Supplemental file

Title:

THE IMPACT OF MALOCCLUSIONS ON ORAL HEALTH RELATED QUALITY OF LIFE IN CHILDREN - A SYSTEMATIC LITERATURE REVIEW AND META-ANALYSIS

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Journal name: Clinical Oral Investigations

1. Supplement S1

Search Strategy

Embase

('quality of life'/exp OR 'self concept'/exp OR 'psychological well being'/de OR ((qualit* NEAR/3 life) OR QoL OR HRQL OR HRQoL OR OHRQL OR OHRQoL OR ((health OR malocclus* OR occlus* OR overbite OR underbite OR emotion* OR aesthet* OR esthet* OR appear* OR attractive* OR 'facial profile' OR psycholog*) NEAR/3 (impact OR percept* OR perciev* OR aware* OR satisf* OR dissatisf*)) OR (self NEXT/1 (concept* OR esteem* OR percept* OR perceiv*)) OR 'personal appearance' OR 'well being' OR wellbeing OR (social NEAR/3 function*) OR ((desire* OR demand* OR need OR needs OR motivat*) NEAR/6 (treatment* OR intervention*))):ab,ti) AND (orthodontics/de OR malocclusion/de OR (orthodont* OR (occlus* NEAR/3 adjust*) OR malocclusion* OR (palat* NEAR/3 expan*) OR (bite NEAR/3 correction*) OR (serial NEAR/3 extraction*) OR overbite OR underbite OR (occlus* NEAR/3 disorder*)):ab,ti)

Medline OvidSP

("quality of life"/ OR exp "self concept"/ OR "Personal Satisfaction"/ OR ((qualit* ADJ3 life) OR QoL OR HRQL OR HRQoL OR OHRQL OR OHRQoL OR ((health OR malocclus* OR occlus* OR overbite OR underbite OR emotion* OR aesthet* OR esthet* OR appear* OR attractive* OR "facial profile" OR psycholog*) ADJ3 (impact OR percept* OR perciev* OR aware* OR satisf* OR dissatisf*)) OR (self ADJ (concept* OR esteem* OR percept* OR perceiv*)) OR "personal appearance" OR "well being" OR wellbeing OR (social ADJ3 function*) OR ((desire* OR demand* OR need OR needs OR motivat*) ADJ6 (treatment* OR intervention*))).ab,ti.) AND (orthodontics/ OR exp "Orthodontics, Corrective"/ OR exp malocclusion/ OR

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Web-of-science

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TITLE-ABS-KEY((((qualit* W/3 life) OR QoL OR HRQL OR HRQoL OR OHRQL OR OHRQoL OR ((health OR malocclus* OR occlus* OR overbite OR underbite OR emotion* OR aesthet* OR esthet* OR appear* OR attractive* OR "facial profile" OR psycholog*) W/3 (impact OR percept* OR perciev* OR aware* OR satisf* OR dissatisf*)) OR (self PRE/1 (concept* OR esteem* OR percept* OR perceiv*)) OR "personal appearance" OR "well being" OR wellbeing OR (social W/3 function*) OR ((desire* OR demand* OR need OR needs OR motivat*) W/6 (treatment* OR intervention*)))) AND ((orthodont* OR (occlus* W/3 adjust*) OR malocclusion* OR (palat* W/3 expan*) OR (bite W/3 correction*) OR (serial W/3 extraction*) OR overbite OR underbite OR (occlus* W/3 disorder*)))) AND DOCTYPE(ar)

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((quality of life*[tiab] OR QoL[tiab] OR HRQL[tiab] OR HRQoL[tiab] OR OHRQL[tiab] OR OHRQoL[tiab] OR ((malocclus*[tiab] OR occlus*[tiab] OR overbite[tiab] OR underbite[tiab] OR emotion*[tiab] OR aesthet*[tiab] OR esthet*[tiab] OR appear*[tiab] OR attractive*[tiab] OR facial profile OR psycholog*[tiab]) AND (impact[tiab] OR percept*[tiab] OR perciev*[tiab] OR aware*[tiab] OR satisf*[tiab] OR dissatisf*[tiab])) OR self concept*[tiab] OR self esteem*[tiab] OR self percept*[tiab] OR self perceiv*[tiab] OR personal appearan*[tiab] OR well being*[tiab] OR wellbeing[tiab] OR social function*[tiab] OR ((desire*[tiab] OR demand*[tiab] OR need[tiab] OR needs[tiab] OR motivat*[tiab]) AND (treatment*[tiab] OR

intervention*[tiab]))))) AND ((orthodont*[tiab] OR (occlus*[tiab] AND adjust*[tiab]) OR malocclusion*[tiab] OR (palat*[tiab] AND expan*[tiab]) OR (bite AND correction*[tiab]) OR serial extraction*[tiab]) OR overbite[tiab] OR underbite[tiab] OR (occlus*[tiab] AND disorder*[tiab]))) AND publisher[sb]

