY	10,368	3.550	0.019220
38	DRUG SAFETY	4,463	3.435	0.006560
39	PREVENTIVE MEDICINE	13,121	3.434	0.025250
40	International Journal of Health Geographics	1,929	3.282	0.003870
40	International Journal of Health Geographics	1,929	3.282	0.003870
42	AIDS PATIENT CARE AND STDS	3,187	3.236	0.006510
43	Travel Medicine and Infectious Disease	1,191	3.055	0.003150
44	JOURNAL OF HEALTH AND SOCIAL BEHAVIOR	7,130	3.000	0.004720
45	Antimicrobial Resistance and Infection Control	490	2.989	0.002190
45	Translational Behavioral Medicine	818	2.989	0.003970
45	Translational Behavioral Medicine	818	2.989	0.003970
48	Journal of Exposure Science and Environmental Epidemiology	3,031	2.927	0.005260
49	AIDS AND BEHAVIOR	7,248	2.916	0.021180
50	Population Health Metrics	1,036	2.910	0.004480
51	MEDICAL CARE	18,046	2.897	0.021300
52	PSYCHIATRIC SERVICES	9,745	2.888	0.015770
52	PSYCHIATRIC SERVICES	9,745	2.888	0.015770
54	NEUROEPIDEMIOLOGY	3,048	2.886	0.005800
55	TROPICAL MEDICINE & INTERNATIONAL HEALTH	7,033	2.850	0.012730
56	SOCIAL SCIENCE & MEDICINE	36,324	2.797	0.050290
56	SOCIAL SCIENCE & MEDICINE	36,324	2.797	0.050290

4. Druckexemplar der ausgewählten Publikation

<https://dx.doi.org/10.2105/AJPH.2017.304180>

5. Appendix

Electronic Appendix

This appendix includes the following elements:

eTable 1: Excluded studies, with reasons for exclusion

eTable 2: Included studies

eTable 3: Risk of bias of included studies

eFigure 1: Forest plot for the association between sex dental services utilization.

eFigure 2: Funnel plot for the meta-analysis of the association between sex and dental services utilization.

eFigure 3: Forest plot for the association between ethnicity and dental services utilization.

eFigure 4: Funnel plot for the meta-analysis of the association between ethnicity and dental services utilization.

eFigure 5: Forest plot for the association between place of living and dental services utilization.

eFigure 6: Funnel plot for the meta-analysis of the association between place of living and dental services utilization.

eFigure 7: Forest plot for the association between educational position and dental services utilization.

eFigure 8: Funnel plot for the meta-analysis of the association between educational position and dental services utilization.

eFigure 9: Forest plot for the association between income and dental services utilization.

eFigure 10: Funnel plot for the meta-analysis of the association between income and dental services utilization.

eFigure 11: Forest plot for the association between occupational position and dental services utilization.

eFigure 12: Funnel plot for the meta-analysis of the association between occupational position and dental services utilization.

eFigure 13: Forest plot for the association between insurance coverage status and dental services utilization.

eFigure 14: Funnel plot for the meta-analysis of the association between insurance coverage status and dental services utilization.

eTable 1: Excluded studies, with reasons for exclusion

Study	Reason for exclusion
1	Drug users
2	Language
3	Outcome not dental utilization
4	Outcome not dental utilization
5	Outcome not dental utilization
6	Outcome not dental utilization
7	Language
8	No multivariable analysis of inequalities in utilization
9	No multivariable analysis of inequalities in utilization
10	No multivariable analysis of inequalities in utilization
11	No multivariable analysis of inequalities in utilization
12	Dental utilization after expansion of a dental project
13	No multivariable analysis of inequalities in utilization
14	No multivariable analysis of inequalities in utilization
15	No multivariable analysis of inequalities in utilization
16	References not clear
17	Outcome not dental utilization
18	Outcome not dental utilization
19	Language
20	Outcome not dental utilization
21	Outcome not dental utilization
22	Language
23	No multivariable analysis of inequalities in utilization
24	Outcome not dental utilization
25	No multivariable analysis of inequalities in utilization
26	Language
27	Outcome not dental utilization
26	Language
28	No multivariable analysis of inequalities in utilization
29	Outcome not dental utilization
30	Language
31	Language
32	No multivariable analysis of inequalities in utilization
33	Language

34 Outcome not dental utilization
35 No multivariable analysis of inequalities in utilization
36 Language
37 No multivariable analysis of inequalities in utilization
38 No multivariable analysis of inequalities in utilization
39 No multivariable analysis of inequalities in utilization
40 No multivariable analysis of inequalities in utilization
41 Outcome not dental utilization
42 No multivariable analysis of inequalities in utilization
43 Outcome not dental utilization
44 Outcome not dental utilization
45 No multivariable analysis of inequalities in utilization
46 No multivariable analysis of inequalities in utilization
47 No multivariable analysis of inequalities in utilization
48 Not available
49 No multivariable analysis of inequalities in utilization
50 Not dental
51 Outcome not dental utilization
52 Outcome not dental utilization
53 No multivariable analysis of inequalities in utilization
54 No multivariable analysis of inequalities in utilization
55 Outcome not dental utilization
56 No multivariable analysis of inequalities in utilization
57 No multivariable analysis of inequalities in utilization
58 No multivariable analysis of inequalities in utilization
59 Outcome not dental utilization
60 No multivariable analysis of inequalities in utilization
61 Unclear estimates
62 Outcome not dental utilization
63 No multivariable analysis of inequalities in utilization
64 No multivariable analysis of inequalities in utilization
65 Outcome not dental utilization
66 Outcome not dental utilization
67 Outcome not dental utilization
68 No multivariable analysis of inequalities in utilization
69 Outcome not dental utilization

70 No multivariable analysis of inequalities in utilization
71 No multivariable analysis of inequalities in utilization
72 No multivariable analysis of inequalities in utilization
73 Outcome not dental utilization
74 No multivariable analysis of inequalities in utilization
75 No multivariable analysis of inequalities in utilization
76 No multivariable analysis of inequalities in utilization
77 No multivariable analysis of inequalities in utilization
78 Reference categories not clear
79 Outcome not dental utilization
80 No multivariable analysis of inequalities in utilization
81 No multivariable analysis of inequalities in utilization
82 Reference categories not clear
83 No multivariable analysis of inequalities in utilization
84 Outcome not dental utilization
85 Outcome not dental utilization
86 No multivariable analysis of inequalities in utilization
87 Outcome not dental utilization
88 Language
89 Not available
90 Reference categories not clear
91 Not available
92 No odd ratios
93 No odd ratios
94 Outcome not dental utilization
95 Outcome not dental utilization
96 Outcome not dental utilization
97 No multivariable analysis of inequalities in utilization
98 Duplicative survey
99 Duplicative survey
100 Duplicative survey
101 Duplicative survey
102 Duplicative survey
103 Duplicative survey
104 Not available
105 Estimates unclear

106 No multivariable analysis of inequalities in utilization
107 Stroke patients
108 References not clear
109 Duplicative survey
110 Not available
41 Outcome with self rated oral health
111 Reference categories not clear
112 Outcome first dental visit
113 Reference categories not clear
11 No multivariable analysis of inequalities in utilization
114 Outcome not dental utilization
115 Factory worker employees
116 Missing data
117 Reference categories not clear
118 Outcome not dental utilization
119 Duplicative survey
120 Reference categories not clear
121 Outcome not dental utilization
122 Cognitive impairment
123 Reference categories not clear
124 Duplicative survey
125 Only cost-related non-attendance
126 Reference categories not clear
127 Pregnant women
128 Pregnant women

eTable 2: Included studies.

Study name	Year of survey	Country	National sample (yes=1, no=0)	Sample	Age	Sample size
Al Agili 2005 ¹²⁹	2003	USA	0	Medicaid-enrolled children	3-19	1766
Al-Haboubi 2013 ¹³⁰	2003	UK	0	Adults in socially deprived, ethnically diverse metropolitan area	16+	695
Al-Shammari 2007 ¹³¹	2003	Kuwait	0	Kuwaiti nationals	18+	1925
Amin 2014 ¹³²	2013	Canada	0	English-speaking mothers	18-43	423
Anikeeva 2013 ¹³³	2009	Australia	0	Adults	30-61	1096
Arcury 2012 ¹³⁴	2007	USA	0	Adults in North Carolina	60+	635
Areai et al 2011 ¹³⁵	2007	New Zealand	1	Secondary school students	13-17	9098
Astrom 2013 ¹³⁶	1942, 1997, 2002, 2007	Sweden	1	Swedish citizens born in the year 1942	50-65	8888
Ayo-Yusuf 2013 ¹³⁷	2003	South Africa	1	Dentate adult population	15+	6181
Baldani 2011 ¹³⁸	2005	Brazil	0	People living in Pona Grossa	0+	747
Bayat 2006 ¹³⁹	2005	Iran	0	Adults in Teheran	18-60+	1086
Bayat 2008 ¹⁴⁰	2005	Iran	0	Adults in Teheran	18-45+	1019
Bcheraiui 2016 ¹⁴¹	2013	Saudi Arabia	1	Individuals 15+	15+	10735
Berglund 2017 ¹⁴²	2009	Sweden	1	Swedish population	16-84	90845
Bhandari 2015 ¹⁴³	2002	66 Countries	1	Adults who participated in the WHO World Health Survey	18+	223299
Borenstein 2013 ¹⁴⁴	2010	Canada	0	Adults in greater Toronto area	25-64	2245
Brennan 2013 ¹⁴⁵	2009	Australia	0	Adults in Australia	18-32	15170
Brothwell 2008 ¹⁴⁶	1995	Canada	0	Adults, aged>65 years, living independently	>65	1751

