Chapter 6

Associations between clinician-graded facial function and patient-reported quality of life in adult patients with peripheral facial palsy: A systematic review and meta-analysis

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Abstract

Importance:
Understanding how the quality of life of adults (≥18 years) with peripheral facial palsy can be estimated using clinician measures of facial function and patient-reported variables might aid in counseling patients and in conducting research.

Objectives:
To analyze associations between clinician-graded facial function and patient-reported quality of life in adults with peripheral facial palsy, compare associations between facial function and the physical and social functions of quality of life, and examine factors that might influence the associations.

Data Sources:
A literature search was conducted in PubMed, Embase, CINAHL, Web of Science and PsycInfo on June 4, 2020, with no restrictions on the start date.

Study Selection:
Twenty-three studies reporting an association between clinician-graded facial function and patient-reported quality of life in adults with peripheral facial palsy were included. Facial function instruments included the House-Brackmann, Sunnybrook Facial Grading System, and electronic clinician-graded facial function assessment. Quality-of-life instruments included the Facial Disability Index and Facial Clinimetric Evaluation Scale.

Data Extraction and Synthesis:
Data extraction and qualitative synthesis were performed according to the Meta-analysis of Observational Studies in Epidemiology guidelines. Record screening, data extraction, and quality assessments were done by 2 researchers independently. Data were pooled using random-effects models.

Main Outcomes and Measures:
The main outcome was the association between facial function and quality of life, quantified by Pearson r, Spearman ρ, or regression analysis.

Results:
In total, 23 studies (3746 participants) were included. In the 21 studies that reported on the sex of the cohorts, there were 2073 women (57.3%). Mean or median age ranged from 21 to 64 years and mean or median duration of palsy ranged from newly diagnosed to 12 years. Bell palsy (n = 1397), benign tumor (n = 980), and infection (n = 257) were the most common

etiologic factors. Pooled correlation coefficients were 0.424 (95% CI, 0.375-0.471) to 0.533 (95% CI, 0.447-0.610) between facial function and Facial Clinimetric Evaluation Scale total, 0.324 (95% CI, 0.128-0.495) to 0.397 (95% CI, 0.242-0.532) between facial function and Facial Clinimetric Evaluation Scale social function, 0.423 (95% CI, 0.322-0.514) to 0.605 (95% CI, −0.124-0.910) between facial function and Facial Disability Index physical function, and 0.166 (95% CI, 0.044-0.283) to 0.208 (95% CI, 0.031-0.373) between facial function and Facial Disability Index social function.

Conclusions and Relevance:
Associations noted in this systematic review and meta-analysis were overall low to moderate, suggesting that only a small part of quality of life is explained by facial function. Associations were higher between facial function and physical function than social function of quality of life.

Key points

1) *Question:* What is the association between clinician-graded facial function and patient-reported quality of life in adults (≥18 years) with peripheral facial palsy?
2) *Findings:* This systematic review and meta-analysis of 23 studies including 3746 participants found that associations between clinician-graded facial function and patient-reported quality of life were overall low to moderate. Facial palsy severity was associated more with the physical than social function of quality of life.
3) *Meaning:* This study noted that quality of life can only moderately be estimated by facial function, suggesting that, in both clinical practice and research, factors other than clinician-graded facial function need to be taken into account.

Introduction

Facial palsy results in weakness of the mimic muscles, which may result in problems with eye closure, eating, drinking, and smiling.[1-3] Facial palsy negatively affects quality of life (QOL).[4-6] Traditionally, measures of facial function impairment are standardized using clinician-graded scales for facial symmetry and function, such as the House-Brackmann scale,[7] Sunnybrook Facial Grading System,[8] and an electronic clinician-graded facial function assessment (eFACE).[9] Quality of life is usually assessed with patient-reported outcome measures (PROMs). More general PROMs, such as the 36-item Short Form, allow for comparison with other diseases.[10, 11] Disease-specific PROMs are better suited for assessing the association between a specific condition and QOL. Disease-specific QOL in persons with facial palsy can be assessed using PROMs, such as the Facial Disability Index (FDI) and the Facial Clinimetric Evaluation scale (FaCE).[12, 13] These questionnaires distinguish physical and social burden. Simultaneous application of a clinician-graded scale and a PROM enables studying associations between the severity of facial function impairment and disease-specific QOL.

Several studies have analyzed this association, but sample sizes are often small and results inconsistent.[4-6,10,12] The strength of the associations found varies widely. This variety may be associated with differences in sample characteristics, such as cause and duration of palsy, age and sex of the sample, and the measurement instruments used.[4-6] Previous systematic reviews evaluating QOL in adults with peripheral facial palsy focus on QOL before and after treatment[14] and on psychosocial symptoms (eg, anxiety and depression).[15, 16] However, current literature lacks an overview and summary of associations between the severity of facial function impairment and QOL, which might provide insight into which part of QOL can be estimated by facial function and which part can be estimated by other variables. Such an overview might be helpful in clinical decision-making. Therefore, we conducted a systematic review and meta-analysis of associations between clinician-graded facial function and patient-reported disease-specific QOL in adults with peripheral facial palsy. We analyzed differences in the strength of the associations between facial function and various domains (ie, physical and social functioning) of QOL. We compared the associations of different facial function instruments with the same QOL instrument. In addition, we performed a meta-regression analysis to examine which patient characteristics appear to influence the associations.

Methods

Database search

This review is reported according to the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) reporting guideline[17] and the review protocol is registered.[18] The search strategy was developed with an information specialist of the University of Groningen. The search was conducted on June 4, 2020, in PubMed/MEDLINE, Embase, CINAHL, Web of Science, and PsycInfo (Appendix 6.1). Search terms included related terms for facial palsy (eg, facial paral*, facial disabil*) and quality of life (eg, patient outcome, QOL). Duplicate publications were removed using an Endnote de-duplication method.[19] Inclusion criteria for abstracts were adults (≥18 years) with facial palsy, reported clinician-graded facial function scores, reported QOL scores, and a reported association or possibility to calculate an association between facial function and QOL. Exclusion criteria were studies with fewer than 10 cases, conference proceedings, and reviews. No language or date restrictions were imposed. A training session regarding the selection of articles using the inclusion and exclusion criteria was held between the 2 reviewers (T.E.B. and M.M.v.V.), using a random sample of 14 publications of the search. Titles and abstracts and thereafter full-text publications were screened for eligibility independently by the 2 reviewers. Disagreement was discussed between the 2 reviewers; if unresolved, a third researcher (P.U.D.) gave a binding verdict. Agreement between the 2 reviewers was calculated for screening titles, abstracts, and full-text publications.

For full-text selection, additional criteria were peripheral facial palsy, specified instruments for grading facial function (House-Brackmann, Sunnybrook Facial Grading System, or eFACE), specified QOL instruments (FDI or FaCE), and a maximum interval of 4 weeks between measurement of facial function and QOL. Full-text articles in the English, Dutch, German, French, Spanish, and Italian languages were included because the research team was sufficiently proficient in these languages.

The choice for specific measurement instruments was based on a preliminary search on eligible studies and recommendations of previous systematic reviews. A systematic review concluded that the Sunnybrook Facial Grading System was the only appropriate tool according to the criteria given in that review.[20] The eFACE was developed and validated, and we included this instrument.[9] The House-Brackmann scale was the most frequently used tool in the past 5 years in eligible studies and was therefore also included.[21] Another systematic review concluded that the FDI and FaCE scale were appropriate QOL instruments.[22] The preliminary search supported this choice and no additional QOL instruments were included.

Quality assessment and data extraction

Quality of the included studies was assessed using the quality assessment tool for observational cohort and cross-sectional studies from the National Institute of Health.[23] Three items regarding comparability between participants and nonparticipants, blinding participants for facial function scores, and reporting missing data were added to fit the aim of this review. A total of 11 items were assessed (Appendix 6.2). A composite score was not used, because it is less suitable for rating overall quality.[24] Extracted data included sample characteristics (number of participants, sex, age, duration of palsy, and cause of palsy), study design, instruments used to assess facial function and QOL, and the calculated association between facial function and QOL. Regardless of the study design, only cross-sectional data were extracted because we were interested in the association between facial palsy severity and perceived QOL. If a study had several measurement moments, available data of the measurement moment with the largest sample size were extracted. Corresponding authors were contacted for additional information in case of missing data and if a regression coefficient was reported instead of a correlation coefficient. Regarding the cause of the palsy, the following categories were distinguished: Bell palsy or idiopathic, tumor (benign, malignant, or unspecified), infection, iatrogenic, trauma, congenital, and other/unknown (Table 1). Quality assessment and data extraction were conducted by the same 2 reviewers independently with the third researcher giving a binding verdict if necessary.

Statistical analysis

Agreement between the 2 reviewers was expressed as absolute agreement and Cohen κ value. Meta-analysis was performed using Comprehensive Meta-analysis, version 3 software (Biostat Inc),[25] using a random-effects model. Effect sizes are presented as correlation coefficients, 95% CIs, and P values, with significance set at $P < .05$. The House-Brackmann correlations were converted to positive correlations for easier comparing. Statistical heterogeneity between studies was assessed by calculating I2 values, whereby 0% to 40% was classified as low, 30% to 60% as moderate, 50% to 90% as substantial, and 75% to 100% as considerable heterogeneity.[26, 27] To explore any apparent influence of age, sex, duration of palsy, and cause of palsy on the association between facial function and QOL, univariate meta-regression analyses were performed using the same software.

Results

The database search resulted in 2109 records. After full-text screening, 23 studies were included for narrative review and meta-analysis (figure 1). The studies by Tavares-Brito et al[5] and van Veen et al[1] both met the inclusion criteria but were based on the same sample; the van Veen et al[1] study was excluded because it provided analysis for the separate groups

(flaccid or nonflaccid palsy) and not for the total sample. The Cohen κ values were 0.65 (88% agreement) for screening abstracts and 0.87 (98% agreement) for full text.

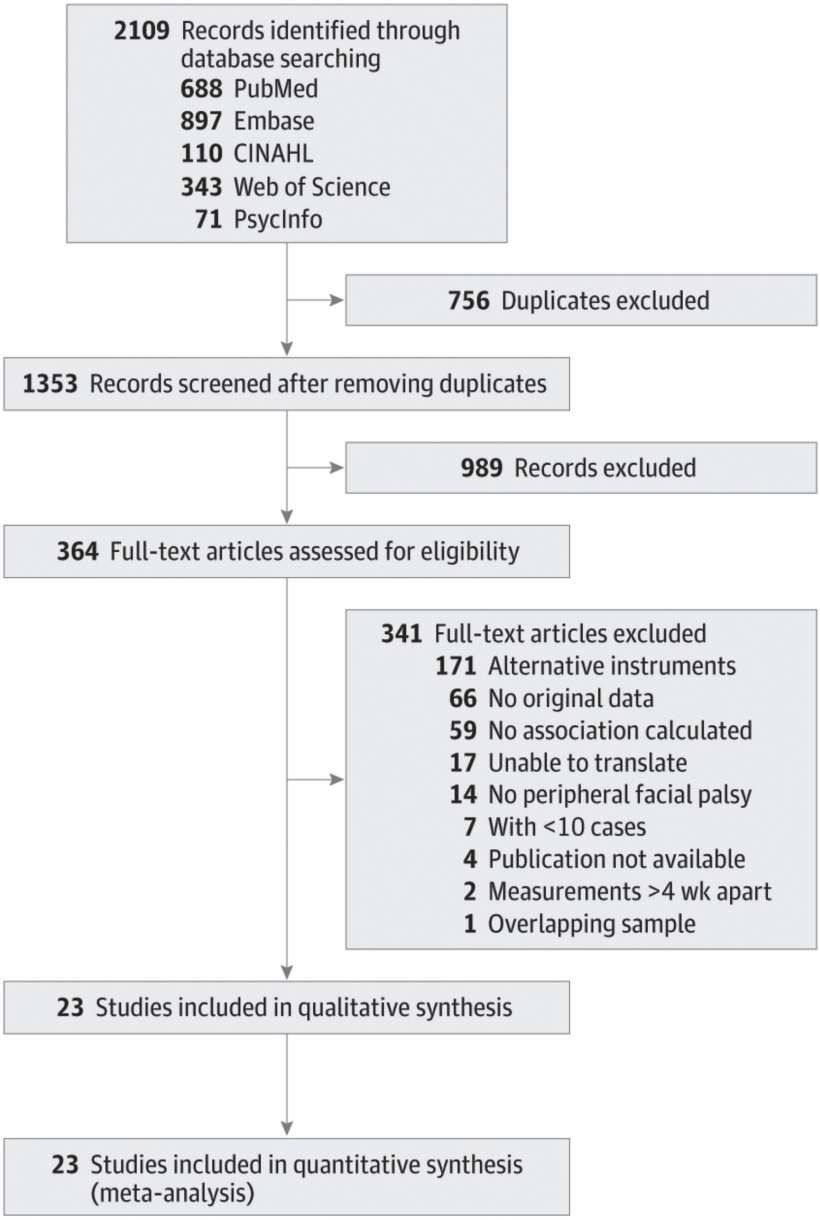


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses Flow Diagram. From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