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(MH "quality of life+" OR MH "self concept+" OR MH "Personal Satisfaction+" OR ((qualit* N3 life) OR QoL OR HRQL OR HRQoL OR OHRQL OR OHRQoL OR ((health OR malocclus* OR occlus* OR overbite OR underbite OR emotion* OR aesthet* OR esthet* OR appear* OR attractive* OR "facial profile" OR psycholog*) N3 (impact OR percept* OR perciev* OR aware* OR satisf* OR dissatisf*)) OR (self N1 (concept* OR esteem* OR percept* OR perceiv*)) OR "personal appearance" OR "well being" OR wellbeing OR (social N3 function*) OR ((desire* OR demand* OR need OR needs OR motivat*) N6 (treatment* OR intervention*)))) AND (MH orthodontics+ OR MH "Orthodontics, Corrective+" OR MH malocclusion+ OR (orthodont* OR (occlus* N3 Nust*) OR malocclusion* OR (palat* N3 expan*) OR (bite N3 correction*) OR (serial N3 extraction*) OR overbite OR underbite OR (occlus* N3 disorder*)))

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"quality of life"|"self concept"|psychological|"well being"|wellbeing|impact|awareness|satisfaction|dissatisfaction|appearance orthodontics|"occlusive|occlusion adjustment|disorder"|malocclusion|"bite correction"|"serial extraction"|overbite|underbite

2. Supplement S2

Table S1 Study characteristics of studies included in the narrative review but excluded from the meta-analysis (N=17)

	Author	Year	Country	Study type	Participants	Age (Mean)	N	OHRQOL	Malocclusion	Ref
1	Abanto, J.et al.	2014	Brasil	cross-sectional	Pre-school children	2.53	879	ECOHIS	Presence/Absence	[1]
2	Agou, S. et al	2008	Canada	cross-sectional	Children seeking orthodontic treatment	12.6	191	CPQ11-14	DAI	[2]
3	Aguilar-Diaz, F.C. et al.	2011	Mexico	cross-sectional	Schoolchildren	8.8	315	CPQ8-10	DAI	[3]
4	Ahn,Y.S. et al.	2012	Korea	cross-sectional	Korean Oral Health Survey 2010	11.8	2236	COHIP	IOTN	[4]
5	Bianco, A. et al.	2010	Italy	cross-sectional	Students from secondary schools, Catanzaro	-	530	child OIDP	IOTN-AC	[5]
6	Castro, R.D.A.L. et al.	2011	Brasil	cross-sectional	Students from public schools, Rio de Janeiro	12.0	571	child OIDP	Presence/Absence	[6]
7	De Baets, E. et al.	2012	Belgium	cross-sectional	Healthy child registered for a first consultation at the Orthodontic Department	13.22	223	CPQ11-14	IOTN-DHC/ -AC	[7]
8	de Oliveira C.M. et al.	2008	United Kingdom	cross-sectional	Referred to orthodontic clinical	12.21	187	OIDP	IOTN-DHC	[8]
9	de Paula J.S. et al.	2013	Brasil	cross-sectional	School children	-	286	CPQ11-14	DAI	[9]
10	Do, et al.	2008	Australia	cross-sectional	nested on cohort	-	842	CPQ8-10/CPQ11-14	DAI	[10]
11	Heravi, et al.	2011	Iran	cross-sectional	High school students	-	120	CPQ	ICON	[11]
12	Johal, A. et al.	2007	United Kingdom	cross-sectional	-	-	90	CPQ11-14	overjet/ spacing	[12]
13	Kotecha, et al	2013	United Kingdom	cross-sectional	clinical sample + comparison	12.5	116	CPQ11-14	Hypodontia	[13]
14	Marshman, et al.	2005	United Kingdom	cross-sectional	Consecutive sample	12.4	89	CPQ11-14	IOTN	[14]
15	Motamedi, M.R.K. et al.	2014	Iran	cross-sectional	Schoolchildren	13.0	336	CPQ11-14	IOTN	[15]
16	Sousa, R. V. et al.	2014	Brasil	cross-sectional	Preschool children	3.9	732	ECOHIS	Overbite, -jet, crossbite	[16]
17	Thelen, D.S. et al.	2011	Norway	cross-sectional	Adolescents in schools	17.2	493	OIDP	IOTN-AC	[17]