Camargo 2012 147	2004	Brazil	0	Children in Pelotas	5	1105
Cavalheiro 2016 148	2002	Brazil	0	Adults and elderly in South Brazil	50-74	720
Christensen 2007 149	1999	Denmark	1	Adults	18+	319809
Christian 2013 150	2006	USA	1	US civilian non- institutionalized adults	18+	22721
Christian 2015 151	2012	Australia	0	Families with 1-4 year old children from Iraqi, Lebanese and Pakistani backgrounds residing in metropolitan Melbourne	1-4	625
Crocombe 2011 152	1996	New Zealand	0	Children born between 1/4/1972 and 31/3/1973	15-32	833
Cruz 2010 153	1998	USA	0	Immigrants in New York	18-65	1417
Davoglio 2013 154	2007	Brazil	0	Adolescents from Gravati	13-15	1170
Drilea 2005 155	2000	USA	1	US adults	18+	15250
Eisen 2015 156	2003	USA	0	Adult Americans in Southwest Baltimore, Maryland	18+	1408
Finlayson 2010 157	2006	USA	0	Hispanic adults	18-55	326
Fuentes-Afflick 2009 158	2001-2004	USA	0	Latina women in the San Francisco Bay Area	17+	710
Gironda 2013 159	2003	USA	1	American adults	40+	2598
Goettems 2012 160	2009	Brazil	0	Mother-child dyads	2-5	608
Granville- Garcia 2015 161	2013	Brazil	0	Preschoolers in Northeastern Brazil	3-6	841
Grytten 2012 75	2008	Norway	1	Norwegian adult population	20+	1861
Guiney 2011 162	2007	Ireland	1	Irish adults	18+	10364
Gülcan 2016 (Norway) 163	2010	Norway	0	Residents of Norway 2007/2012	65-70	3733
Gülcan 2016 (Sweden) 163	2010	Sweden	0	Residents of Sweden 2007/2012	65-70	5697
Hakeberg 2017 164	2011	Sweden	1	Swedish adults	19+	3500
Isong 2005 165	2001	USA	0	California children	2-11	10569

Jang 2017 ¹⁶⁶	2009, 2010, 2011, 2012, 2013, 2014	Korea	1	Korean population	19+	317558 4
Jatrana 2012 ¹⁶⁷	2004	New Zealand	1	New Zealand population	15+	17069
John 2017 ¹⁶⁸	2014	Australia	0	Primary school children	6-13	667
Kaylor et al 2010 ¹⁶⁹	2004	USA	0	Women of child bearing age	18-44	9819
Kim et al 2015 ¹⁷⁰	2008	Korea	0	Adults	19+	184405
Koletsis-Kounari 2011 ¹⁷¹	2006	Greece	1	greek adult	18+	1005
Kosteniuk 2006 ¹⁷²	1999	Canada	0	Saskatchewan residents	18+	5003
Lang 2008 ¹⁷³	2005	England	1	Elderly	65+	4240
Lee 2014 ¹⁷⁴	2010	USA	0	Eldery living in Ohio	65+	2166
Leroy 2013 (a) ¹⁷⁵	2007	Belgium	0	Children	3	587
Leroy 2013 (b) ¹⁷⁵	2009	Belgium	0	Children	5	699
Lewis 2007 ¹⁷⁶	2004	USA	1	US Children	1-17	102353
Lewis 2009 ¹⁷⁷	2003	USA	0	Medicaid-insured children	<6	158125
Li 2011 ¹⁷⁸	1990	Denmark	1	Non-institutionalized Danes	15+	4172
Liu 2007 ¹⁷⁹	2007	USA	1	US Children	1--17	89071
Lopez 2007 ¹⁸⁰	2000	Chile	0	Chilean students	12-21	9203
Macek 2005 ¹⁸¹	2000	USA	0	Maryland school children	kinderg arten and third grade	2642
Machado et al 2012 ¹⁸²	2009	Brazil	0	Older adults in Southern Brazil	20+	3391
Machry 2013 ¹⁸³	2007	Brazil	0	Brazilian preschool children	1-5	478
Maharani 2009 ¹⁸⁴	2006	Indonesia	1	Indonesian population	<15-60 +	116701 9
Mak 2011 ¹⁸⁵	2000	China	0	Students	14-15	4927
Mandal 2013 ¹⁸⁶	2003, 2011	USA	1	American children	1-17	90555
Manski 2010 ¹⁸⁷	2006	USA	1	Retired individuals	51+	16911
Manski 2012 ¹⁸⁸	2008	USA	1	US individuals	51+	14970

Marin 2010 ¹⁸⁹	2001	Argentina	1	Adult population in Buenos Aires	18+	1122
Martin 2012 ¹⁹⁰	2008	USA	0	Early childhood population in South Carolina	<4	95489
Maserejian 2008 ¹⁹¹	1998	USA	0	Children of New England	6-10	534
Mckernan 2015 ¹⁹²	2008	USA	0	Medicaid enrolled children	3-18	146055
Medina-Solis 2006 ¹⁹³	1997	Mexico	0	Preschool children	3-6	1303
Medina-Solis 2008 ¹⁹⁴	2002	Nicaragua	1	Nicaraguan children	6-12	1353
Moeller 2010 ¹⁹⁵	2002	USA	1	American population	<65	10582
Muirhead 2009 ¹⁹⁶	2001	Canada	1	Working Canadians	18-64	1049
Mullachery 2016 ¹⁹⁷	2010	Brazil	1	Brazilian population	18+	60202
Murakami 2014 ¹⁹⁸	2010	Japan	0	Japanese adults	25-50	3083
Netuveli 2006 ¹⁹⁹	2001	England	1	Adolescents and adults	≥16	13784
Newbold 2006 ²⁰⁰	1996	Canada	1	Foreign born residents of Canada	12+	55303
Nihtila 2013 ²⁰¹	2004	Finland	0	Finnish adults	18-44	252
Norton 2013 ²⁰²	2009	USA	1	Children in New York	2-12	2435
Obeidat 2014 ²⁰³	2008	Jordan	0	Jordanian adults	18+	614
Ohi 2009 ²⁰⁴	2002	Japan	0	Community dwelling elderly	70+	1178
Okunseri 2013 ²⁰⁵	2001	USA	1	Adolescents progressing to early adulthood	12-19	50653
Okunseri 2015 ²⁰⁶	2001	USA	1	Young adults	16-26	151760
Ola 2013 ²⁰⁷	2007	Nigeria	1	Senior secondary school pupils in Ile-Ife	15.8	1043
Östberg 2010 ²⁰⁸	2005	Sweden	0	Swedish individuals	19	758
Palacio-Vieira 2013 ²⁰⁹	2003	Spain	0	Children and adolescents	8-18	444
Pavi 2010 ²¹⁰	2006	Greece	1	Greek adults	18+	4003
Piovesan 2011 ²¹¹	2005	Brazil	0	School children	12	792

Pizarro 2009 212	1994, 2001	Spain	0	Catalonia population	0+	23400
Raitto 2014 213	2004	Finland	0	Finnish adults	44+	7553
Roberts- Thomson 2008 214	2005	Australia	1	Australian population	15+	12609
Roberts- Thomson 2011 215	1998	Australia	0	Australian Citizens	18+	819
Sakalauskeine 2009 216	2005	Lithuania	0	University employees	35-44	553
Sanchez- Garcia 2007 217	2005	Mexico	0	Social Security beneficiaries	60+	698
Seirawan 2008 218	2003	USA	1	Non-institutionalized adults	18+	39300
Shi 2010 219	2004	USA	1	US individuals	<65	34403
Sibbritt 2010 220	2001	Australia	1	Older Australian women	18-75	12432
Silva 2011 221	2007	Brazil	0	School children and mothers	11-12	190
Silva 2013 222	2009	Brazil	0	Elderly	60+	438
Slack-Smith 2007 223	2001	Australia	1	Australian Adults	18-24	26863
Sohn 2005 224	2000	USA	0	Adults residing in Detroit	18-69	630
Sohn 2007 225	2002	USA	0	Black children and their primary caregiver	3-5	508
Somkotra 2013 226	2007	Thailand	1	Elderly population	60+	10096
Sözmen 2016 227	2008	Turkey	1	Turkish adults	15+	14655
Stapleton 2015 228	2010	USA	0	African Americans in Indiana	18+	1444
Sugihara 2010 229	2008	Japan	0	Elderly in Mihama Ikiiki Plaza Institute	60-98	211
Takehara 2009 230	2002	Japan	0	Elderly in Tokyo	60+	215
Talla 2013 231	2004	Belgium	1	Non-institutionalized population	15+	5940
Tapias- Ledesma 2005 232	2001	Spain	1	Spanish children	3-15	4023
Tapias- Lesesma 2011 233	2005	Spain	0	Children living in Madrid	3-15	960