Study characteristics

In total, 3746 participants were included in 23 studies (table 1).[1,4-6,10,12,13,25-40] Sample sizes ranged from 15 to 920 patients.[5,26] In the meta-analysis, the number of participants used to calculate associations between facial function and QOL ranged from 3039 (81%) to 3665 (98%). In the 21 studies that reported on the sex of the cohorts, there were 2073 women (57.3%) and 1546 men (42.7%). Mean or median age ranged from 21 to 64 years.[29,32] Mean or median duration of palsy ranged from newly diagnosed to 12 years.[4,29] Bell palsy (1397 [37%]); benign tumors (980 [26%]), most of which were acoustic neuroma (≥774 [≥80%]); and infection (257 [7%]) were the most common causes of palsy; 2 studies did not report cause.[12,25] The Sunnybrook Facial Grading System was the most commonly used facial function instrument in 16 studies,[4,6,12,13,25,26,28-31,33-36,38,40] and the FDI was the most commonly used QOL instrument in 18 studies.[4,10,12,13,25-28,30-36,38-40]

Risk of bias

In 22 studies (96%), the populations were clearly defined (item 1), in 21 studies (91%), participants were selected from similar populations (item 4a), and in all studies, inclusion and exclusion criteria were specified and uniformly applied (item 4b) (Appendix 6.3). Three (12%) studies analyzed comparability between participant and nonparticipant characteristics (items 3a, 3b). Three (13%) studies provided a sample size justification (item 5), clinicians were blinded in 2 (9%) studies, and participants were blinded in 4 (17%) studies (items 9a, 9b). In 20 studies (87%), potential confounding variables were measured, but only 5 studies (22%) adjusted for confounders.[4,5,10,37,40]

Associations between facial function and QOL

Figure 2A shows correlation of FaCE total with heterogeneity (I^2) of pooled associations.[4-6,10,13,31,34-38,40,44] In the meta-analyses, pooled correlation coefficients between the QOL instrument FaCE total score and the other facial function instruments showed 0.424 (95% CI, 0.375-0.471; $I^2 = 0\%$) for eFACE, 0.533 (95% CI, 0.447-0.610; $I^2 = 69\%$) for House-Brackmann, and 0.533 (95% CI, 0.447-0.610; $I^2 = 52\%$) for the Sunnybrook Facial Grading System (Figure 2A). Pooled correlation coefficients between FaCE social function and the other instruments were 0.324 (95% CI, 0.324 (95% CI, 0.128-0.462; $I^2 = 23\%$) for eFACE, 0.397 (95% CI, 0.242-0.532; $I^2 = 79\%$) for House-Brackmann, and 0.356 (95% CI, 0.238-0.463; $I^2 = 44\%$) for Sunnybrook Facial Grading System (Figure 2B).[10,13,28,29,31,34-36.38,40,44]

Table 1. Study Characteristics

Souce	N total (% women), No. analyzed	Age, Mean (SD), y	Duration of palsy, Mean (SD), y	Cause, No. (%)	Facial function instrument	QOL instrument	Spearman's ρ [a]	Pearson's r [a]
VanSwearingen and Brach,[12] 1996	46 (65.0); FDI(p), 46; FDI(s), 44	46.8 (15.6)	Unknown	Unknown	SB	FDI(p)	NA	0.507
						FDI(s)	NA	0.066
Van Swearingen,[25] 1998	48 (NR); FDI(p), 48; FDI(s), 47	49.0 (16.3)	Unknown	Bell's palsy, benign and malignant tumor, other/unclear	SB	FDI(p)	0.44	NA
						FDI(s)	0.39	NA
Kahn et al,[13] 2001	86 (64.0); 41	Median, 50.5	Median, 3.9	Bell's palsy/idiopathic, 37 (34.0); benign tumor, 26 (30.2); malignant tumor, 4 (4.7); tumor unspecified, 4 (4.7); infection, 8 (9.3); trauma, 4 (4.7); congenital, 1 (1.2); other/unknown, 2 (2.3)	HB	FaCE	-0.55	NA
						FDI(p/s)	NA	NA
					SB	FaCE	0.57	NA
						FDI(p/s)	NA	NA
Frijters et al,[26] 2008	15 (26.7); 15	22.6 (8.9); median (IQR), 22.2 (22.2-26.2)	8.8 (5.9); median (IQR), 6.6 (4.2-14.9)	Trauma, 15 (100)	SB	FDI(p)	0.76	NA
						FDI(s)	NA	NA
Gonzalez-Cardero et al,[27] 2012	79 (NR); 79	Mean, 40.0	3 mo after parotid surgery	Benign tumor, 79 (100)	HB	FDI(p)	0.405	NA
						FDI(s)	NA	NA
Marsk et al,[28] 2013	93 (53.0); 93	Mean, 56.9; median, 59.0	Mean, 4.3; median, 1.9	Bell's palsy/ idiopathic, 73 (78.5); benign tumor, 4 (4.3); infection 16 (17.2); congenital, 1 (1.1)	HB	FaCE	-0.69	NA
						FDI(p)	-0.61	NA
						FDI(s)	-0.38	NA
						FaCE	0.74	NA
					SB	FDI(p)	0.63	NA
						FDI(s)	0.40	NA

Table 1. [continued]

Souce	N total (% women), No. analyzed	Age, Mean (SD), y	Duration of palsy, Mean (SD), y	Cause, No. (%)	Facial function instrument	QOL instrument	Spearman's ρ [a]	Pearson's r [a]
Ng et al,[29] 2013	21 (47.6); 21	Median, 21.0	Newly diagnosed	Bell's palsy/idiopathic, 21 (100)	SB	FaCE	0.63	NA
Pavese et al, [30] 2014	100 (72.0); 100	45.0 (15.0)	3.5 (5.8)	Iatrogenic, 46 (46.0); traumatic, 5 (5.0); congenital, 2 (2.0); other, 47 (47.0)	SB	FDI(p)	0.44	NA
						FDI(s)	0.19	NA
Kleiss et al,[31] 2015	93 (66.0); HB: 62; SB: 54	55.1 (13.8); median, 55	3.8 (4.3); median, 2.4	Bell's palsy/idiopathic, 48 (51.6); benign tumor, 6 (6.5); infection 16 (17.2); iatrogenic, 7 (7.5); other/unknown, 16 (17.2)	HB	FaCE	-0.292	NA
						FDI(p/s)	NA	NA
					SB	FaCE	0.570	NA
						FDI(p/s)	NA	NA
Kleiss et al,[6] 2015	794 (59.9); HB: 794; SB: 188	47.0 (16.0)	Median (IQR), 1.0 (0.3; 4.0)	Bell's palsy/idiopathic, (353 (44.5); benign tumor, 99 (12.5); other/unknown, 342 (43.1)	HB	FaCE	-0.373	NA
					SB	FaCE	NA	0.488
Tveiten et al,[32] 2017	539 (44.0); 539	63.9 (12.4)	7.7 (2.4)	Benign tumor, 539 (100)	HB	FDI(p)	-0.468[b]	NA
						FDI(s)	-0.039	NA
Chong et al,[33] 2017	83 (60.2); 83	45.4 (16.2)	6.8 (9.7)	Bell's palsy/idiopathic, 46 (55.4); tumor unspecified, 27 (32.5); trauma, 4 (4.8); congenital, 6 (2.3); other/unknown, 1 (3.3)	HB	NA	NA	NA
					SB	FDI(p)	0.38	NA
						FDI(s)	0.09	NA
					eFACE	FDI(p)	0.28	NA
						FDI(s)	0.22	NA

Table 1. [continued]

Souce	N total (% women), No. analyzed	Age, Mean (SD), y	Duration of palsy, Mean (SD), y	Cause, No. (%)	Facial function instrument	QOL instrument	Spearman's ρ [a]	Pearson's r [a]
Volk et al,[34] 2017	256 (60.0); 256	52.0 (18.0); median, 54.0	4.0 (8.7); median, 0.8	Bell's palsy/idiopathic, (116 (45.3); tumor unspecified, 36 (14.1); infection, 33 (12.9); iatrogenic, 47 (18.4); traumatic, 46 (18.0); congenital, 6 (2.3); other, 2 0.8)	HB	FaCE	-0.461	NA
						FDI(p)	-0.221	NA
						FDI(s)	-0.054	NA
Györi et al,[34] 2018	30 (60.0); 30	48.8 (15.6)	10.7 (13.5)	Bell's palsy/idiopathic, 6 (20.0); infection, 5 (16.7); iatrogenic, 12 (40.0); trauma, 6 (20.0); other/unknown, 1 (3.3)	SB	FaCE	0.495	NA
						FDI(p)	0.536	NA
						FDI(s)	0.001	NA
Barry et al,[35] 2019	67 (61.2); 67	56.4 (14.2); median, 55	2.4 (5.5), median, 0.4	Bell's palsy/idiopathic, 36 (53.7); tumor unspecified, 3 (4.5); infection, 4 (6.0); iatrogenic, 20 (29.9); trauma, 4 (6.0	HB	FaCE	-0.51	NA
						FDI(p)	-0.35	NA
						FDI(s)	-0.25	NA
					SB	FaCE	0.49	NA
						FDI(p)	0.30	NA
						FDI(s)	0.21	NA
Díaz-Aristizabal et al,[36] 2019	30 (76.7); 30	51.1 (16.0)	8.5 (16.4)	Bell's palsy/idiopathic, 17 (56.7); benign tumor, 5 (16.7); infection, 5 (16.7); iIatrogenic, 2 (6.7); trauma, 1 (3.3)	SB	FaCE	0.662	NA
						FDI(p)	NA	0.542
						FDI(s)	NA	NA

Table 1. [continued]

Souce	N total (% women), No. analyzed	Age, Mean (SD), y	Duration of palsy, Mean (SD), y	Cause, No. (%)	Facial function instrument	QOL instrument	Spearman's ρ [a]	Pearson's r [a]
Tavares-Brito et al,[44] 2019	90 (60.0); 90	Median (IQR), 44.5 (28.8-62.0)	Median (IQR), 0.1 (0.0-1.1)	Bell's palsy/idiopathic, 53 (58.9); infection, 10 (11.1); trauma, 16 (17.8); other/unknown, 11 (12.2)	HB	FaCE	-0.538	NA
					eFACE	FaCE	0.537	NA
Tavares-Brito et al,[5] 2019[c,d]	920 (59.5); 920	48.6 (16.7)	Median (IQR), 0.8 (0.2-3.5)	Bell's palsy/idiopathic, 375 (40.8); benign tumor, 143 (15.5); malignant tumor, 74 (8.0); infection, 124 (13.5); trauma, 52 (5.7); iatrogenic, 40 (4.3); congenital, 17 (1.8); other/unknown, 95 (10.3	eFACE	FaCE	0.409[c]	NA
Van Veen et al,[37] 2019[e]	92 (77.0); 92	Median (IQR), 53.5 (34.0-64.1)	Median (IQR), 1.2 (0.5-3.6)	Bell's palsy/idiopathic, 48 (52.2); benign tumor, 9 (9.8); malignant tumor, 4 (4.3); infection, 25 (27.2); iatrogenic, 4 (4.3); trauma, 1 (1.1); other/unknown, 1 (1.1)	eFACE	FaCE	0.482[c]	NA
Bruins et al,[4] 2020[f]	121 (52.0); FaCE, 71; FDI(p), 69; FDI(s), 70	Median (IQR), 62.0 (48.0-81.0)	Median (IQR), 12.0 (7.0-27.0)	Bell's palsy/idiopathic, 11 (9.1); benign tumor, 44 (36.4); malignant tumor, 13 (10.7); infection, 11 (9.1); trauma, 18 (14.9); congenital, 10 (8.3); other/unknown, 14 (11.6	SB	FaCE	0.332[c]	NA
						FDI(p)	0.147[c]	NA
						FDI(s)	0.076[c]	NA
Bylund et al,[38] 2021	First visit, 96 (37.5); 88-96	First visit, 49.0 (17.0)	First visit (days), 7.0 (8.0)	Bell's palsy/idiopathic, 96 (100)	HB	FaCE	-0.43	NA
						FDI(p)	-0.25	NA
						FDI(s)	-0.07	NA
					SB	FaCE	0.42	NA
						FDI(p)	0.32	NA
						FDI(s)	0.08	NA

Table 1. [continued]

Souce	N total (% women), No. analyzed	Age, Mean (SD), y	Duration of palsy, Mean (SD), y	Cause, No. (%)	Facial function instrument	QOL instrument	Spearman's ρ [a]	Pearson's r [a]
Özden et al,[39] 2020	51 (51.0); 51	46.7 (17.1)	0.3 (0.3)	Bell's palsy/idiopathic, 51 (100)	HB	FDI(p)		-0.837
						FDI(s)		-0.355
						FaCE	0.450[g]	NA
Volk et al,[40] 2020	41 (46.0); 41	48.4 (19.9); median, 55.0	Time between lesion and surgery, 2.4 (4.2); median, 1.2; time between surgery and measurements, 4.1 (3.2); median, 3.5	Benign tumor, 26 (63.4); malignant tumor, 7 (17.1); trauma, 3 (7.3); other, 5 (12.2)	SB	FDI(p)	0.176[g]	NA
						FDI(s)	0.199[g]	NA
						FaCE	0.373[g]	NA
					eFACE	FDI(p)	0.811[g]	NA
						FDI(s)	0.184[g]	NA

Abbreviations: eFACE, Clinician-Graded Electronic Facial Paralysis Assessment; FaCE, Facial Clinimetric Evaluation scale; FDI, Facial Disability Index physical (p) and social (s) fundtion; NR, not reported, HB; House-Brackmann; IQR, interquartile range; QOL, quality of life; SB, Sunnybrook Facial grading Instrument

[a]Two or 3 decimals reported, depending on the reported decimals in the original article.