Narrative review of studies not included in meta-analysis

Of all 57 studies, 17 studies could not be included in the meta-analysis, because the mean OHRQOL score was not reported [1, 2, 7-9, 12-15], the number of cases per subgroup were missing [3-6, 10, 11, 16], or orthodontic treatment need was only assessed with the IOTN-AC [5, 7, 15, 17].

Malocclusion assessment and OHRQOL measures of studies included in meta-analysis

The most commonly (n = 10) used OHRQOL questionnaires were the two Child Perception Questionnaires (CPQ), i.e. for the age group 8-10 years [3, 10] and the age group 11-14 years [2, 7, 9-15]. Also the Oral Impacts of Daily Performances (OIDP) was often used (n = 4) [5, 6, 8, 17]. Two studies used the Early Childhood Oral Health Scale (ECOHIS) [1, 16].One study used the Child Oral health impact profile (COHIP) [4].

Studies used several methods to assess malocclusions or orthodontic treatment need in their study population. Most of the time (n= 5) the IOTN-DHC was used [4, 7, 8, 14, 15]. The DAI was used in four studies [2, 3, 14, 15]. The ICON was used in one study [11]. Four studies only assessed presence of any malocclusion trait or anterior malocclusion trait . One study assessed hypodontia [13].

Nine studies used the Aesthetic Component of the Index of Orthodontic treatment need (IOTN-AC), either exclusive or in combination with the IOTN-DHC [5, 7, 15, 17-22].

Narrative review

All studies that investigated the association between malocclusions measured with the DAI and OHRQOL measured by the CPQ found significant lower OHRQOL in children with malocclusions [2, 3, 9, 10]. However, these association were mostly weak and one study showed that this association between malocclusion based on DAI scores and CPQ scores was lost in children with low self-esteem [2]. All studies that investigated the association between malocclusions measured with the IOTN-DHC and OHRQOL measured by the CPQ found no relationship between OHRQOL and orthodontic treatment need (IOTN-DHC >3) [7, 8, 14, 15]. Only one study investigated additionally the correlation between IOTN scores and CPQ scores, which was significant but weak [7]. One study investigated the relationship of malocclusions measured with the ICON and showed only non-significant higher OHRQOL scores (CPQ) in the severe and moderate group compared to the acceptable group [11]. Johal et al found highly statistical significant differences between groups with either an

increased overjet or spaced dentition compared to a control group [12]. Finally, one study investigated the relationship between tooth agenesis with OHRQOL measured by the CPQ. Tooth agenesis was associated with lower OHRQOL, however there was no correlation with the number of missing teeth [13].

Two studies that were not included in the meta-analysis used the ECOHIS to assess OHRQOL in children up to 5 years old [1, 16]. Both studies investigated the relationship between the presence of malocclusion and ECOHIS scores as well as kind of malocclusion with ECOHIS scores, but no significant association between any malocclusion trait and children's OHRQOL was found [16, 23].

One study used the COHIP to assess OHRQOL in children. Ahn et al. related the IOTN-DHC scores with OHRQOL measured by the COHIP and found significant but little worse OHRQOL in children with orthodontic treatment need (IOTN-DHC > 3) [4]. Castro et al used the OIDP to assess OHRQOL in children and found an significant association between inadequate position of the teeth with lower OHRQOL (OIDP > 0) [6].

In total, 4 articles of the studies that were not included in the meta-analyses investigated the relationship between the IOTN-AC and OHRQOL in children [5, 7, 15, 17]. Of these, three article did not find a relationship between IOTN-AC scores and OHRQOL measured with the CPQ [15] or the OIDP [5, 17]. One article found a significant but weak association between the IOTN-AC and OHRQOL measured with the CPQ [7]. In contrast, the studies that were included into the meta-analyses and assessed the IOTN-AC found significant relations between the IOTN-AC scores and OHRQOL [19, 22], except Kragt et al. who did only find a borderline significant relation [20].