Tchicaya 2014 234	2007	Europe	1	European citizens	16+	389405
Telleen 2012 78	2006	USA	0	Low income Latino children	4-8	320
Teusner 2013 235	2004	Australia	0	South Australian adults	45+	493
Teusner 2015 236	2008	Australia	1	Australian dentate adults	18+	1858
Valencia 2012 237	2005	USA	1	Racially diverse children	3-17	3288
Vallejos-Sanchez 2012 238	2006	Mexico	0	Mexican school children	6-12	1373
Vikum 2012 239	2007	Norway	1	Norwegian adults	20+	38550
Wilson 2016 240	2010	USA	1	Adults with Immigration status	18+	98107
Wu 2007a 241	2000	USA	1	Community dwelling older adults	60+	1984
Wu 2007b 242	2003	China	0	Elderly	60+	1044
Wu 2013 243	2001	USA	1	Middle-aged and older Americans	50+	644635

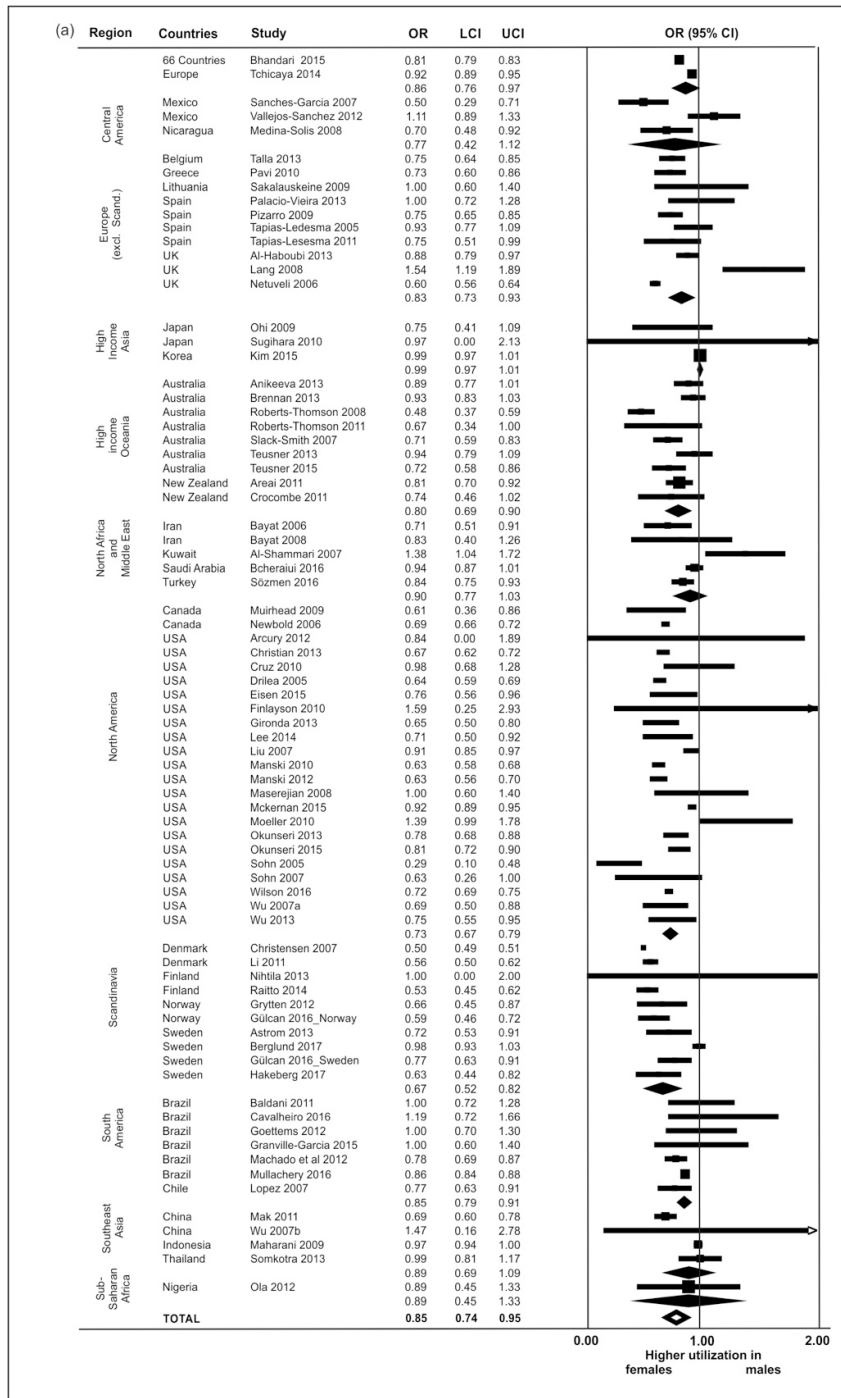
eTable 3: Risk of bias of included studies. The following domains were used, with maximal 1-2 points being given: Representativeness of sample (somewhat/fully= 1, no description=0); national sample (yes=1, no=0); sample size justified (justified or inclusive sampling=1 no=0); sampling bias (non-responders <30%, or justified/explained) (yes=1, no / otherwise =0); ascertainment of exposure (validated tool or interviews=2, non-validated tooth or self-report=1, no tool stated =0); control of confounders (always 2); outcome assessment (independent blinded=2, records or self-report=1; no description =0); statistical test fully described and error estimates given value given (always 1).

S # Study name	Re	Nat	Sa	As	Co	mp	ass	Sta	Tot
	pre	ion	mpl	cer	nt	ass	ess	tisti	
	se	al	e	tain	Co	mp	ass	Sta	
	nta	ion	mpl	me	mp	ass	ess	tisti	
	tiv	al	ma	nt	ass	ess	cal	test	
	es	mp	tion	re	y	ent	test	al	
	s	le	s	e	ty	ent	t	al	
Al Agili 2005 ¹²⁹	1	0	1	1	1	2	1	1	8
Al-Haboubi 2013 ¹³⁰	1	0	1	0	1	2	1	1	7
Al-Shammari 2007 ¹³¹	1	0	1	1	1	2	1	1	8
Amin 2014 ¹³²	0	0	0	1	2	2	0	1	6
Anikeeva 2013 ¹³³	1	0	1	0	1	2	1	1	7
Arcury 2012 ¹³⁴	0	0	1	1	2	2	1	1	8
Areai et al 2011 ¹³⁵	0	1	1	1	2	2	1	1	9
Astrom 2013 ¹³⁶	1	0	1	1	2	2	1	1	9
Ayo-Yusuf 2013 ¹³⁷	1	1	1	1	2	2	1	1	10

Baldani 2011 ¹³⁸	1	0	1	1	2	2	1	1	9
Bayat 2006 ¹³⁹	0	0	0	0	2	2	1	1	6
Bayat 2008 ¹⁴⁰	0	0	0	1	2	2	1	1	7
Bcheraiui 2016 ¹⁴¹	1	1	1	1	2	2	1	1	10
Berglund 2017 ¹⁴²	1	1	1	0	1	2	1	1	8
Bhandari 2015 ¹⁴³	1	1	1	1	2	2	1	1	10
Borenstein 2013 ¹⁴⁴	0	0	0	0	1	2	1	1	6
Brennan 2013 ¹⁴⁵	1	0	1	0	1	2	1	1	7
Brothwell 2008 ¹⁴⁶	0	0	1	1	2	2	1	1	8
Camargo 2012 ¹⁴⁷	1	0	1	1	2	2	1	1	9
Cavalheiro 2016 ¹⁴⁸	0	0	1	1	2	2	1	1	8
Christensen 2007 ¹⁴⁹	1	1	1	1	2	2	1	1	10
Christian 2013 ¹⁵⁰	1	1	1	0	1	2	1	1	8
Christian 2015 ¹⁵¹	0	0	0	1	2	2	1	0	6
Crocombe 2011 ¹⁵²	0	0	1	1	1	2	1	1	7
Cruz 2010 ¹⁵³	1	0	1	1	2	2	1	1	9
Davoglio 2013 ¹⁵⁴	0	0	1	1	1	2	1	1	7
Drilea 2005 ¹⁵⁵	1	1	1	1	2	2	1	1	10
Eisen 2015 ¹⁵⁶	1	0	1	0	2	2	1	1	8
Finlayson 2010 ¹⁵⁷	0	0	0	0	2	2	1	1	6
Fuentes-Afflick 2009 ¹⁵⁸	1	0	1	1	2	2	1	1	9
Gironda 2013 ¹⁵⁹	1	1	1	1	2	2	1	1	10
Goettems 2012 ¹⁶⁰	1	0	1	1	2	2	1	1	9
Granville-Garcia 2015 ¹⁶¹	1	0	1	1	2	2	1	1	9
Grytten 2012 ⁷⁵	1	1	1	1	1	2	1	1	9
Guiney 2011 ¹⁶²	1	1	0	0	2	2	1	1	8
Gülcan 2016 (Norway) ¹⁶³	0	0	1	1	1	2	1	1	7
Gülcan 2016 (Sweden) ¹⁶³	0	0	1	0	1	2	1	1	6
Hakeberg 2017 ¹⁶⁴	1	1	1	0	2	2	1	1	9
Isong 2005 ¹⁶⁵	0	0	1	0	1	2	1	1	6
Jang 2017 ¹⁶⁶	1	1	1	1	2	2	1	1	10
Jatrana 2012 ¹⁶⁷	1	1	1	1	2	2	1	1	10
John 2017 ¹⁶⁸	0	0	1	0	1	2	1	1	6
Kaylor et al 2010 ¹⁶⁹	0	0	1	1	2	2	1	1	8
Kim et al 2015 ¹⁷⁰	1	0	1	1	2	2	1	1	9
Koletsis-Kounari 2011 ¹⁷¹	0	1	0	0	2	2	2	1	8
Kosteniuk 2006 ¹⁷²	1	0	1	1	2	2	1	1	9