[b]The article described a positive correlation, but based on the third figure in that article, the correlation should be negative.

[c]Spearman ρ requested from authors.

[d]Univariate regression coefficient, 0.343.

[e]Univariate regression coefficient, 0.772 (95% CI, 0.497 to 1.047).

[f]Univariate regression coefficient, FaCE, 0.37 (95% CI, 0.22 to 0.53); FDI(p), 0.20 (95%, 0.04 to 0.36); FDI(s), 0.06 (95% CI, -0.09 to 0.22).

[g]Before surgery

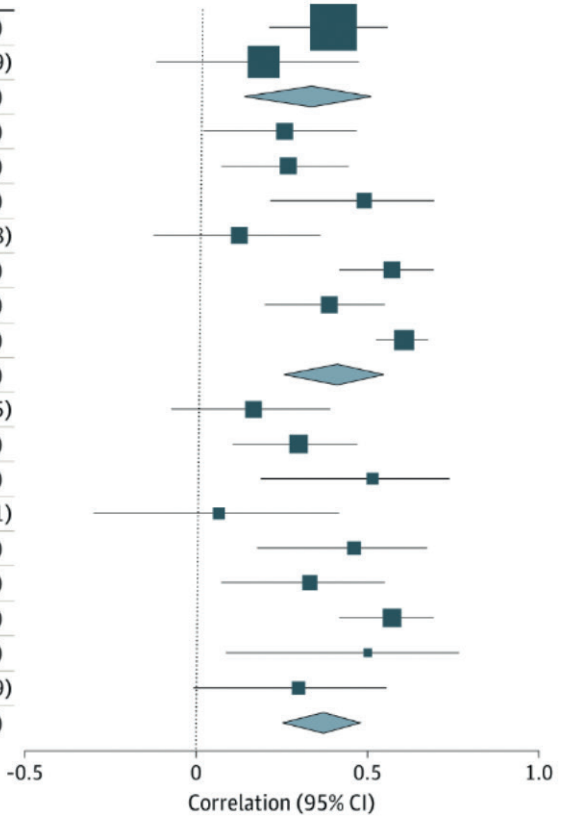
Figure 2. Correlations Between the Facial Clinimetric Evaluation Scale (FaCE) and Other Instruments.

A FaCE total

Source	Comparison	Total	Correlation (95% CI)
Tavares-Brito et al,[44] 2019	eFACE	90	0.537 (0.371 to 0.670)
Tavares-Brito et al,[5] 2019	eFACE	920	0.409 (0.354 to 0.461)
van Veen et al,[37] 2019	eFACE	92	0.482 (0.308 to 0.625)
Volk et al,[40] 2020	eFACE	41	0.373 (0.074 to 0.611)
Pooled	eFACE		0.424 (0.375 to 0.471)
Kahn et al,[13] 2021	HB	41	0.550 (0.292 to 0.734)
Marsk et al,[28] 2013	HB	93	0.690 (0.566 to 0.784)
Kleiss et al,[31] 2015	HB	62	0.292 (0.046 to 0.505)
Kleiss et al,[6] 2015	HB	794	0.373 (0.312 to 0.431)
Volk et al,[10] 2017	HB	256	0.461 (0.359 to 0.552)
Barry et al,[35] 2019	HB	67	0.510 (0.307 to 0.668)
Tavares-Brito et al,[44] 2019	HB	90	0.538 (0.372 to 0.670)
Bylund et al,[38] 2021	HB	95	0.430 (0.250 to 0.581)
Pooled	HB		0.481 (0.391 to 0.562)
Kahn et al,[13] 2001	SB	41	0.570 (0.318 to 0.747)
Marsk et al,[28] 2013	SB	93	0.740 (0.631 to 0.820)
Ng et al,[29] 2013	SB	21	0.630 (0.272 to 0.835)
Kleiss et al,[31] 2015	SB	54	0.570 (0.357 to 0.727)
Kleiss et al,[6] 2015	SB	188	0.488 (0.371 to 0.590)
Györi et al,[34] 2018	SB	30	0.495 (0.164 to 0.726)
Barry et al,[35] 2019	SB	67	0.490 (0.283 to 0.653)
Díaz-Aristizabal et al,[36] 2019	SB	30	0.662 (0.396 to 0.825)
Bruins et al,[4] 2020	SB	71	0.332 (0.107 to 0.525)
Bylund et al,[38] 2021	SB	96	0.420 (0.239 to 0.573)
Volk et al,[40] 2020	SB	41	0.450 (0.165 to 0.666)
Pooled	SB		0.533 (0.447 to 0.610)

B FaCE social function

Source	Comparison	Total	Correlation (95% CI)
Tavares-Brito et al,[44] 2019	eFACE	90	0.391 (0.200 to 0.553)
Volk et al,[40] 2020	eFACE	41	0.189 (-0.126 to 0.469)
Pooled	eFACE		0.324 (0.128 to 0.495)
Barry et al,[35] 2019	HB	67	0.250 (0.010 to 0.462)
Bylund et al,[38] 2021	HB	95	0.260 (0.062 to 0.439)
Kahn et al,[13] 2001	HB	41	0.480 (0.202 to 0.686)
Kleiss et al,[31] 2015	HB	62	0.119 (-0.135 to 0.358)
Marsk et al,[28] 2013	HB	93	0.560 (0.402 to 0.686)
Tavares-Brito et al,[44] 2019	HB	90	0.379 (0.187 to 0.543)
Volk et al,[10] 2017	HB	256	0.595 (0.510 to 0.669)
Pooled	HB		0.397 (0.242 to 0.532)
Barry et al,[35] 2019	SB	67	0.160 (-0.083 to 0.385)
Bylund et al,[38] 2021	SB	95	0.290 (0.094 to 0.464)
Díaz-Aristizabal et al,[36] 2019	SB	30	0.504 (0.176 to 0.731)
Györi et al,[34] 2018	SB	30	0.060 (-0.307 to 0.411)
Kahn et al,[13] 2001	SB	41	0.450 (0.165 to 0.666)
Kleiss et al,[31] 2015	SB	54	0.323 (0.060 to 0.544)
Marsk et al,[28] 2013	SB	93	0.560 (0.402 to 0.686)
Ng et al,[29] 2013	SB	21	0.490 (0.074 to 0.761)
Volk et al,[40] 2020	SB	41	0.290 (-0.019 to 0.549)
Pooled	SB		0.356 (0.238 to 0.463)

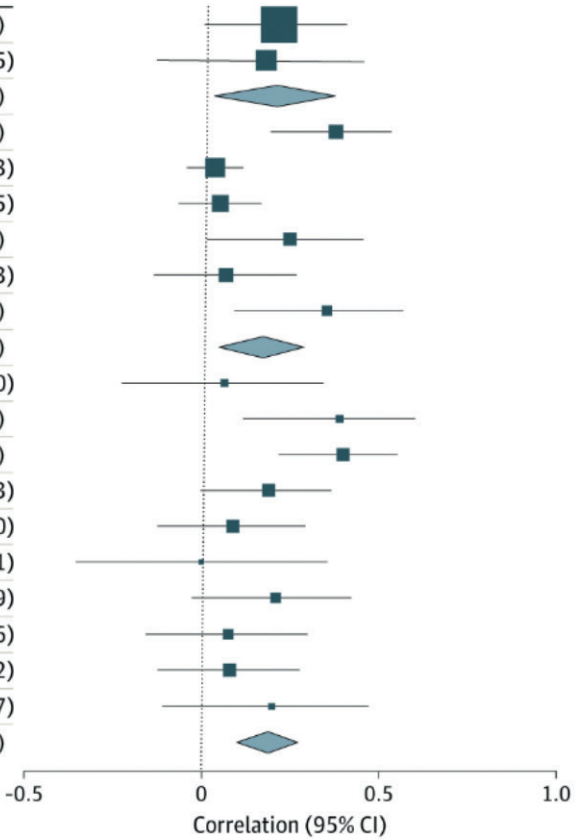


A, Correlation of FaCE total with heterogeneity (I2) of pooled associations between electronic, clinician-graded facial function assessment (eFACE) (0%), House-Brackmann (HB) (69%), and Sunnybrook Facial Grading System (SB) (52%). B, FaCE social function with heterogeneity of pooled associations between eFACE (23%), HB (79%), and SB (44%). Correlations including the HB were converted to positive values for easier comparison. Squares represent mean values, with the size of the squares indicating weight and horizontal lines representing 95% CIs. Diamonds represent the pooled mean with the points of the diamonds representing 95% CIs.

Figure 3. Correlations Between the Facial Disability Index (FDI) Physical (p) and Social (s) Scales and Other Instruments.

B FDI(s)

Source	Comparison	Total	Correlation (95% CI)
Chong et al,[33] 2017	eFACE	83	0.220 (0.005 to 0.416)
Volk et al,[40] 2020	eFACE	41	0.184 (-0.131 to 0.465)
Pooled	eFACE		0.208 (0.031 to 0.373)
Marsk et al,[28] 2013	HB	93	0.380 (0.191 to 0.542)
Tveiten et al,[32] 2016	HB	539	0.039 (-0.046 to 0.123)
Volk et al,[10] 2020	HB	256	0.054 (-0.069 to 0.175)
Barry et al,[35] 2019	HB	67	0.250 (0.010 to 0.462)
Bylund et al,[38] 2021	HB	90	0.070 (-0.139 to 0.273)
Özden et al,[39] 2020	HB	51	0.355 (0.088 to 0.574)
Pooled	HB		0.166 (0.044 to 0.283)
van Swearingen and Brach,[12] 1996	SB	46	0.066 (-0.229 to 0.350)
van Swearingen et al,[25] 1998	SB	47	0.390 (0.116 to 0.609)
Marsk et al,[28] 2013	SB	93	0.400 (0.214 to 0.558)
Pavese et al,[30] 2014	SB	100	0.190 (-0.007 to 0.373)
Chong et al,[33] 2017	SB	83	0.090 (-0.128 to 0.300)
Györi et al,[34] 2018	SB	30	0.001 (-0.359 to 0.361)
Barry et al,[35] 2019	SB	67	0.210 (-0.032 to 0.429)
Bruins et al,[4] 2020	SB	70	0.076 (-0.162 to 0.306)
Bylund et al,[38] 2021	SB	90	0.080 (-0.129 to 0.282)
Volk et al,[40] 2020	SB	41	0.199 (-0.116 to 0.477)
Pooled	SB		0.182 (0.095 to 0.266)



A, Correlation of FDI(p) with heterogeneity (I2) of pooled associations between electronic, clinician-graded facial function assessment (eFACE) (95%), House-Brackmann (HB) (88%), and Sunnybrook Facial Grading System (SB) (55%). B, Correlation of FDI(s) with heterogeneity of pooled associations between eFACE (0%), HB (68%), and SB (21%). Correlations including the HB were converted to positive values for easier comparison. Squares represent mean values, with the size of the squares indicating weight and horizontal lines representing 95% CIs. Diamonds represent the pooled mean with the points of the diamonds representing 95% CIs.