3. Supplement S3

Table 2S Quality assessment of studies included in the meta-analysisbased on the Newcastle-Ottawa Scale adapted for cross-sectional studies

		Selection:				Comparability	Outcome		Score
Artikel	***Ref***	***Sample representativeness***	***SS***	***Non respondents***	***Exposure assessment***	***Control for differences***	***Outcome assessment***	***Statistics***	
Abanto, J.et al.	[23]	0	0	1	1	1	1	1	5/10
Aguilar-Diaz, F.C. et al.	[24]	0	0	1	2	1	1	1	6/10
Anosike, A.N. et al.	[25]	1	0	1	2	0	1	1	6/10
Asgari, I. et al.	[26]	1	1	1	2	0	1	1	7/10
Barbosa, T.S. et al.	[27]	1	0	0	2	0	1	1	5/10
Bhayat, A. et al.	[28]	1	0	1	1	0	1	1	5/10
Bekes, K. et al.	[29]	1	0	0	1	0	1	0	3/10
Bernabe, E. et al.	[30]	1	1	1	2	1	1	1	8/10
Bernabe, E. et al. (1)	[31]	1	1	0	1	1	1	1	6/10
Bernabe, E. et al. (1)	[32]	1	1	0	2	1	1	1	7/10
Bernabe, E. et al.	[33]	0	1	1	2	1	1	1	7/10
Brown A. et al.	[34]	1	0	1	1	0	1	1	5/10
Carvalho, A.C. et al.	[35]	1	1	1	1	1	1	1	7/10
Dawoodbhoy, I. et al.	[36]	1	1	0	2	0	1	1	6/10
Feu D. et al.	[18]	1	1	1	2	1	1	1	8/10
Foster Page, L.A. et al.	[37]	1	1	1	2	0	1	1	7/10
Foster Page, L.A. et al.	[38]	1	0	0	2	1	1	1	6/10
Ghijselings, I. et al.	[19]	1	1	0	2	0	1	0	5/10
Gomes, M.C. et al.	[39]	1	1	1	1	1	1	1	7/10
Herkrath, F.J. et al.	[40]	1	1	0	1	0	1	1	5/10
Hvaring, C.L. et al.	[41]	0	1	1	2	1	1	1	7/10
Kolawole, et al.	[42]	1	1	1	2	0	1	1	7/10
Kragt, et al.	[20]	1	0	1	2	0	1	1	7/10
Kramer, P.F. et al.	[43]	1	0	1	1	1	1	1	7/10
Laing, E. et al.	[44]	0	1	0	2	1	1	1	6/10
Locker, D. et al.	[45]	0	0	0	1	0	1	1	3/10
Manijth, C.M. et al.	[46]	0	0	0	2	1	1	0	4/10
Marques, L.S. et al.	[47]	1	1	1	2	0	1	1	7/10
Mbawalla, H.S. et al.	[48]	0	1	0	1	1	1	1	5/10
Montiel-Company, J.M. et al.	[22]	1	0	0	2	1	1	1	6/10
Onyeaso, et al.	[49]	1	1	0	2	1	1	1	7/10
Paula, J.S. et al.	[50]	1	1	0	2	1	1	1	7/10
Paula Jr, et al.	[51]	1	0	0	2	1	1	1	6/10
Peres, K.G. et al.	[52]	1	0	1	2	1	1	1	7/10
Sardenberg F. et al.	[53]	1	1	0	2	1	1	1	7/10
Scapini, A. et al.	[54]	1	1	1	2	1	1	1	8/10
Scarpelli, A.C. et al.	[55]	1	1	0	1	1	1	1	6/10
Schuch, H.S. et al.	[56]	1	1	0	2	0	1	1	6/10
Ukra, A. et al.	[57]	1	0	0	2	1	1	1	6/10
Zhang, M. et al.	[21]	1	0	1	2	1	0	1	6/10