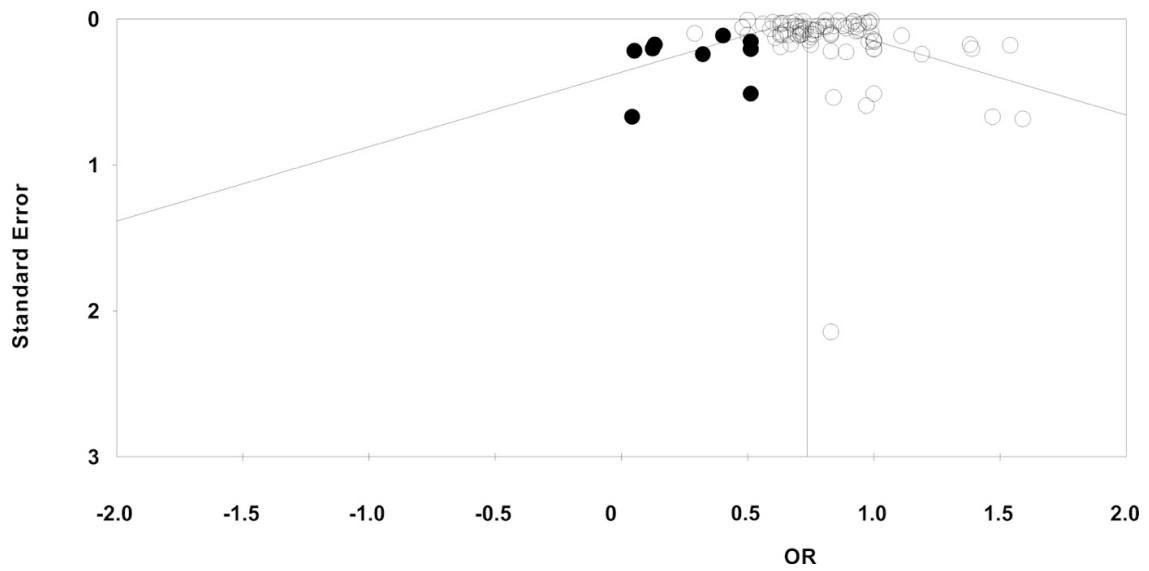
Lang 2008 ¹⁷³	1	1	1	1	2	2	1	1	10
Lee 2014 ¹⁷⁴	1	0	1	1	2	2	1	1	9
Leroy 2013 (a) ¹⁷⁵	1	0	1	0	2	2	1	1	8
Leroy 2013 (b) ¹⁷⁵	1	0	1	0	2	2	1	1	8
Lewis 2007 ¹⁷⁶	1	1	1	1	2	2	1	1	10
Lewis 2009 ¹⁷⁷	0	0	1	1	1	2	1	1	7
Li 2011 ¹⁷⁸	1	1	1	1	2	2	1	1	10
Liu 2007 ¹⁷⁹	1	1	1	1	2	2	1	1	10
Lopez 2007 ¹⁸⁰	0	0	0	1	1	2	1	1	6
Macek 2005 ¹⁸¹	0	0	0	1	2	2	1	1	7
Machado et al 2012 ¹⁸²	1	0	1	1	2	2	1	1	9
Machry 2013 ¹⁸³	0	0	1	1	2	2	1	1	8
Maharani 2009 ¹⁸⁴	1	1	1	1	1	2	1	1	9
Mak 2011 ¹⁸⁵	1	0	1	1	2	2	1	1	9
Mandal 2013 ¹⁸⁶	1	1	1	1	2	2	1	1	10
Manski 2010 ¹⁸⁷	1	1	1	1	2	2	1	1	10
Manski 2012 ¹⁸⁸	1	1	1	1	2	2	1	1	10
Marin 2010 ¹⁸⁹	1	1	1	1	2	2	0	1	9
Martin 2012 ¹⁹⁰	1	0	1	1	2	2	1	1	9
Maserejian 2008 ¹⁹¹	1	0	1	0	2	2	1	1	8
Mckernan 2015 ¹⁹²	1	0	1	1	2	2	1	1	9
Medina-Solis 2006 ¹⁹³	1	0	1	1	2	2	1	1	9
Medina-Solis 2008 ¹⁹⁴	1	1	1	1	1	2	1	1	9
Moeller 2010 ¹⁹⁵	1	1	1	1	2	2	1	1	10
Muirhead 2009 ¹⁹⁶	1	1	1	0	2	2	2	1	10
Mullachery 2016 ¹⁹⁷	1	1	1	1	1	2	1	1	9
Murakami 2014 ¹⁹⁸	1	0	1	0	1	2	1	1	7
Netuveli 2006 ¹⁹⁹	0	1	1	1	1	2	1	1	8
Newbold 2006 ²⁰⁰	1	1	1	1	2	2	1	1	10
Nihtila 2013 ²⁰¹	0	0	1	0	1	2	1	1	6
Norton 2013 ²⁰²	0	1	1	1	2	2	1	1	9
Obeidat 2014 ²⁰³	0	0	0	1	1	2	1	1	6
Ohi 2009 ²⁰⁴	0	0	1	0	1	2	1	1	6
Okunseri 2013 ²⁰⁵	1	1	1	1	2	2	1	1	10
Okunseri 2015 ²⁰⁶	1	1	1	1	2	2	1	1	10
Ola 2013 ²⁰⁷	1	1	1	1	2	2	1	1	10
Östberg 2010 ²⁰⁸	0	0	1	0	1	2	1	1	6

Palacio-Vieira 2013 ²⁰⁹	0	0	1	0	2	2	1	1	7
Pavi 2010 ²¹⁰	1	1	1	1	2	2	1	1	10
Piovesan 2011 ²¹¹	0	0	1	1	2	2	1	1	8
Pizarro 2009 ²¹²	1	0	1	1	2	2	1	1	9
Raitto 2014 ²¹³	1	1	1	1	2	2	1	1	10
Roberts-Thomson 2008 ²¹⁴	1	0	1	0	2	2	0	1	7
Roberts-Thomson 2011 ²¹⁵	0	0	1	0	1	2	1	1	6
Sakalauskeine 2009 ²¹⁶	0	0	0	1	2	2	1	1	7
Sanchez-Garcia 2007 ²¹⁷	1	1	1	1	2	2	1	1	10
Seirawan 2008 ²¹⁸	1	1	1	1	2	2	1	1	10
Shi 2010 ²¹⁹	1	1	1	1	2	2	1	1	10
Sibbritt 2010 ²²⁰	0	0	0	1	2	2	1	1	7
Silva 2011 ²²¹	0	0	1	1	2	2	1	1	8
Silva 2013 ²²²	1	1	1	1	2	2	1	1	10
Slack-Smith 2007 ²²³	0	0	0	1	2	2	1	1	7
Sohn 2005 ²²⁴	0	0	0	1	2	2	1	0	6
Sohn 2007 ²²⁵	1	1	1	1	2	2	1	1	10
Somkotra 2013 ²²⁶	1	1	1	1	2	2	1	1	10
Sözmen 2016 ²²⁷	0	0	1	0	1	2	1	1	6
Stapleton 2015 ²²⁸	0	0	0	1	1	2	1	1	6
Sugihara 2010 ²²⁹	0	0	0	1	1	2	1	1	6
Takehara 2009 ²³⁰	1	1	1	0	2	2	1	1	9
Talla 2013 ²³¹	0	1	1	1	2	2	1	1	9
Tapias-Ledesma 2005 ²³²	0	0	0	1	2	2	1	1	7
Tapias-Ledesma 2011 ²³³	1	1	1	1	1	2	1	1	9
Tchicaya 2014 ²³⁴	0	0	1	1	2	2	1	1	8
Telleen 2012 ⁷⁸	0	0	1	1	1	2	1	1	7
Teusner 2013 ²³⁵	1	1	1	0	2	2	1	1	9
Teusner 2015 ²³⁶	1	1	1	1	2	2	1	1	10
Valencia 2012 ²³⁷	0	0	1	1	1	2	1	1	7
Vallejos-Sanchez 2012 ²³⁸	1	1	1	0	1	2	1	1	8
Vikum 2012 ²³⁹	1	1	1	1	2	2	1	1	10
Wilson 2016 ²⁴⁰	1	1	1	1	2	2	1	1	10
Wu 2007a ²⁴¹	0	0	1	1	2	2	1	1	8
Wu 2007b ²⁴²	1	1	1	1	1	2	1	1	9