Pooled correlation coefficients between FDI physical function and the other instruments were 0.605 (95% CI, −0.124 to 0.910; I^2 = 95%), for eFACE, 0.473 (95% CI, 0.311-0.607; I^2 = 88%) for House-Brackmann, and 0.423 (95% CI, 0.322-0.514; I^2 = 55%) for Sunnybrook Facial Grading System and (Figure 3A).[4, 10, 12, 25, 28, 30, 32-35, 38-40] Pooled correlation coefficients between FDI social function and the other instruments were 0.208 (95% CI, 0.301-0.373; I^2 = 0%) for eFACE, 0.166 (95% CI, 0.044-0.283; I^2 = 68%) for House-Brackmann, and 0.182 (95% CI, 0.095-0.266; I^2 = 21%) for Sunnybrook Facial Grading System (Figure 3B).[4, 10, 12, 25, 28, 30, 32-35, 38-40] The strongest pooled correlation, based on 2 studies, was found between the eFACE and the FDI physical function. The weakest pooled correlation, also based on 2 studies, was found between the House-Brackmann and FDI social function. We examined whether the choice of facial function instrument was associated with the association between facial function and QOL by comparing 95% CIs. Forest plots show overlapping 95% CIs of the pooled correlations between eFACE, House-Brackmann, and Sunnybrook Facial Grading System and the same QOL outcome (Figure 2).

Associations between facial function and the physical and social domain of QOL

Pooled correlation coefficients between facial function and QOL were higher for the physical domain of QOL, represented by FaCE total and FDI physical function (Figure 2A, Figure 3A), than for the social domain, represented by FaCE and FDI social function (Figure 2B, Figure 3B).

The results of the meta-analysis examining the correlations between facial function and all FaCE subdomains are presented in Appendix 6.4. The strongest correlations with the subdomain facial movement of the FaCE were noted with House-Brackmann (0.593; 95% CI, 0.443-0.711), Sunnybrook Facial Grading System (0.634; 95% CI, 0.496-0.741), and eFACE (0.531; 95% CI, 0.197-0.754).

Factors influencing the association between facial function and QOL

Only factors apparently influencing the associations between the Sunnybrook Facial Grading System score and QOL could be evaluated in the meta-regression analysis, because the number of studies was too limited for any other associations to be analyzed. The number of studies included in the meta-regression analysis ranged from 6 to 11. This meta-regression does not show the association between a factor and QOL; rather, how a factor relates to the association between facial function (Sunnybrook Facial Grading System) and QOL is estimated. The mean age of the participants was associated with the correlation between Sunnybrook Facial Grading System and FDI social function (0.018; 95% CI, 0.000-0.037) (Table 2), indicating that, in studies with a higher mean age of the populations, the associations found apparently are higher (0.018 per means in years of age).

Table 2. Meta-regression univariate

Association	Covariate (n studies)	Coefficient (CI95%)	p-value
SB with FaCE total	Intercept age	-1.150 (-3.332; 1.032)	0.30
	Age, mean (6)	0.034 (-0.008; 0.076)	0.11
	Intercept % female	0.300 (-0.524; 1.121)	0.48
	% female (7)	0.006 (-0.009; 0.021)	0.41
	Intercept % Bell's palsy	0.467 (0.251; 0.683)	<0.001
	% Bell's palsy (11)	0.003 (-0.001; 0.006)	0.18
SB with FaCE social function	Intercept age	-1.742 (-3.397; 1.914)	0.58
	Age, mean (6)	0.021 (-0.030; 0.071)	0.42
	Intercept % Bell's palsy	0.240 (-0.041; 0.521)	0.10
	% Bell's palsy (9)	0.002 (-0.002; 0.007)	0.30
SB with FDI(p)	Intercept age	0.843 (-0.050; 1.736)	0.06
	Age, mean (11)	-0.007 (-0.026; 0.011)	0.42
	Intercept % female	0.479 (-0.113; 1.070)	0.11
	% female (10)	0.000 (-0.010; 0.010)	0.98
	Intercept duration palsy	0.382 (-0.259, 1.022)	0.24
	Duration palsy (4)	0.047 (-0.120; 0.213)	0.58
	Intercept % Bell's palsy	0.407 (0.184; 0.630)	<0.001
	% Bell's palsy (10)	<0.001 (-0.003; 0.005)	0.68
SB with FDI(s)	Intercept age	-0.712 (-1.617; 0.193)	0.12
	Age, mean (9)	0.018 (0.000; 0.037)	0.05
	Intercept % female	0.170 (-0.378; 0.718)	0.54
	% female (8)	<0.001 (-0.009; 0.010)	0.98
	Intercept % Bell's palsy	0.144 (-0.012; 0.300)	0.07
	% Bell's palsy (8)	<0.001 (-0.002; 0.003)	0.63

Abbreviations: FaCE, Facial Clinimetric Evaluation scale; FDI, Facial Disability Index physical (p) and social (s) function; SB, Sunnybrook Facial Grading Instrument.

Discussion

This systematic review and meta-analysis examined the association between clinician-graded facial function and patient-reported, disease-specific QOL in adults with peripheral facial palsy. Associations were low to moderate, meaning that only a small part of QOL is explained by facial function and a considerable part of QOL is explained by other factors. Our findings are in concordance with previous literature. In a systematic review examining the association between disease-related impairments and health-related QOL in patients with various disorders, pooled effect sizes less than or equal to 0.46

were found.[45] The authors stated that QOL scores do not adequately reflect impairment because these scores appear to be influenced by factors in addition to the impairment. Studies analyzing variables associated with QOL in patients with facial palsy described that, in general, a shorter duration of palsy, an older age, female sex, higher depression scores, higher anxiety scores, and worse facial function were associated with lower QOL.[4-6, 46] A study examining the explained variance (R^2) of QOL suggested that the FaCE total score is largely determined by the eFACE and a smaller portion might be explained by other factors, such as sex and type of visit (initial evaluation or follow-up).[37]

In this review, the correlation between the facial function and social function domain of QOL was weaker than the correlation between facial function and physical function. Different patients with the same facial palsy severity may experience social burden differently, and patients experiencing the same social burden may have variations in facial palsy severity. Previous studies found increased anxiety and depression rates in persons with facial palsy,[15, 47-49] but anxiety or depression was not associated with facial palsy severity.[16] A systematic review examining the psychosocial aspects of facial palsy advises psychological screening of every patient given the inconsistencies between studies in the strength of the correlation between facial palsy severity and psychosocial outcomes.[16] Although psychosocial counseling has been previously recommended, to our knowledge, there is no research published on what type of counseling is needed most in the facial palsy population.[16, 50, 51]

We examined whether the choice of facial function instrument affects the association between facial function and QOL. We consistently found overlapping 95% CIs of summary statistics when correlating the 3 facial function instruments with the same QOL instrument (Figures 2 and 3), so no significant differences in strength of the correlations were found. The House-Brackmann instrument has received increasing criticism owing to its crude scale, which does not allow for distinguishing changes in different regions of the face and is therefore deemed less suitable for clinical and scientific evaluation of facial palsy.[7, 20, 52]

The meta-regression analyses showed that only mean age of the study population influenced the association between the Sunnybrook Facial Grading System and FDI social function, indicating that in studies with a higher mean age, the associations were somewhat higher (0.018 per means in years of age). Clinically, this finding suggests that, in older participants, the association between facial function and social function is somewhat higher, and vice versa, with younger patients more variable in experiencing social burden independent of facial palsy severity. Other factors analyzed in the meta-regression were percentage of women, duration of palsy, and diagnosis of idiopathic facial palsy, which were not significantly different or could not be analyzed owing to the small number of studies. The lack of significant findings in our meta-regression could be due to heterogeneity between

studies, probably related to large variability in patient characteristics, such as sex ratio, age, and duration of palsy (clinical heterogeneity). Obtaining a homogeneous sample with a sufficient number of patients with facial palsy is difficult owing to the great variability in age at occurrence, disease course, cause of palsy, laterality, previous treatment, and a low incidence.[53, 54] Methodologic variations between studies, such as differences in facial function assessment, outcome assessment, and handling of confounders and missing data, may also have contributed to the large heterogeneity.[55]

Risk of bias assessment

There is no single method best for assessing risk of bias in observational studies because there is disagreement on how to approach risk of bias assessment.[56, 57] Because this review analyzed cross-sectional data, we chose a tool suited for this purpose and modified it slightly so that it better met the aim of the study. Overall, it appeared that studies failed to report the method. For example, 57% of the studies analyzed did not report whether facial function and 43% whether QOL assessments were implemented consistently. Whether assessors were blinded to QOL scores of patients was not reported in 61% of the studies and whether participants were blinded to facial function scores was not reported in 70% of the studies. For better comparison of studies and to estimate the risk of bias adequately, future research should better report exposure and outcome assessment.

Limitations

The study had limitations. In this review, physical function is defined as FaCE total score and FDI physical function. A limitation of this approach is that the FaCE total score also comprises a social subdomain. There is not one subdomain of the FaCE that directly matches the FDI physical function and it was not possible to exclude the social subdomain and merge all physical subdomains of the FaCE. However, when comparing the pooled correlations of the FaCE total (Figure 2A) with the FaCE subdomains (Appendix 6.4), there was no indication that including social function data as part of the FaCE total score was associated with the conclusion of this review. Clinical and methodologic heterogeneity, indicated by high I2 values, was substantial between studies, suggesting bias. Another limitation of this review is that every study analyzed the association between facial function severity and QOL in a linear model. To our knowledge no study has ever explored whether another model fit might better explain the association between facial function and QOL. Another model might better explain the association between clinician-graded facial function and QOL. Furthermore, some of the included studies used Spearman ρ and some used Pearson r to analyze their data, but there were too few studies that used Pearson r to test whether the choice of test statistic appeared to influence the association found. In addition, the pooled correlations were not adjusted for covariates.

This review provides insight into which part of QOL can be explained by facial function and which part is explained by other variables. Given the considerably large unexplained part, we recommend assessing facial palsy using both clinician-graded as well as patient-reported instruments. Existing relevant literature is limited by small sample sizes and a large amount of heterogeneity between studies. Although large sample sizes are often difficult to obtain in the field of facial palsy, it would be beneficial to aim for such sample sizes in future research.

Conclusions

This systematic review and meta-analysis noted that clinician-graded facial function and patient-reported, disease-specific QOL appear to be only moderately correlated. Particularly, the social function domain of QOL is weakly correlated with the severity of facial function impairment, emphasizing that the psychosocial burden that comes with peripheral facial palsy is not necessarily defined by the severity of the palsy. Therefore, we recommend assessing facial palsy using both clinician-graded and patient-reported instruments. Future research should focus on identifying factors other than severity of facial function impairment that might influence QOL in adults with peripheral facial palsy.