4. Supplement S4

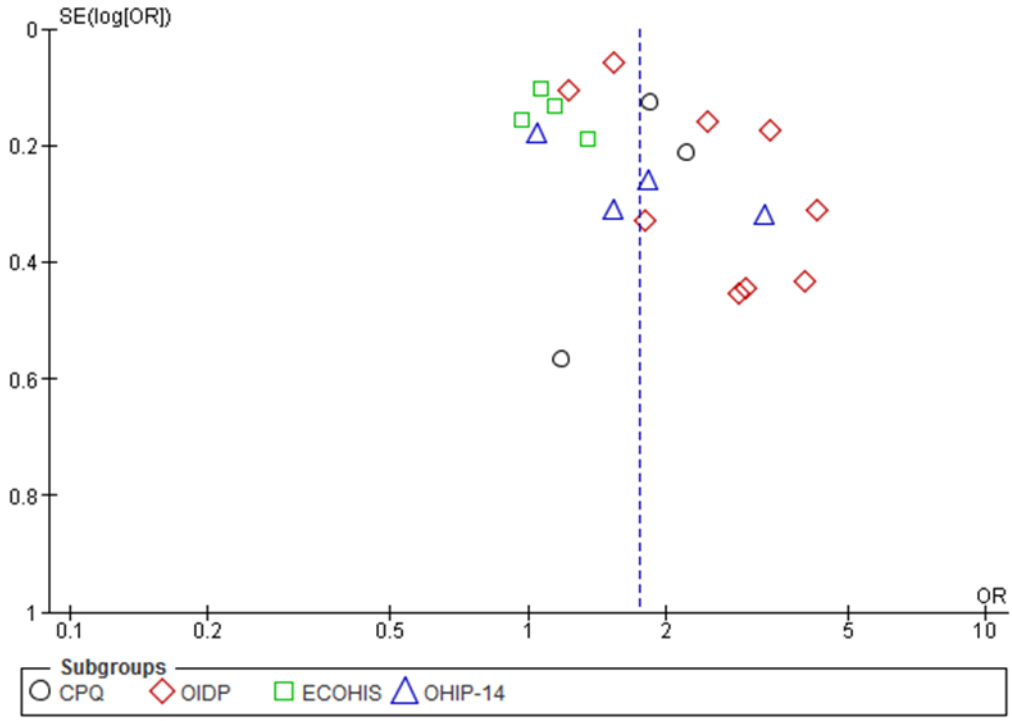

Figure S1 Funnel plot fort he evaluation of publication bias for studies evaluating the association of malocclusion and OHRQOL categorically

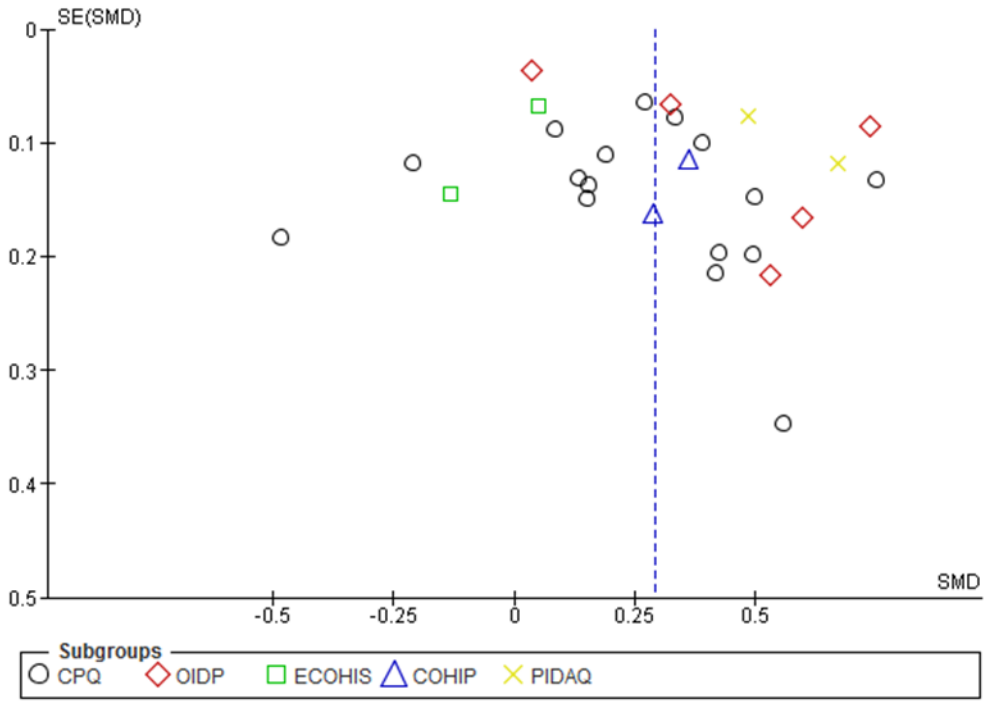

Figure S2 Funnel plot fort he evaluation of publication bias for studies evaluating the association of malocclusion and OHRQOL dichotomously