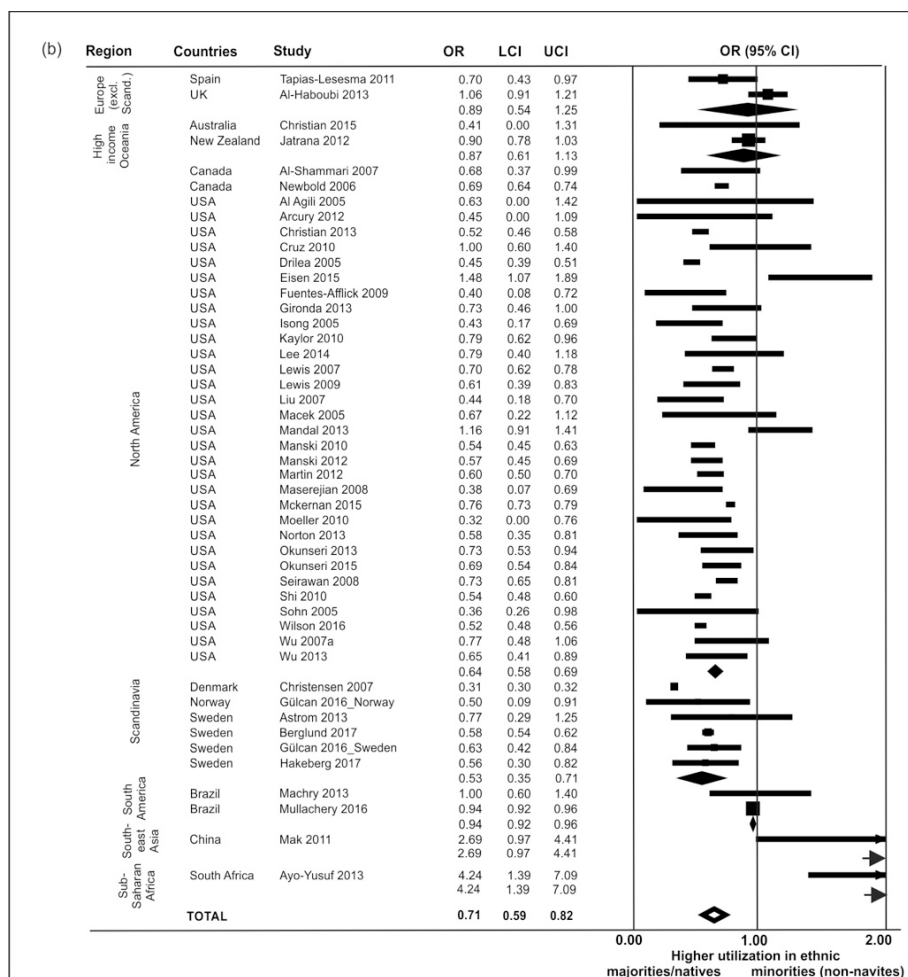


eFigure 1: Forest plot of studies on the association between sex with dental service utilization. Studies are categorized and ordered according to the region and country they were conducted in. Squares indicate the estimates (Odds Ratio [OR]) of single studies; lines the 95% confidence intervals (95% CI). Closed diamonds show the

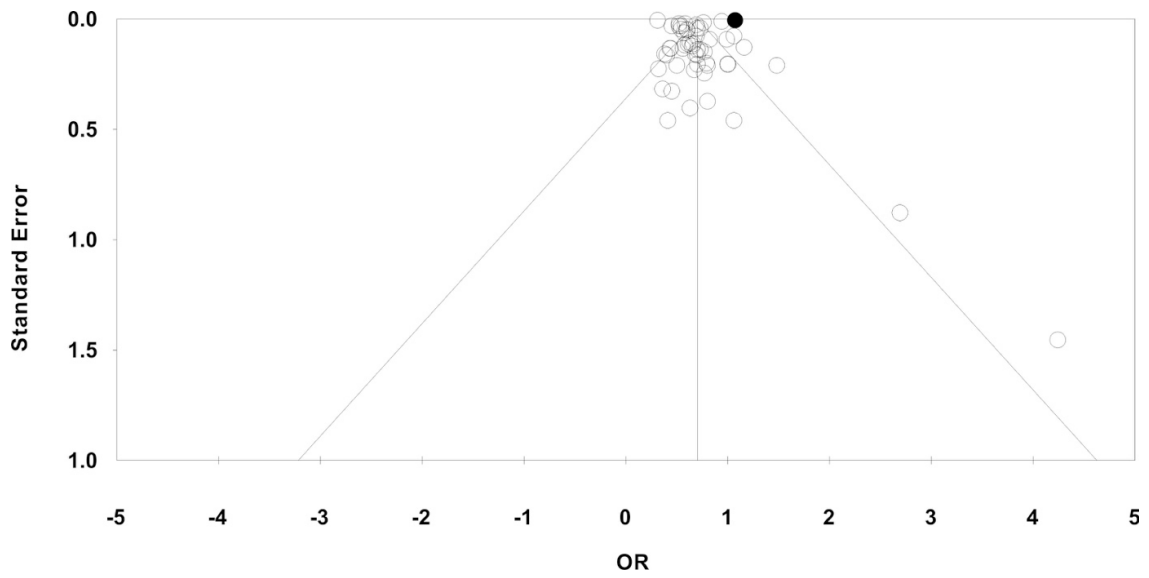
pooled estimates for regions, while the open diamond indicates the overall pooled estimate.



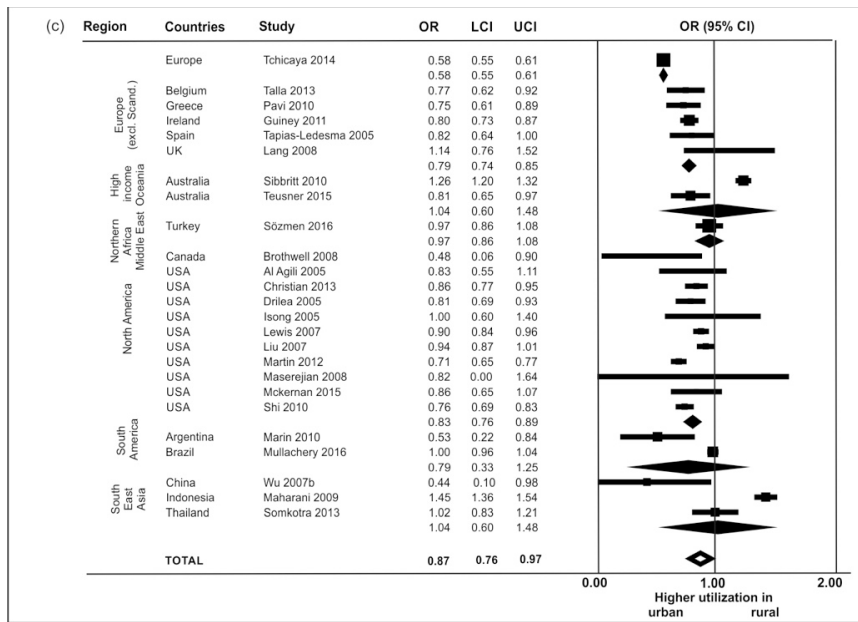
eFigure 2: Funnel plot for the meta-analysis of the association between sex and dental services utilization. The standard error of each estimate is plotted against the OR. An asymmetry indicates possible publication bias. Rings: Reported estimates from included studies. Black circles: imputed estimates.