Literature

1. van Veen MM, Tavares-Brito J, van Veen BM et al. Association of Regional Facial Dysfunction With Facial Palsy-Related Quality of Life. JAMA Facial Plast Surg 2019;21:32-37.
2. Movérare T, Lohmander A, Hultcrantz M et al. Peripheral facial palsy: Speech, communication and oral motor function. Eur Ann Otorhinolaryngol Head Neck Dis 2017;134:27-31.
3. Terzis JK, Karypidis D. Blink restoration in adult facial paralysis. Plast Reconstr Surg 2010;126:126-139.
4. Bruins TE, van Veen MM, Mooibroek-Leeuwerke T et al. Association of Socioeconomic, Personality, and Mental Health Factors With Health-Related Quality of Life in Patients With Facial Palsy. JAMA Otolaryngoloy - Head-Neck Surgery 2020;146:331-337.
5. Tavares-Brito J, van Veen MM, Dusseldorp JR et al. Facial Palsy-Specific Quality of Life in 920 Patients: Correlation With Clinician-Graded Severity and Predicting Factors. Laryngoscope 2019;129:100-104.
6. Kleiss IJ, Hohman MH, Susarla SM et al. Health-related quality of life in 794 patients with a peripheral facial palsy using the FaCE Scale: a retrospective cohort study. Clin Otolaryngol 2015;40:651-656.
7. House JW, Brackmann DE. Facial nerve grading system. Otolaryngol Head Neck Surg 1985;93:146-147.
8. Ross BG, Fradet G, Nedzelski JM. Development of a sensitive clinical facial grading system. Otolaryngol Head Neck Surg 1996;114:380-386.
9. Banks CA, Bhama PK, Park J et al. Clinician-Graded Electronic Facial Paralysis Assessment: The eFACE. Plast Reconstr Surg 2015;136:223e-230e.
10. Volk GF, Granitzka T, Kreysa H et al. Initial severity of motor and non-motor disabilities in patients with facial palsy: an assessment using patient-reported outcome measures. Eur Arch Otorhinolaryngol 2017;274:45-52.
11. Ware JE, Jr., Gandek B. Overview of the SF-36 Health Survey and the International Quality of Life Assessment (IQOLA) Project. J Clin Epidemiol 1998;51:903-912.
12. VanSwearingen JM, Brach JS. The Facial Disability Index: reliability and validity of a disability assessment instrument for disorders of the facial neuromuscular system. Phys Ther 1996;76:1288-1298; discussion 1298-1300.
13. Kahn JB, Gliklich RE, Boyev KP et al. Validation of a patient-graded instrument for facial nerve paralysis: the FaCE scale. Laryngoscope 2001;111:387-398.
14. Luijmes RE, Pouwels S, Beurskens CH et al. Quality of life before and after different treatment modalities in peripheral facial palsy: A systematic review. Laryngoscope 2017;127:1044-1051.
15. Cuenca-Martínez F, Zapardiel-Sánchez E, Carrasco-González E et al. Assessing anxiety, depression and quality of life in patients with peripheral facial palsy: a systematic review. PeerJ 2020;8:e10449.
16. Hotton M, Huggons E, Hamlet C et al. The psychosocial impact of facial palsy: A systematic review. Br J Health Psychol 2020;25:695-727.
17. Stroup DF, Berlin JA, Morton SC et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. Jama 2000;283:2008-2012.
18. Bruins TE, van Veen MM, Werker PMN, Broekstra DC, Dijkstra PU. Systematic review and meta-analysis of the strength of the association between facial function and quality of life in patients with facial palsy. [CRD42020197253]. (PROSPERO). 2020.
19. Bramer WM, Giustini D, de Jonge GB et al. De-duplication of database search results for systematic reviews in EndNote. J Med Libr Assoc 2016;104:240-243.
20. Fattah AY, Gurusinghe AD, Gavilan J et al. Facial nerve grading instruments: systematic review of the literature and suggestion for uniformity. Plast Reconstr Surg 2015;135:569-579.
21. Fattah AY, Gavilan J, Hadlock TA et al. Survey of methods of facial palsy documentation in use by members of the Sir Charles Bell Society. Laryngoscope 2014;124:2247-2251.

22. Ho AL, Scott AM, Klassen AF et al. Measuring quality of life and patient satisfaction in facial paralysis patients: a systematic review of patient-reported outcome measures. Plast Reconstr Surg 2012;130:91-99.

23. National Heart, Lung, and Blood Institute Study Quality Assessment Tools. (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools).

24. O'Connor SR, Tully MA, Ryan B et al. Failure of a numerical quality assessment scale to identify potential risk of bias in a systematic review: a comparison study. BMC Res Notes 2015;8:224.

25. VanSwearingen JM, Cohn JF, Turnbull J, Mrzai T, Johnson P. Psychological distress: linking impairment with disability in facial neuromotor disorders. Otolaryngol Head Neck Surg. 1998;118(6):790-796. doi:10.1016/S0194-5998(98)70270-0

26. Frijters E, Hofer SO, Mureau MA. Long-term subjective and objective outcome after primary repair of traumatic facial nerve injuries. Ann Plast Surg 2008;61:181-187.

27. Gonzalez-Cardero E, Infante-Cossio P, Cayuela A et al. Facial disability index (FDI): adaptation to Spanish, reliability and validity. Med Oral Patol Oral Cir Bucal 2012;17:e1006-1012.

28. Marsk E, Hammarstedt-Nordenvall L, Engström M et al. Validation of a Swedish version of the Facial Disability Index (FDI) and the Facial Clinimetric Evaluation (FaCE) scale. Acta Otolaryngol 2013;133:662-669.

29. Ng JH, Ngo RY. The use of the facial clinimetric evaluation scale as a patient-based grading system in Bell's palsy. Laryngoscope 2013;123:1256-1260.

30. Pavese C, Cecini M, Camerino N et al. Functional and social limitations after facial palsy: expanded and independent validation of the Italian version of the facial disability index. Phys Ther 2014;94:1327-1336

31. Kleiss IJ, Beurskens CH, Stalmeier PF et al. Quality of life assessment in facial palsy: validation of the Dutch Facial Clinimetric Evaluation Scale. Eur Arch Otorhinolaryngol 2015;272:2055-2061.

32. Tveiten Ø V, Carlson ML, Goplen F et al. Patient- versus physician-reported facial disability in vestibular schwannoma: an international cross-sectional study. J Neurosurg 2017;127:1015-1024.

33. Chong LSH, Eviston TJ, Low TH et al. Validation of the Clinician-Graded Electronic Facial Paralysis Assessment. Plast Reconstr Surg 2017;140:159-167.

34. Györi E, Przestrzelski C, Pona I et al. Quality of life and functional assessment of facial palsy patients: A questionnaire study. Int J Surg 2018;55:92-97.

35. Barry P, Mancini J, Alshukry A et al. Validation of French versions of the Facial Disability Index and the Facial Clinimetric Evaluation Scale, specific quality of life scales for peripheral facial palsy patients. Clin Otolaryngol 2019;44:313-322.

36. Díaz-Aristizabal U, Valdés-Vilches M, Fernández-Ferreras TR et al. Correlations between impairment, psychological distress, disability, and quality of life in peripheral facial palsy. Neurologia 2019;34:423-428.

37. van Veen MM, Quatela O, Tavares-Brito J et al. Patient-perceived severity of synkinesis reduces quality of life in facial palsy: A cross-sectional analysis in 92 patients. Clin Otolaryngol 2019;44:483-486.

38. Bylund N, Hultcrantz M, Jonsson L et al. Quality of Life in Bell's Palsy: Correlation with Sunnybrook and House-Brackmann Over Time. Laryngoscope 2020.

39. Özden F, Karaman Ö N, Tuğay N et al. The reliability and validity of the Turkish version of the Facial Disability Index. Disabil Rehabil 2020:1-10.

40. Volk GF, Geitner M, Geißler K et al. Functional Outcome and Quality of Life After Hypoglossal-Facial Jump Nerve Suture. Front Surg 2020;7:11.

41. Borenstein M HL, Higgins J, Rothstein H. Comprehensive Meta-Analysis, Version 3. 2013.

42. Higgins JP, Thompson SG, Deeks JJ et al. Measuring inconsistency in meta-analyses. Bmj 2003;327:557-560.

43. Deeks JJ HJ, Altman DG; on behalf of the Cochrane Statistical Methods Group. In: Cochrane Handbook for Systematic Reviews of Interventions 2020.

44. Tavares-Brito J, Fonseca ACO, Torres RP et al. Facial Clinimetric Evaluation Scale and Synkinesis Assessment Questionnaire Translation into Brazilian Portuguese: A Validation Study. Int Arch Otorhinolaryngol 2020;24:e24-e30.

45. Weisscher N, de Haan RJ, Vermeulen M. The impact of disease-related impairments on disability and health-related quality of life: a systematic review. BMC Med Res Methodol 2007;7:24.

46. Nellis JC, Ishii M, Byrne PJ et al. Association Among Facial Paralysis, Depression, and Quality of Life in Facial Plastic Surgery Patients. JAMA Facial Plast Surg 2017;19:190-196.

47. Pouwels S, Beurskens CH, Kleiss IJ et al. Assessing psychological distress in patients with facial paralysis using the Hospital Anxiety and Depression Scale. J Plast Reconstr Aesthet Surg 2016;69:1066-1071.

48. Saadi R, Shokri T, Schaefer E et al. Depression Rates After Facial Paralysis. Ann Plast Surg 2019;83:190-194.

49. Chang YS, Choi JE, Kim SW et al. Prevalence and associated factors of facial palsy and lifestyle characteristics: data from the Korean National Health and Nutrition Examination Survey 2010-2012. BMJ Open 2016;6:e012628.

50. Eviston TJ, Croxson GR, Kennedy PG et al. Bell's palsy: aetiology, clinical features and multidisciplinary care. J Neurol Neurosurg Psychiatry 2015;86:1356-1361.

51. Butler DP, Grobbelaar AO. Facial palsy: what can the multidisciplinary team do? J Multidiscip Healthc 2017;10:377-381.

52. Vrabec JT, Backous DD, Djalilian HR et al. Facial Nerve Grading System 2.0. Otolaryngol Head Neck Surg 2009;140:445-450.

53. Hohman MH, Hadlock TA. Etiology, diagnosis, and management of facial palsy: 2000 patients at a facial nerve center. Laryngoscope 2014;124:E283-293.

54. Peitersen E. Bell's palsy: the spontaneous course of 2,500 peripheral facial nerve palsies of different etiologies. Acta Otolaryngol Suppl 2002:4-30.

55. Haraldstad K, Wahl A, Andenæs R et al. A systematic review of quality of life research in medicine and health sciences. Qual Life Res 2019;28:2641-2650.

56. Mueller M, D'Addario M, Egger M et al. Methods to systematically review and meta-analyse observational studies: a systematic scoping review of recommendations. BMC Med Res Methodol 2018;18:44.

57. Losilla JM, Oliveras I, Marin-Garcia JA et al. Three risk of bias tools lead to opposite conclusions in observational research synthesis. J Clin Epidemiol 2018;101:61-72.

Appendix 6.1. Search strategy

Database	Strings
Pubmed (Medline)	(“Facial Paralysis”[Mesh] OR “Facial Nerve Diseases”[Mesh] OR “facial paral*”[tiab] OR “facial pals*” [tiab] OR “facial pares*”[tiab] OR “facial disabil*”[tiab] OR “facial dysfunct*”[tiab] OR “facial function*”[tiab] OR “Sunnybrook Facial”[tiab] OR SFGS[tiab] OR eFACE[tiab] OR “House-Brackmann”[tiab]) AND (“Quality of Life”[Mesh] OR “Patient Reported Outcome Measures”[Mesh] OR “Patient Outcome Assessment”[Mesh:NoExp] OR “quality of life”[tiab] OR QoL[tiab] OR HRQoL[tiab] OR “patient-reported”[tiab] OR “patient outcome*”[tiab] OR “Facial Clinimetric evaluation”[tiab] OR “FaCE scale”[tiab] OR “Facial Disability Index”[tiab] OR FDI[tiab])
Embase	(‘Facial Nerve Diseases’/exp OR ‘Facial paralysis’/exp OR (‘facial function*’ OR ‘facial dysfunct*’ OR ‘facial disabil*’ OR ‘facial pals*’ OR ‘facial pares*’ OR ‘facial paral*’ OR ‘Sunnybrook Facial’ OR ‘SFGS’ OR ‘eFACE’ OR ‘House-Brackmann’):ab,ti) AND (‘Quality of life’/exp OR ‘Patient Reported Outcome Measures’/exp OR (‘HRQoL’ OR ‘QoL’ OR ‘quality of life’ OR ‘patient-reported’ OR ‘patient outcome’ OR ‘Facial Clinimetric evaluation’ OR ‘FaCE scale’ OR ‘Facial Disability Index’ OR ‘FDI’):ab,ti)
Cinahl (EBSCO)	(MH “Facial Nerve Diseases+” OR MH “Facial paralysis+” OR TI “facial function*” OR AB “facial function*” OR TI “facial disabil*” OR AB “facial disabil*” OR TI “facial pals*” OR AB “facial pals*” OR TI “facial paral*” OR AB “facial paral*” OR TI “facial pares*” OR AB “facial pares*” OR TI “facial dysfunct*” OR AB “facial dysfunct*” OR TI “Sunnybrook Facial” OR AB “Sunnybrook Facial” OR TI “SFGS” OR AB “SFGS” OR TI “eFACE” OR AB “eFACE” OR TI “House-Brackmann” OR AB “House-Brackmann”) AND (MH “Quality of life+” OR MH “Patient Reported Outcome Measures+” OR TI “quality of life” OR AB “quality of life” OR TI “HRQoL” OR AB “HRQoL” OR TI “QoL” OR AB “QoL” OR TI “patient-reported” OR AB “patient-reported” OR TI “patient outcome” OR AB “patient outcome” OR TI “facial clinimetric evaluation” OR AB “facial clinimetric evaluation” OR TI “FaCE scale” OR AB “FaCE scale” OR TI “Facial disability index” OR ”B “Facial disability index” OR TI “FDI” OR AB “FDI”)
Web of science	(TS=(“facial nerve diseas*”) OR TS=(“facial paral*”) OR TS=(“facial function*”) OR TS=(“facial disabil*”) OR TS=(“facial pals*”) OR TS=(“facial pares*”) OR TS=(“facial dysfunct*”) OR TS=(“Sunnybrook Facial”) OR TS=(“SFGS”) OR TS=(“eFACE”) OR TS=(“House-Brackmann”)) AND (TS=(“Quality of life”) OR TS=(“patient reported outcome measure*”) OR TS=(HRQoL) OR TS=(QoL) OR TS=(“patient-reported”) OR TS=(“patient outcome”) OR TS=(“facial clinimetric evaluation”) OR TS=(“FaCE scale”) OR TS=(“Facial disability index”) OR TS=(“FDI”)) AND DOCUMENT TYPES: (Article)
Psycinfo	(DE(“Facial Nerve” OR “Facial Expressions”) OR AB(“facial function*” OR “facial disabil*” OR “facial pals*” OR “facial paral*” OR “facial pares*” OR “facial dysfunct*” OR “facial nerve diseas*” OR “Sunnybrook Facial” OR “SFGS” OR “eFACE” OR “House-Brackmann”) OR TI(“facial function*” OR “facial disabil*” OR “facial pals*” OR “facial paral*” OR “facial pares*” OR “facial dysfunct*” OR “facial nerve diseas*” OR “Sunnybrook Facial” OR “SFGS” OR “eFACE” OR “House-Brackmann”)) AND (DE(“Quality of Life” OR “Health Related Quality of Life” OR “Quality of Life Measures” OR “Patient Reported Outcome Measures”) OR AB(“quality of life” OR HRQoL OR QoL OR “patient-reported” OR “patient outcome*” OR “Facial clinimetric evaluation” OR “FaCE scale” OR “Facial disability index” OR FDI) OR TI(“quality of life” OR HRQoL OR QoL OR “patient-reported” OR “patient outcome*” OR “Facial clinimetric evaluation” OR “FaCE scale” OR “Facial disability index” OR FDI))