5. Supplement S5

Table S3 Sensitivity analysis for the different meta-analyses about OHRQOL and malocclusions

	OHRQOL	Study Omitted	Ref	SMD / OR [95% CI]	P-value for difference
continuous	CPQ[1]	Aguilar-Diaz (2011) (1)	[24]	0.30 [0.19, 0.40]	0.892
		Barbosa (2009)	[27]	0.29 [0.18, 0.39]	1.000
		Barbosa (2009b)	[27]	0.29 [0.18, 0.39]	1.000
		Bhayat (2014)	[28]	0.30 [0.19, 0.40]	0.892
		Bekes (2012)	[29]	0.29 [0.18, 0.40]	1.000
		Brown (2006)	[34]	0.28 [0.18, 0.39]	0.892
		Dawoodbhoy (2013)	[36]	0.27 [0.17, 0.37]	0.782
		Foster Page (2005)	[37]	0.29 [0.18, 0.39]	1.000
		Foster Page (2013)	[38]	0.30 [0.19, 0.40]	0.892
		Kolawole (2011)	[42]	0.31 [0.21, 0.41]	0.782
		Laing (2010)	[44]	0.31 [0.21, 0.41]	0.782
		Locker (2007)	[45]	0.29 [0.18, 0.39]	1.000
		Scapini (2013)	[54]	0.30 [0.19, 0.40]	0.892
		Schuch (2014)	[56]	0.30 [0.19, 0.41]	0.895
		Ukra (2013)	[57]	0.29 [0.18, 0.40]	1.000
		Zhang (2009)	[21]	0.28 [0.18, 0.39]	0.892
	OIDP[2]	Bernabe (2008)	[30]	0.28 [0.18, 0.39]	0.892
		Bernabe (2009)	[33]	0.29 [0.18, 0.40]	1.000
		Bernabe (2009) (1)	[32]	0.27 [0.17, 0.37]	0.782
		Hvaring (2014)	[41]	0.28 [0.18, 0.38]	0.890
		Mbawalla (2011)	[48]	0.30 [0.20, 0.41]	0.892
	ECOHIS[3]	Abanto (2011)	[23]	0.31 [0.20, 0.41]	0.787
		Kramer (2013)	[43]	0.30 [0.20, 0.41]	0.892
	COHIP[4]	Asgari (2013)	[26]	0.29 [0.18, 0.39]	1.000
		Kragt (2015)	[20]	0.29 [0.19, 0.40]	1.000
	PIDAQ[5]	Montiel-Company (2009)	[22]	0.28 [0.18, 0.39]	0.892
		Paula jr (2011)	[51]	0.27 [0.17, 0.38]	0.787
dichotomous	CPQ	Ghijselings (2014)	[19]	1.76 [1.47, 2.10]	0.929
		Paula (2012)	[50]	1.72 [1.43, 2.06]	0.929
		Sardenberg (2013)	[53]	1.74 [1.44, 2.10]	1.000
	OIDP	Bernabe (2008)	[30]	1.72 [1.44, 2.06]	0.929
		Bernabe (2008) (1)	[31]	1.74 [1.45, 2.09]	1.000
		Bernabe (2009)	[33]	1.70 [1.42, 2.03]	0.857
		Bernabe (2009)	[33]	1.65 [1.40, 1.95]	0.859
		Herkrath (2012)	[40]	1.72 [1.44, 2.05]	0.856
		Hvaring (2014)	[41]	1.70 [1.42, 2.03]	0.857
		Marques (2006)	[47]	1.67 [1.41, 1.98]	0.852
		Mbwalla (2011)	[48]	1.80 [1.49, 2.17]	0.798
		Peres (2013)	[52]	1.79 [1.45, 2.21]	0.810
	ECOHIS	Carvalho (2013)	[35]	1.80 [1.49, 2.16]	0.797
		Gomes (2014)	[39]	1.81 [1.51, 2.16]	0.760
		Kramer (2013)	[43]	1.77 [1.47, 2.14]	0.897
		Scarpelli (2013)	[55]	1.81 [1.51, 2.17]	0.762
	OHIP-14	Anosike (2010)	[25]	1.87 [1.56, 2.26]	0.614
		Feu (2010)	[18]	1.76 [1.46, 2.11]	0.930
		Manjith (2012)	[46]	1.82 [1.51, 2.20]	0.735
		Onyeaso (2009)	[49]	1.81 [1.50, 2.18]	0.766

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