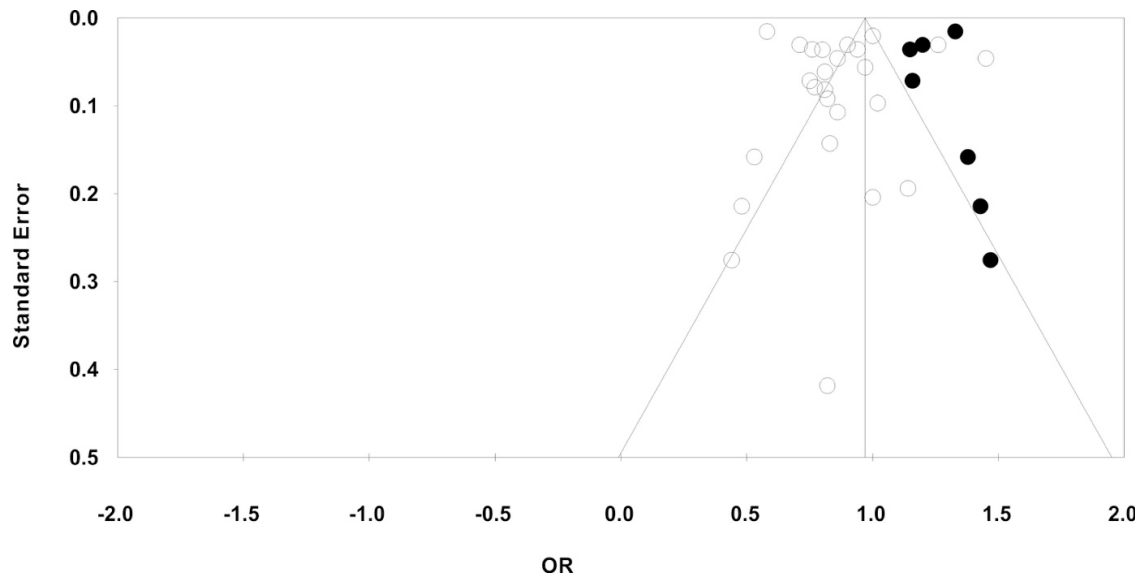
eFigure 3: Forest plot of studies on the association between ethnicity with dental service utilization. Studies are categorized and ordered according to the region and country they were conducted in. Squares indicate the estimates (Odds Ratio [OR]) of single studies; lines the 95% confidence intervals (95% CI). Closed diamonds show the pooled estimates for regions, while the open diamond indicates the overall pooled estimate.



eFigure 4: Funnel plot for the meta-analysis of the association between ethnicity and dental services utilization. The standard error of each estimate is plotted against the OR. An asymmetry indicates possible publication bias. Rings: Reported estimates from included studies. Black circles: imputed estimates.



eFigure 5: Forest plot of studies on the association between place of living with dental service utilization. Studies are categorized and ordered according to the region and country they were conducted in. Squares indicate the estimates (Odds Ratio [OR]) of single studies; lines the 95% confidence intervals (95% CI). Closed diamonds show the pooled estimates for regions, while the open diamond indicates the overall pooled estimate.



eFigure 6: Funnel plot for the meta-analysis of the association between place of living and dental services utilization. The standard error of each estimate is plotted against the OR. An asymmetry indicates possible publication bias. Rings: Reported estimates from included studies. Black circles: imputed estimates.

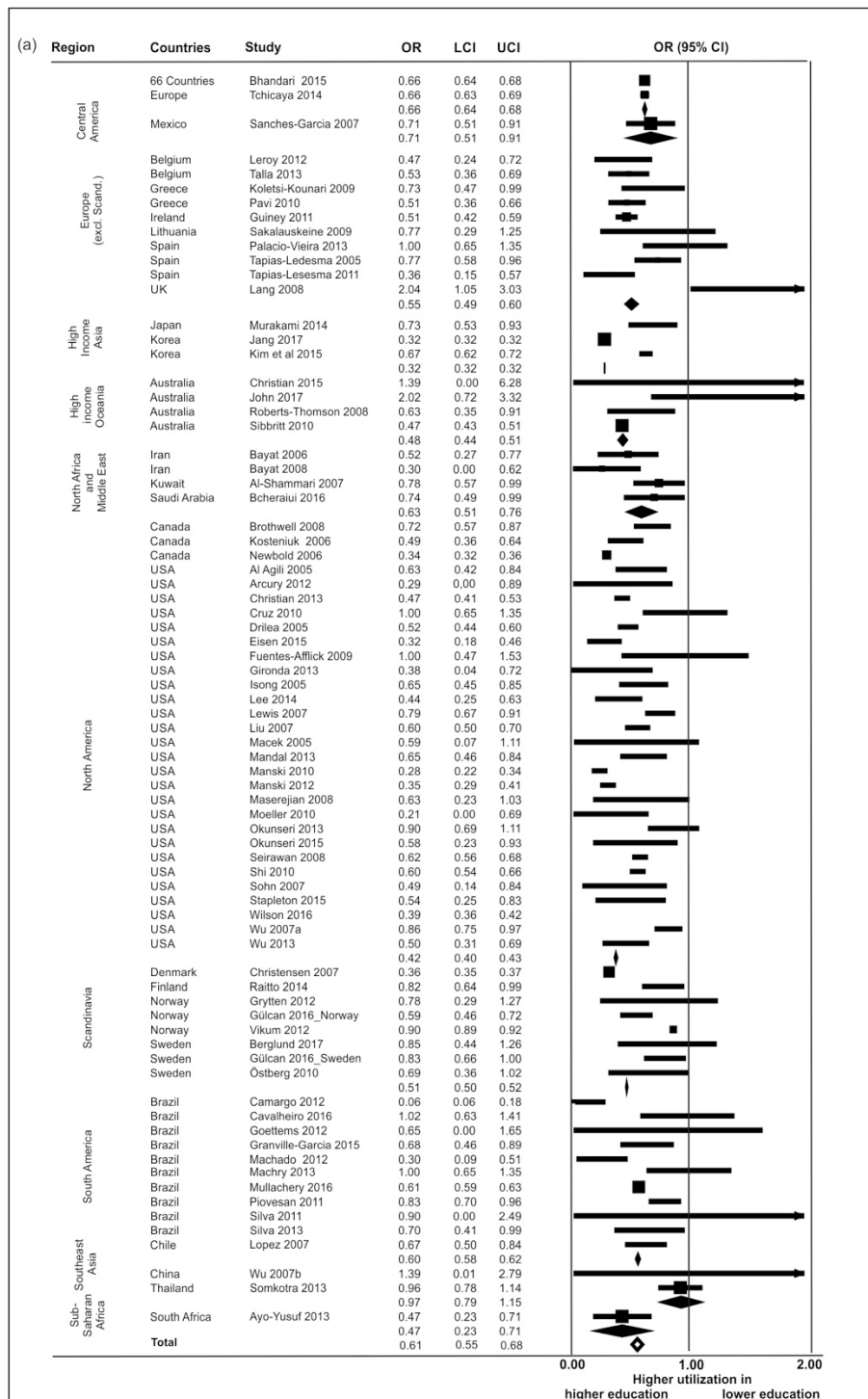
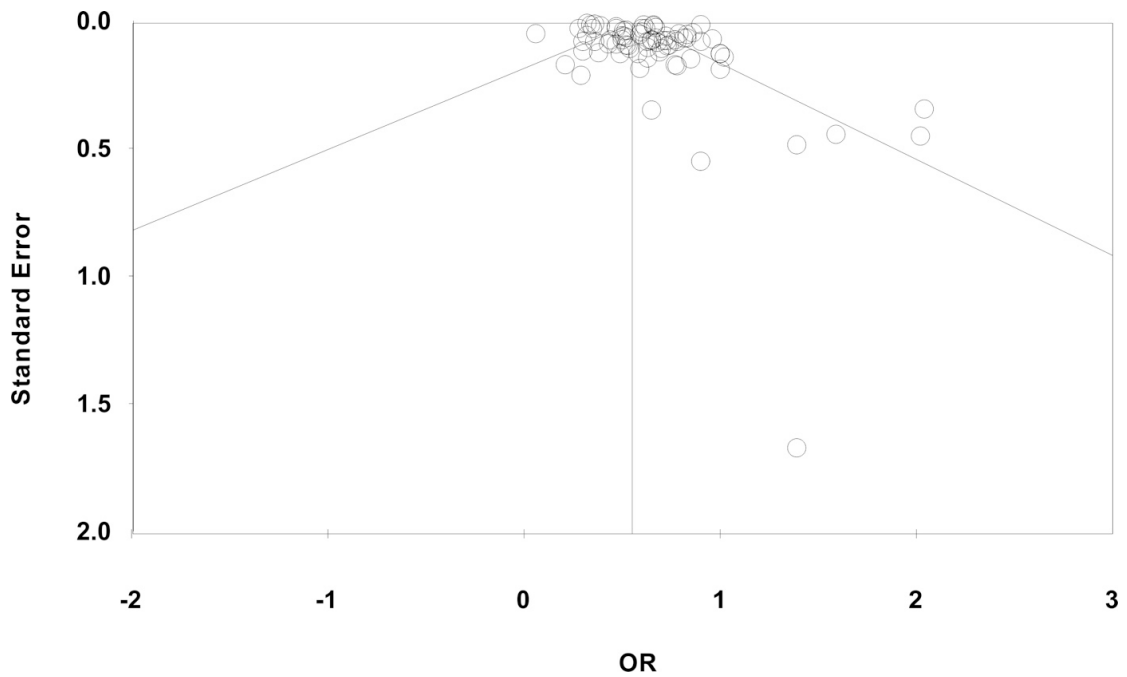
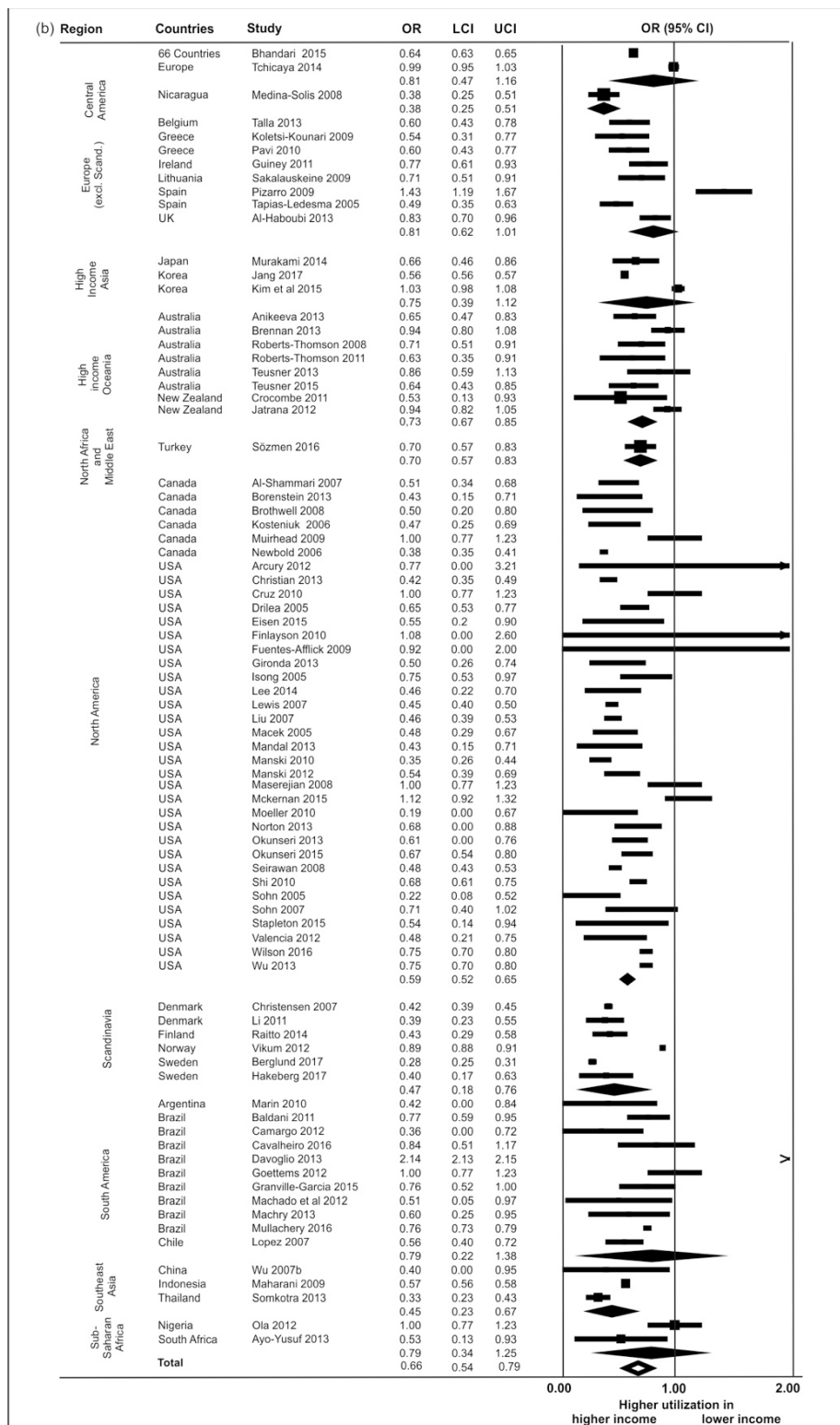