Appendix 6.2. Risk of bias tool

Name/initials reviewer:

Article (first author, year):

	Question	Yes	No	Don't know, NA, comment
1	Was the study population clearly specified and defined?			
2	Was the participation rate of eligible persons at least 50%?			
3	a. Is the comparability between participant and non-participant characteristics analyzed?			
	b. Are the participant and non-participant characteristics comparable?			
4	a. Were all the subjects selected or recruited from the same or similar populations (including the same time period)?			
	b. Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?			
5	Was a sample size justification, or power description, or variance and effect estimates provided?			
6	Did the study examine different levels of facial function as related to quality of life (e.g., categories of facial function, or facial function measured as continuous variable)?			
7	Were the facial function measures (independent variables) implemented consistently across all study participants?			
8	Were the quality of life measures (dependent variables) implemented consistently across all study participants?			
9	a. Was/were the assessor(s) blinded to the quality of life scores of participants?			
	b. Were the participants blinded to the facial function scores as measured by the assessor(s)?			
10	Were key potential confounding variables:			
	Measured?			
	Adjusted statistically for their impact on the relationship between facial function and quality of life?			
11	Is missing data reported?			

Appendix 6.3. Risk of Bias Assessment

Source	Selection[a]							Exposure and outcome assessment[b]					Confounding[c]	Missing[d]	
	1	2	3a	3b	4a	4b	5	6	7	8	9a	9b	10a	10b	11
VanSwearingen and Brach, 1996	Yes	NR	No	NA	Yes	Yes	No	NR	NR	NR	NR	NR	No	No	Yes
VanSwearingen et al, 1998	Yes	No	No	NA	Yes	Yes	No	Yes	NR	NR	NR	NR	No	No	Yes
Kahn et al, 2001	Yes	Yes	No	NA	Yes	Yes	No	Yes	Yes	No	No	NR	Yes	No	Yes
Frijters et al, 2008	Yes	Yes	No	NA	Yes	Yes	No	Yes	Yes	Yes	Yes	NR	Yes	No	Yes
Gonzalez-Cardero et al, 2012	Yes	NR	No	NA	Yes	Yes	No	NR	NR	Yes	NR	NR	No	No	Yes
Marsk et al, 2013	Yes	NR	No	NA	Yes	Yes	No	Yes	NR	Yes	No	No	Yes	No	No
Ng et al, 2013	Yes	Yes	No	NA	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	No	No
Pavese et al, 2014	Yes	NR	No	NA	Yes	Yes	Yes	Yes	Yes	Yes	NR	Yes	Yes	No	Yes
Kleiss et al, 2015	Yes	NR	No	NA	Yes	Yes	No	Yes	NR	No	NR	NR	Yes	No	No
Kleiss et al, 2015	Yes	No	No	No	Yes	Yes	No	Yes	NR	NR	NR	NR	Yes	No	Yes
Tveiten et al, 2017	Yes	Yes	Yes	Yes	No	Yes	No	Yes	NR	NR	NR	NR	Yes	No	Yes
Chong et al, 2017	No	NR	No	NA	NR	Yes	No	Yes	Yes	Yes	Yes	NR	Yes	No	No
Volk et al, 2017	Yes	Yes	No	NA	Yes	Yes	No	Yes	NR	NR	NR	NR	Yes	Yes	Yes
Györi et al, 2018	Yes	NR	No	NA	Yes	Yes	No	Yes	NR	NR	NR	NR	Yes	No	No
Barry et al, 2019	Yes	NR	No	NA	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Diaz-Aristizabal et al, 2019	Yes	NR	No	NA	Yes	Yes	No	Yes	NR	NR	NR	NR	Yes	No	No
Tavares-Brito et al, 2019	Yes	NR	No	NA	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	No	No
Tavares-Brito et al, 2019	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	NR	NR	NR	Yes	Yes	Yes
van Veen et al, 2019	Yes	Yes	Yes	Yes	Yes	Yes	No	NR	Yes	Yes	No	Yes	Yes	Yes	Yes
Bruins et al, 2020	Yes	No	No	NA	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Bylund et al, 2021	Yes	NR	No	NA	Yes	Yes	No	Yes	No	Yes	NR	NR	Yes	No	Yes
Özden et al, 2020	Yes	NR	No	NA	Yes	Yes	Yes	Yes	NR	NR	NR	NR	Yes	No	Yes
Volk et al, 2020	Yes	NR	No	NA	Yes	Yes	No	Yes	NR	NR	NR	NR	Yes	Yes	No
Total No. of papers with yes selection	22	7	3	3	21	23	3	20	9	11	2	4	20	5	15

Appendix 6.3. [continued]

Abbreviations: NA, not applicable; NR, not reported.
[a]1: Was population clearly specified? 2: Was participation rate greater than or equal to 50%. 3a: Are comparability nonparticipant and participant characteristics analyzed? 3b: Are nonparticipant and participant characteristics comparable? 4a: Were participants selected from similar populations? 4b: Were inclusion and exclusion criteria prespecified and uniformly applied? 5: Was sample size justification provided?
[b]6: Were different levels of facial function severity examined? 7. Were facial function measures consistently implemented? 8: Were quality-of-life measures consistently implemented? 9a: Were assessors blinded? 9b: Were participants blinded?
[c]10a: Were confounding variables measured? 10b: Were confounding variables adjusted statistically for their impact on the association/correlation?
[d]11. Are missing data reported?

Appendix 6.4. Meta-analysis of the House-Brackmann, Sunnybrook Facial Grading System and the eFACE correlated with the Facial Clinimetric Evaluation subdomain scores

Comparison	Outcome (n studies)	Pooled Correlation (CI95%)	p-value
HB[a]	Facial movement (8)	0.593 (0.443; 0.711)	<0.001
	Facial comfort (7)	0.197 (0.092; 0.298)	<0.001
	Oral function (7)	0.444 (0.377; 0.507)	<0.001
	Eye comfort (7)	0.281 (0.168; 0.168)	<0.001
	Lacrimal control (7)	0.148 (0.040; 0.252)	0.007
	Social function (7)	0.397 (0.242; 0.532)	<0.001
SB	Facial movement (8)	0.634 (0.496; 0.741)	<0.001
	Facial comfort (8)	0.216 (0.051; 0.369)	0.011
	Oral function (8)	0.436 (0.340; 0.524)	<0.001
	Eye comfort (8)	0.350 (0.231; 0.459)	<0.001
	Lacrimal control (8)	0.258 (0.160; 0.352)	<0.001
	Social function (9)	0.356 (0.238; 0.463)	<0.001
eFACE	Facial movement (2)	0.531 (0.197; 0.754)	0.003
	Facial comfort (2)	0.309 (0.144; 0.458)	<0.001
	Oral function (2)	0.405 (0.250; 0.541)	<0.001
	Eye comfort (2)	0.348 (0.063; 0.580)	0.018
	Lacrimal control (2)	0.016 (-0.158; 0.189)	0.862
	Social function (2)	0.324 (0.128; 0.495)	0.001

HB: House-Brackmann, SB: Sunnybrook Facial Grading System, CI: Confidence Interval.
[a] Correlations including the House-Brackmann were converted to positive correlations for easier comparing.

Appendix References

VanSwearingen JM, Brach JS. The Facial Disability Index: reliability and validity of disability assessment instrument for disorders of the facial neuromuscular system. Phys Ther. 1996;76(12):1288-1298. Medline:8959998 doi:10.1093/ptj/76.12.1288

VanSwearingen JM, Cohn JF, Turnbull J, Mrzai T, Johnson P. Psychological distress: linking impairment with disability in facial neuromotor disorders. Otolaryngol Head Neck Surg. 1998;118(6):790-796. Medline:9627238 doi:10.1016/S0194-5998(98)70270-0

Kahn JB, Gliklich RE, Boyev KP, Stewart MG, Metson RB, McKenna MJ. Validation of a patient-graded instrument for facial nerve paralysis: the FaCE scale. Laryngoscope. 2001;111(3):387-398. Medline:11224766 doi:10.1097/00005537-200103000-00005

Frijters E, Hofer SO, Mureau MA. Long-term subjective and objective outcome after primary repair of traumatic facial nerve injuries. Ann Plast Surg. 2008;61(2):181-187. Medline:18650612 doi:10.1097/SAP.0b013e3181591e27

Gonzalez-Cardero E, Infante-Cossio P, Cayuela A, Acosta-Feria M, Gutierrez-Perez JL. Facial Disability Index (FDI): adaptation to Spanish, reliability and validity. Med Oral Patol Oral Cir Bucal. 2012;17(6):e1006-e1012. Medline:22926474 doi:10.4317/medoral.18054

Marsk E, Hammarstedt-Nordenvall L, Engström M, Jonsson L, Hultcrantz M. Validation of a Swedish version of the Facial Disability Index (FDI) and the Facial Clinimetric Evaluation (FaCE) scale. Acta Otolaryngol. 2013;133(6):662-669. Medline:23675814 doi:10.3109/00016489.2013.766924

Ng JH, Ngo RY. The use of the Facial Clinimetric Evaluation Scale as a patient-based grading system in Bell's palsy. Laryngoscope. 2013;123(5):1256-1260. Medline:23553515 doi:10.1002/lary.23790

Pavese C, Cecini M, Camerino N, et al. Functional and social limitations after facial palsy: expanded and independent validation of the Italian version of the Facial Disability Index. Phys Ther. 2014;94(9):1327-1336. Medline:24786937 doi:10.2522/ptj.20130254

Kleiss IJ, Hohman MH, Susarla SM, Marres HA, Hadlock TA. Health-related quality of life in 794 patients with a peripheral facial palsy using the FaCE Scale: a retrospective cohort study. Clin Otolaryngol. 2015;40(6):651-656. Medline:25858429 doi:10.1111/coa.12434

Kleiss IJ, Beurskens CH, Stalmeier PF, Ingels KJ, Marres HA. Quality of life assessment in facial palsy: validation of the Dutch Facial Clinimetric Evaluation Scale. Eur Arch Otorhinolaryngol. 2015;272(8):2055-2061. Medline:25628237 doi:10.1007/s00405-015-3508-x

Tveiten ØV, Carlson ML, Goplen F, et al. Patient- versus physician-reported facial disability in vestibular schwannoma: an international cross-sectional study. J Neurosurg. 2017;127(5):1015-1024. Medline:27911236 doi:10.3171/2016.8.JNS16707

Chong LSH, Eviston TJ, Low TH, Hasmat S, Coulson SE, Clark JR. Validation of the clinician-graded electronic facial paralysis assessment. Plast Reconstr Surg. 2017;140(1):159-167. Medline:28338582 doi:10.1097/PRS.0000000000003447