Figure 7: Forest plot of studies on the association between educational position with dental service utilization. Studies are categorized and ordered according to the region and country they were conducted in. Squares indicate the estimates (Odds Ratio [OR]) of single studies; lines the 95% confidence intervals (95% CI). Closed

diamonds show the pooled estimates for regions, while the open diamond indicates the overall pooled estimate.

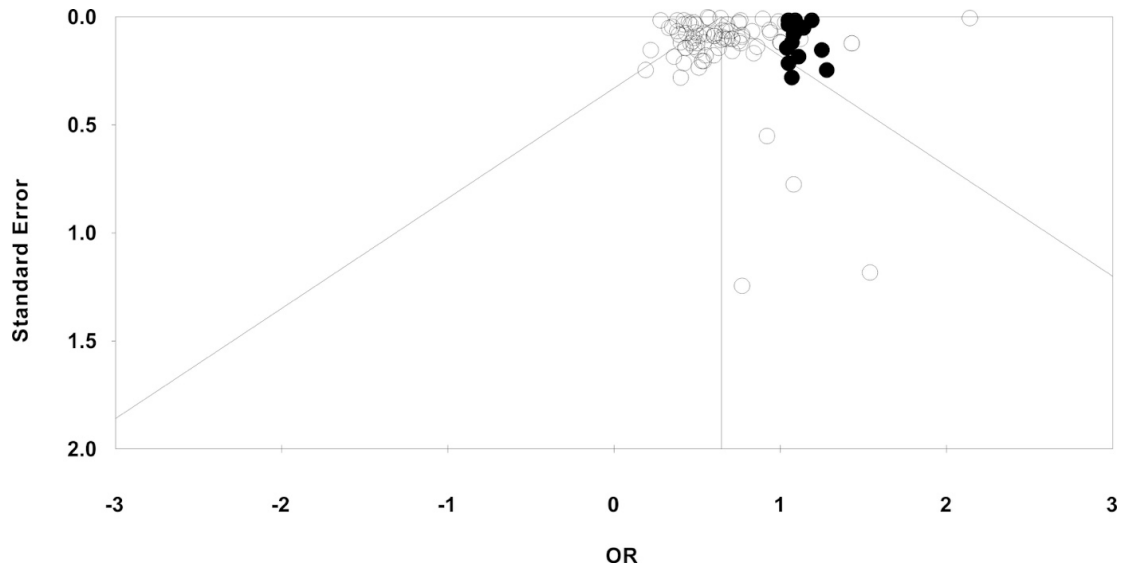


eFigure 8: Funnel plot for the meta-analysis of the association between education and dental services utilization. The standard error of each estimate is plotted against the OR. An asymmetry indicates possible publication bias. Rings: Reported estimates from included studies.

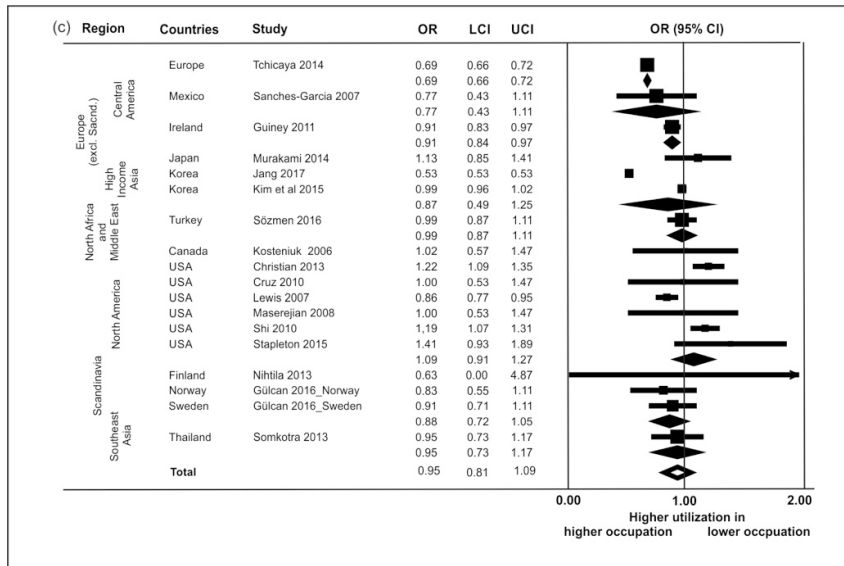


eFigure 9: Forest plot of studies on the association between income with dental service utilization. Studies are categorized and ordered according to the region and country they were conducted in. Squares indicate the estimates (Odds Ratio [OR]) of

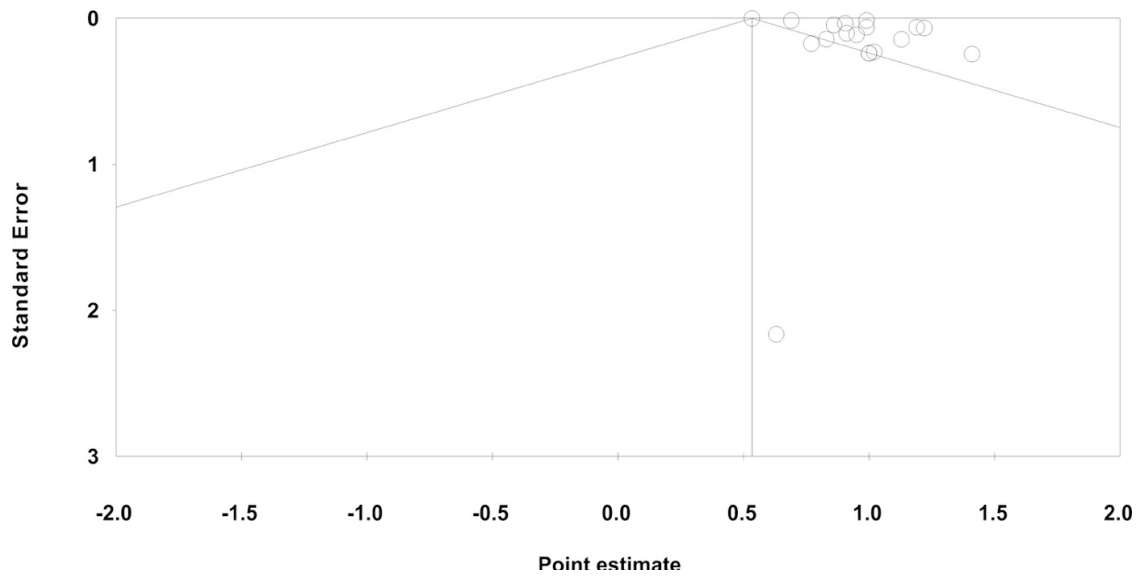
single studies; lines the 95% confidence intervals (95% CI). Closed diamonds show the pooled estimates for regions, while the open diamond indicates the overall pooled estimate.



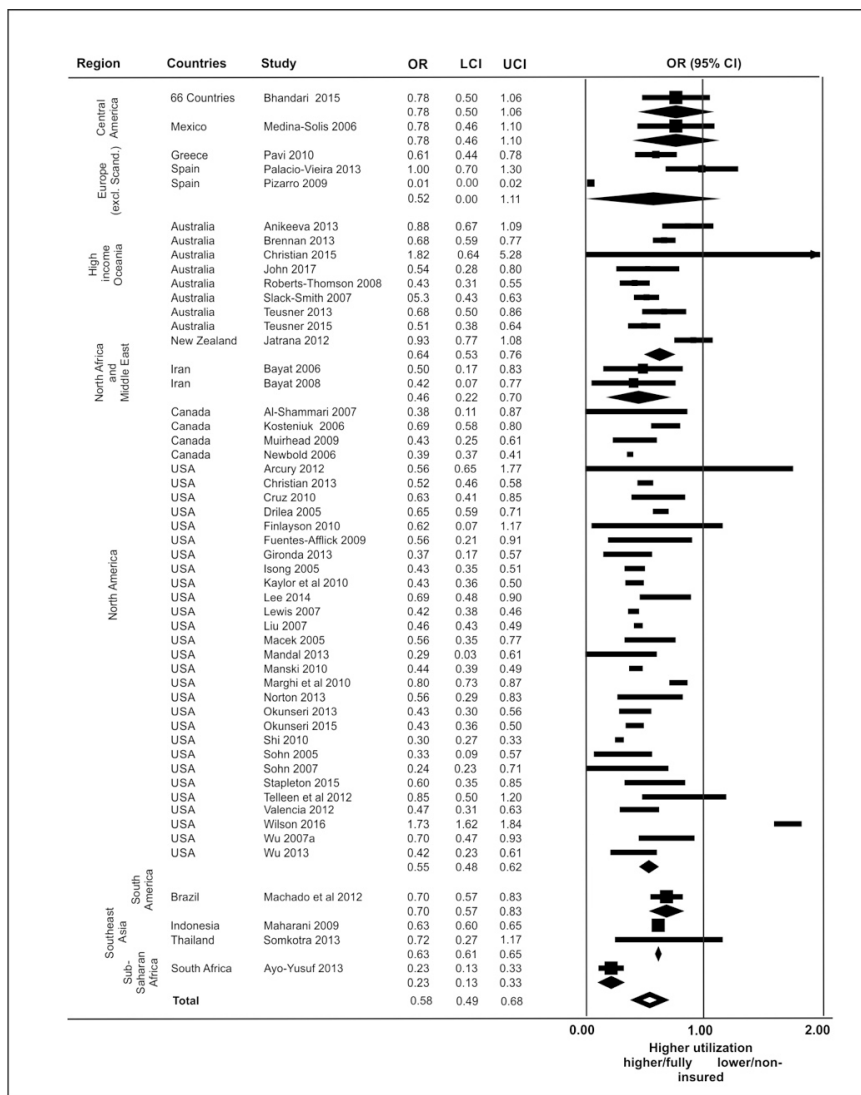
eFigure 10: Funnel plot for the meta-analysis of the association between income and dental services utilization. The standard error of each estimate is plotted against the OR. An asymmetry indicates possible publication bias. Rings: Reported estimates from included studies. Black circles: imputed estimates.



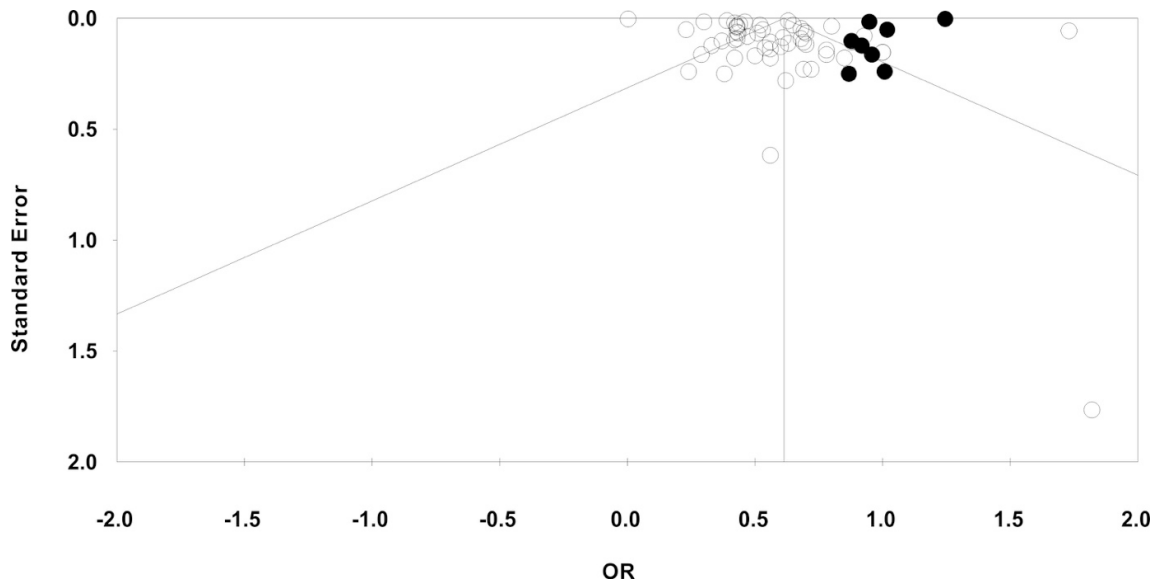
eFigure 11: Forest plot of studies on the association between occupational position with dental service utilization. Studies are categorized and ordered according to the region and country they were conducted in. Squares indicate the estimates (Odds Ratio [OR]) of single studies; lines the 95% confidence intervals (95% CI). Closed diamonds show the pooled estimates for regions, while the open diamond indicates the overall pooled estimate.



eFigure 12: Funnel plot for the meta-analysis of the association between occupation and dental services utilization. The standard error of each estimate is plotted against the OR. An asymmetry indicates possible publication bias. Rings: Reported estimates from included studies.



eFigure 13: Forest plot of studies on the association between insurance status with dental service utilization. Studies are categorized and ordered according to the region and country they were conducted in. Squares indicate the estimates (Odds Ratio [OR]) of single studies; lines the 95% confidence intervals (95% CI). Closed diamonds show the pooled estimates for regions, while the open diamond indicates the overall pooled estimate.



eFigure 14: Funnel plot for the meta-analysis of the association between insurance coverage status and dental services utilization. The standard error of each estimate is plotted against the OR. An asymmetry indicates possible publication bias. Rings: Reported estimates from included studies. Black circles: imputed estimates.

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6. Lebenslauf

Mein Lebenslauf wird aus datenschutzrechtlichen Gründen in der elektronischen Version meiner Arbeit nicht veröffentlicht.

7. Komplette Publikationsliste

Sophie Reda, Seif Reda, William Murray Thompson, Falk Schwendicke
Inequality in utilization of dental services: Systematic Review and meta-analysis

Zeitschrift: American Journal of Public Health

Erscheinungsdatum: Published online ahead of print December 21, 2017

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Seif Reda, Joachim Krois, Sophie Reda, William Murray Thompson, Falk Schwendicke

The impact of demographic, health-related and social factors on dental services utilization: Systematic review and meta-analysis

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