Volk GF, Granitzka T, Kreysa H, Klingner CM, Guntinas-Lichius O. Initial severity of motor and non-motor disabilities in patients with facial palsy: an assessment using patient-reported outcome measures. Eur Arch Otorhinolaryngol. 2017;274(1):45-52. Medline:27040558 doi:10.1007/s00405-016-4018-1

Györi E, Przestrzelski C, Pona I, et al. Quality of life and functional assessment of facial palsy patients: a questionnaire study. Int J Surg. 2018;55:92-97. Medline:29787803 doi:10.1016/j.ijsu.2018.04.061

Barry P, Mancini J, Alshukry A, Salburgo F, Lavieille JP, Montava M. Validation of French versions of the Facial Disability Index and the Facial Clinimetric Evaluation Scale, specific quality of life scales for peripheral facial palsy patients. Clin Otolaryngol. 2019;44(3):313-322. Medline:30672663 doi:10.1111/coa.13294

Díaz-Aristizabal U, Valdés-Vilches M, Fernández-Ferreras TR, Calero-Muñoz E, Bienzobas-Allué E, Moracén-Naranjo T. Correlations between impairment, psychological distress, disability, and quality of life in peripheral facial palsy [Spanish]. Neurologia. 2019;34(7):423-428. Medline:28549753 doi:10.1016/j.nrleng.2019.03.001

Tavares-Brito J, van Veen MM, Dusseldorp JR, Bahmad F Jr, Hadlock TA. Facial palsy–specific quality of life in 920 patients: correlation with clinician-graded severity and predicting factors. Laryngoscope. 2019;129(1):100-104. Medline:30208215 doi:10.1002/lary.27481

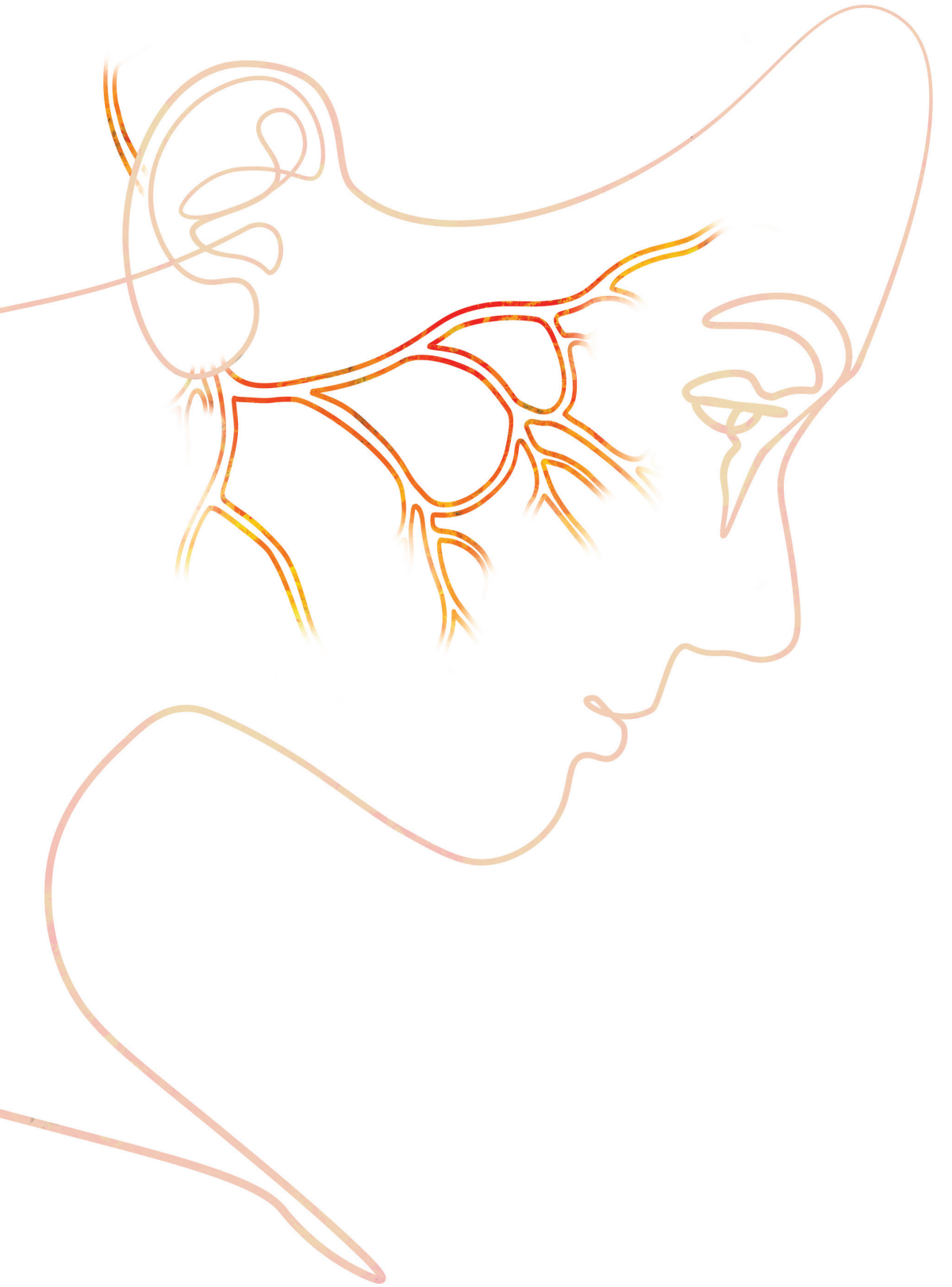
van Veen MM, Tavares-Brito J, van Veen BM, et al. Association of regional facial dysfunction with facial palsy–related quality of life. JAMA Facial Plast Surg. 2019;21(1):32-37. Medline:30073264 doi:10.1001/jamafacial.2018.0804

Bruins TE, van Veen MM, Mooibroek-Leeuwerke T, Werker PMN, Broekstra DC, Dijkstra PU. Association of socioeconomic, personality, and mental health factors with health-related quality of life in patients with facial palsy. JAMA Otolaryngol Head Neck Surg. 2020;146(4):331-337. doi:10.1001/jamaoto.2019.4559

Bylund N, Hultcrantz M, Jonsson L, Marsk E. Quality of life in Bell's Palsy: correlation with Sunnybrook and House-Brackmann over time. Laryngoscope. 2021;131(2):E612-E618. doi:10.1002/lary.28751

Özden F, Karaman ÖN, Tuğay N, Savaş Ö, Sözen T, Üçüncü H. The reliability and validity of the Turkish version of the Facial Disability Index. Disabil Rehabil. 2020;1-10. Medline:32412806 doi:10.1080/09638288.2020.1762768

Volk GF, Geitner M, Geißler K, et al. Functional Outcome And Quality Of Life After Hypoglossal-Facial Jump Nerve Suture. Front Surg. 2020;7:11. Medline:32266284 doi:10.3389/fsurg.2020.00011



Appendix to Chapter 6

A cross-sectional analysis of facial palsy-related quality of life in 125 patients: Comparing linear, quadratic and cubic regression analyses

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Key points

1) Facial function correlates with quality of life in facial palsy.
2) Previous studies examined a linear relationship; based on clinical experience we hypothesize a curved regression (i.e. quadratic or cubic) will be more fitting to show the correlation between quality of life and facial function.
3) We compared the fit of a linear regression model between Sunnybrook scores (facial function) and FaCE and FDI scores (quality of life) to a quadratic and cubic regression model in 125 patients cross-sectionally.
4) The quadratic regression proved a significant improvement over a linear regression analysis in the model using the FaCE total score (linear $R^2 = 0.346$, quadratic $R^2 = 0.378$, $p = 0.033$) and the FDI physical score (linear $R^2 = 0.245$, quadratic $R^2 = 0.276$, $p = 0.034$). The cubic regression analysis was no significant improvement over a quadratic regression.
5) The relationship between facial function and quality of life in facial palsy is not linear and should not be included as such in future research studies.

Introduction

Facial palsy is a condition characterized by disturbed function of the facial muscles. Long-standing facial palsy can be categorized into two groups, those in whom synkinesis is absent (chronic flaccid paralysis) and those in whom synkinesis is present (post-paralysis synkinesis). Post-paralysis synkinesis is characterized by unwanted facial movements during a volitional alternate movement, due to aberrant reinnervation of the facial nerve. Both can result in functional problems such as oral incompetence and speech impairment and can influence psychosocial well-being by introducing problems with negative self-image and feelings of anxiety or depression.[1] Evaluation of facial palsy should thus not solely consist of a measure of facial function but must also include a patient-reported outcome measure. Prior studies have examined factors influencing quality of life (QoL) in facial palsy and found that facial function was the greatest contributing factor currently known to influence QoL.[2] Until now the relationship studied between facial function and QoL has always been assessed as a linear one, assuming an equal decrease in QoL in relation to the decrease in facial function. Based on our clinical experience, we believe the relationship between facial function and QoL is non-linear: we expect a strong correlation between QoL and mild impairment of facial function, while the correlation between QoL and facial function in severe and moderate cases may be weak.

In the present study we examined if the curved relationship, is a better fitting model compared to the most commonly used linear model.

Methods

This study was a reanalysis of previously collected data for the translation and validation studies of the Dutch versions of the Facial Clinimetric Evaluation (FaCE) scale[3], Synkinesis Assessment Questionnaire (SAQ)[4] and Facial Disability Index (FDI)[5]. No new patients were included and no new data was gathered for the current study. Approval of the Medical Ethics committee and written consent of participants was gathered with the before mentioned studies.

Data collection

Adult patients with facial palsy visiting the outpatient department of plastic surgery at the University Medical Center Groningen, the Netherlands, or the department of otorhinolaryngology at the Radboud University Medical Center, the Netherlands were approached to participate. Patients filled out the FaCE scale, the FDI, and some demographical questions. Facial function was measured using the Sunnybrook Facial Grading System (Sunnybrook)[6], at each institution an assessor experienced in performing Sunnybrook scoring performed the Sunnybrook scoring. Patients younger than 18 years old or not sufficiently fluent in Dutch were excluded from participation.[3-5]

Statistical analysis

Descriptive statistics were calculated using numbers and frequencies, means and standard deviations (SD), and medians and interquartile ranges (IQR). Nested regression models were analyzed for each of the outcome variables: FaCE total score, FDI physical score and FDI social/well-being score. The first model contained the descriptive variables gender, age, duration of palsy, and etiology. The second model contained a linear function for facial function, the third a quadratic function for facial function (i.e. a relationship with one curve), and the fourth a cubic function (i.e. a relationship with two curves). The model correlation coefficient (R^2) was calculated as a measure of fit for each model; the R^2 represents the proportion of variance in the output variable that can be explained by the input variable. R^2 was compared between the nested models, change in R^2 and a p-value for change was calculated.

A sub analysis was performed for patients suffering from chronic flaccid paralysis and post-paralysis synkinesis separately. Additional, above described analyses were performed with all FaCE scale subdomain scales as outcome variables and are presented as additional material.

All statistical analyses were done using the Statistical Package for Social Sciences (SPSS) version 23 (IBM, NY, US). A p-value ≤0.05 was considered statistically significant.

Results

One hundred and twenty-five patients could be included for this study. Sixty-seven patients were female (53.6%) and mean (SD) age at the time of inclusion was 56.6 (16.7) years. Both groups of chronic flaccid paralysis (n=60 (48%)) and post-paralysis synkinesis (n=65 (52%)) were equally represented. The most common etiology of facial palsy was Bell's palsy (n=31 (24.8%)), followed by postoperative complication of vestibular schwannoma treatment (n=24 (19.2%)), Ramsay-Hunt syndrome (n=11 (8.8%)) and trauma (n=9 (7.2%)). Median (IQR) duration of palsy was 6.6 (1.5; 18.3) years. Median (IQR) Sunnybrook scores were 34.0 (25.0; 55.5), FaCE total scores were 51.7 (40.0; 61.7), FDI physical function scores were 70.0 (55.0; 80.0), and FDI social function scores were 76.0 (64.0; 88.0).

The quadratic regression model was found to be a statistically significant improvement over the model containing a linear function for the outcomes FaCE total score and FDI physical function (table 1). In both models an increase in explained variance of 3% was seen. The cubic model did not prove to be an improvement compared to the quadratic model. Correlation between facial function and the FDI social/well-being score was weak, and both the quadratic and cubic models were no improvement compared to the linear function (table 1).

Table 1. Results of nested regression analyses for the FaCE total score, FDI physical function, FDI social/well-being in the total study sample (n = 125).

	Model*	R^2	R^2 change	Significance change
FaCE total score	1	0.138		
	2	0.346	0.208	**<0.001**
	3	0.378	0.032	**0.033**
	4	0.378	0.001	0.785
FDI physical function	1	0.190		
	2	0.245	0.055	**0.006**
	3	0.276	0.031	**0.034**
	4	0.279	0.003	0.525
FDI social/well-being function	1	0.090		
	2	0.113	0.023	0.089
	3	0.113	0.000	0.990
	4	0.113	0.001	0.777

* Model 1 includes the descriptive variables gender, age, duration of palsy and etiology. Model 2 consists of model 1 with an added variable for the linear relationship between facial function and the outcome variable. In model 3 a quadratic function for facial function is added. In model 4 a cubic function is added.

Table 2. Results of nested regression analyses for the FaCE total score, FDI physical function, FDI social/well-being in the patients suffering from chronic flaccid paralysis (n = 60).

	Model*	R^2	R^2 change	Significance change
FaCE total score	1	0.331		
	2	0.493	0.162	**0.002**
	3	0.497	0.004	0.617
	4	0.513	0.016	0.299
FDI physical function	1	0.271		
	2	0.368	0.097	**0.011**
	3	0.374	0.006	0.524
	4	0.405	0.031	0.138
FDI social/well-being function	1	0.169		
	2	0.169	0.000	0.890
	3	0.171	0.002	0.758
	4	0.201	0.030	0.189

* Model 1 includes the descriptive variables gender, age, duration of palsy and etiology. Model 2 consists of model 1 with an added variable for the linear relationship between facial function and the outcome variable. In model 3 a quadratic function for facial function is added. In model 4 a cubic function is added.

Interestingly, the model including a quadratic function proved to be better fitting in patients suffering from post-paralysis synkinesis (R^2 changes of 4.3%, 11.2% and 2.3% for the FaCE total score, FDI physical function and FDI social/well-being function respectively) compared to patients suffering from chronic flaccid paralysis (R^2 changes <1%) (table 2-3). A similar trend was seen in the FaCE subdomain score models (additional material table 1-3).

Discussion

In the current study we found that a quadratic regression model provides a significantly better estimation of the association between facial function and QoL compared to a linear regression model. A cubic regression model did not prove an improvement over a quadratic regression.

The explained variance (R^2) of both the FaCE total score and the FDI physical score model improved significantly by 3.2% and 3.1% respectively. The FDI social score showed no-significant improvement for any of the applied models. This is in line with previous research showing a weak and often non-significant correlation between facial function and the social aspect of QoL in facial palsy.[7]

Table 3. Results of nested regression analyses for the FaCE total score, FDI physical function, FDI social/well-being in the patients suffering from post-paralysis synkinesis (n = 65).

	Model*	R^2	R^2 change	Significance change
FaCE total score	1	0.171		
	2	0.350	0.179	**0.001**
	3	0.393	0.043	0.081
	4	0.408	0.015	0.300
FDI physical function	1	0.147		
	2	0.160	0.013	0.368
	3	0.272	0.112	**0.007**
	4	0.290	0.018	0.264
FDI social/well-being function	1	0.130		
	2	0.183	0.052	0.068
	3	0.205	0.023	0.223
	4	0.240	0.035	0.130

* Model 1 includes the descriptive variables gender, age, duration of palsy and etiology. Model 2 consists of model 1 with an added variable for the linear relationship between facial function and the outcome variable. In model 3 a quadratic function for facial function is added. In model 4 a cubic function is added.

In a previous study examining factors influencing quality of life in facial palsy an explained variance of 3.8% was found for a multivariate model predicting FaCE total scores by age, gender, duration of palsy and etiology.[8] In a follow-up study the authors found an explained variance of 18.9% in a linear model predicting FaCE total scores by eFACE facial function scores.[2] The addition of 10 clinical and demographic variables to this model increased the explained variance by 7.2%. In our study, the explained variance of the models containing descriptive characteristics and a quadratic function for facial function was 37.8% and 27.6% respectively. Modelling a quadratic regression can be seen as a rather large and clinically relevant improvement, since we were able to achieve similar values for explained variance with far fewer variables.

The quadratic function was most clearly present in patients suffering from post-paralysis synkinesis with changes in explained variance of 4.3%, 11.2% and 2.3%, compared to a change in explained variance of smaller than 1% in patients suffering from chronic flaccid paralysis. These changes were not statistically significant, which could be due to small sample size. We believe this means the experienced burden of synkinesis is much more individual compared to flaccid paralysis, as is supported by a previous study demonstrating the importance of incorporating patient self-experience synkinesis scores in QoL modeling in patients suffering from synkinesis .[9]

One of the limitations of our study was that we reanalyzed data previously collected in two different centers. All Sunnybrook scores were performed by experienced assessors. However, small local differences could be present. Furthermore, the scores from the Radboud University Medical Center were retrospectively collected from the medical charts. Although only patients with stable disease were included, this could potentially allow for variation in the Sunnybrook scores.

The findings from the current study cannot directly be generalized to other situations. We have used the Sunnybrook scale as a measurement for facial function and although it is shown to be valid, reliable, and is frequently used, findings may be different for other facial grading instruments such as the more recently developed eFACE scale or the historically much used House-Brackmann facial grading scale. A future study comparing linear and non-linear functions between individual items of facial function and QoL would be very interesting but was outside the scope of this pilot-type study.

We present a study of QoL and although the FaCE scale and FDI were translated and culturally validated according to standard guidelines, QoL remains highly individual and may very well be influenced by cultural background.[10] Variables predicting QoL may differ, so the magnitude of association found in our study population may not necessarily be equal in other populations.

Conclusions

Our study demonstrates that a quadratic relationship between severity of long-standing facial palsy and QoL provides a better estimation compared to a linear regression analysis. This means that in mild cases of facial palsy QoL can be relatively well estimated, while there is a lot of variation in QoL in cases with severe and moderate facial impairment. This is most applicable to patients suffering from post-paralysis synkinesis, proving the highly individually experienced burden of synkinesis.

Additional material table 1. Results of nested regression analyses for the FaCE sub domain scores in the total study sample (n = 125).

	Model*	R^2	R^2 change	Significance change
Facial movement score	1	0.093		
	2	0.482	0.386	**<0.001**
	3	0.493	0.010	0.153
	4	0.494	0.001	0.602
Facial comfort score	1	0.211		
	2	0.238	0.027	0.057
	3	0.272	0.034	**0.029**
	4	0.274	0.001	0.646
Oral function score	1	0.197		
	2	0.234	0.037	**0.022**
	3	0.246	0.012	0.187
	4	0.247	0.001	0.672
Eye comfort score	1	0.159		
	2	0.269	0.110	**<0.001**
	3	0.294	0.025	0.056
	4	0.300	0.006	0.339
Lacrimal control score	1	0.207		
	2	0.268	0.061	**0.003**
	3	0.289	0.021	0.075
	4	0.374	0.085	**<0.001**
Social function score	1	0.129		
	2	0.165	0.036	**0.033**
	3	0.178	0.013	0.197
	4	0.179	0.001	0.687

* Model 1 includes the descriptive variables gender, age, duration of palsy and etiology. Model 2 consists of model 1 with an added variable for the linear relationship between facial function and the outcome variable. In model 3 a quadratic function for facial function is added. In model 4 a cubic function is added.

Additional material table 2. Results of nested regression analyses for the FaCE sub domain scores in the patients suffering from chronic flaccid paralysis (n = 60).

	Model*	R^2	R^2 change	Significance change
Facial movement score	1	0.212		
	2	0.614	0.402	**<0.001**
	3	0.624	0.010	0.308
	4	0.625	0.000	0.828
Facial comfort score	1	0.294		
	2	0.300	0.006	0.542
	3	0.302	0.001	0.771
	4	0.345	0.043	0.112
Oral function score	1	0.321		
	2	0.409	0.088	**0.011**
	3	0.416	0.007	0.476
	4	0.435	0.020	0.216
Eye comfort score	1	0.371		
	2	0.570	0.200	**<0.001**
	3	0.602	0.032	0.070
	4	0.609	0.007	0.395
Lacrimal control score	1	0.227		
	2	0.318	0.091	**0.017**
	3	0.320	0.002	0.705
	4	0.465	0.145	0.001
Social function score	1	0.223		
	2	0.237	0.015	0.356
	3	0.254	0.017	0.321
	4	0.259	0.004	0.627

* Model 1 includes the descriptive variables gender, age, duration of palsy and etiology. Model 2 consists of model 1 with an added variable for the linear relationship between facial function and the outcome variable. In model 3 a quadratic function for facial function is added. In model 4 a cubic function is added.

Additional material table 3. Results of nested regression analyses for the FaCE sub domain scores in the patients suffering frm post-paralysis synkinesis (n = 65).

	Model*	R^2	R^2 change	Significance change
Facial movement score	1	0.216		
	2	0.423	0.206	**<0.001**
	3	0.425	0.003	0.631
	4	0.482	0.056	**0.027**
Facial comfort score	1	0.230		
	2	0.266	0.036	0.118
	3	0.337	0.072	**0.023**
	4	0.339	0.002	0.724
Oral function score	1	0.237		
	2	0.259	0.022	0.208
	3	0.311	0.051	0.052
	4	0.322	0.011	0.356
Eye comfort score	1	0.130		
	2	0.167	0.037	0.135
	3	0.210	0.044	0.100
	4	0.212	0.002	0.757
Lacrimal control score	1	0.380		
	2	0.393	0.013	0.289
	3	0.427	0.034	0.085
	4	0.459	0.031	0.091
Social function score	1	0.168		
	2	0.209	0.041	0.106
	3	0.209	0.000	0.951
	4	0.225	0.015	0.322

* Model 1 includes the descriptive variables gender, age, duration of palsy and etiology. Model 2 consists of model 1 with an added variable for the linear relationship between facial function and the outcome variable. In model 3 a quadratic function for facial function is added. In model 4 a cubic function is added.

References

1. Nellis JC, Ishii M, Byrne PJ, Boahene KDO, Dey JK, Ishii LE. Association Among Facial Paralysis, Depression, and Quality of Life in Facial Plastic Surgery Patients. JAMA Facial Plastic Surgery 2016 Dec 8;19(3):19-196.
2. Tavares-Brito J, van Veen MM, Dusseldorp JR, Bahmad F, Hadlock TA. Facial Palsy-Specific Quality of Life in 920 Patients: Correlation With Clinician-Graded Severity and Predicting Factors. The Laryngoscope 2019 Jan;129(1):100-104.
3. Kleiss IJ, Beurskens CHG, Stalmeier PFM, Ingels, K. J. A. O, Marres HAM. Quality of life assessment in facial palsy: validation of the Dutch Facial Clinimetric Evaluation Scale. European Archives of Otorhinolaryngoly 2015;272(8):2055-2061.
4. Kleiss IJ, Beurskens CHG, Stalmeier PFM, Ingels, K. J. A. O, Marres HAM. Synkinesis assessment in facial palsy: validation of the Dutch Synkinesis Assessment Questionnaire. Acta Neurologica Belgica 2016;116(2):171-178.
5. Veen MMv, Bruins TE, Artan M, Mooibroek-Leeuwerke T, Beurskens CHG, Werker PM, et al. Health-related quality of life in facial palsy: translation and validation of the Dutch version Facial Disability Index. Health and Quality of Life Outcomes 2020;18(1):1-256.
6. Ross BG, Fradet G, Nedzelski JM. Development of a sensitive clinical facial grading system. Otolaryngology-Head and Neck Surgery 1996;114(3):380-386.
7. Bruins TE, van Veen MM, Werker PMN, Dijkstra PU, Broekstra DC. Associations Between Clinician-Graded Facial Function and Patient-Reported Quality of Life in Adults With Peripheral Facial Palsy. JAMA Otolaryngology-- Head & Neck Surgery 2021 Jul 1;147(8):717-728.
8. Kleiss IJ, Hohman MH, Susarla SM, Marres HAM, Hadlock TA. Health-related quality of life in 794 patients with a peripheral facial palsy using the FaCE Scale: a retrospective cohort study. Clinical Otolaryngology 2015 Dec;40(6):651-656.
9. Veen MM, Quatela O, Tavares-Brito J, Robinson M, Baiungo JH, Werker PMN, et al. Patient-perceived severity of synkinesis reduces quality of life in facial palsy: A cross-sectional analysis in 92 patients. Clinical Otolaryngology 2019 May;44(3):483-486.
10. Molzahn AE, Kalfoss M, Schick Makaroff K, Skevington S. Comparing the importance of different aspects of quality of life to older adults across diverse cultures. Age and Ageing 2011;40(2):192-199.