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CLINICAL INVESTIGATION

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Conversion between the Montreal Cognitive Assessment and the Mini-Mental Status Examination

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Abstract

Background: Early and accurate detection of cognitive changes using simple tools is essential for an appropriate referral to a more detailed neurocognitive assessment and for the implementation of therapeutic strategies. The Mini-Mental Status Examination (MMSE) and the Montreal Cognitive Assessment (MoCA) are two commonly used psychometric tests for cognitive screening. Both tests have different strengths and weaknesses. Preferences regarding test selection may therefore differ among clinicians. The aim of this retrospective observational cohort study was to define corresponding scores for the MMSE and the MoCA.

Methods: We examined the relationship between the cognitive screening tests in 803 German-speaking Memory Clinic outpatients, encompassing a wide range of neurocognitive disorders. We produced a conversion table using the equipercentile equating method with log-linear smoothing. In addition, we conducted a systematic review of existing MMSE-MoCA conversions to create a table allowing for the conversion of MoCA scores into MMSE scores and vice versa using the weighted mean method.

Results: The Memory Clinic sample showed that the prediction of MMSE to MoCA was overall less accurate compared to the conversion from MoCA to MMSE. The 19 studies included after thorough literature search showed that MoCA scores were consistently lower than MMSE scores. Eleven of 19 conversion studies had addressed the conversion of the MoCA to the MMSE, while two studies converted MMSE to MoCA scores. Another six studies applied bi-directional conversions. We provide an easy-to-use table covering the entire range of scores and taking into account all currently existing conversion formulas.

Jael S. Fasnacht and Alexandra S. Wueest contributed equally to this study.

Conclusion: The comprehensive MMSE-MoCA conversion table enables a direct comparison of cognitive test scores at screening examinations and over the course of disease in patients with neurocognitive disorders.

KEYWORDS
conversion, equating, equipercentile, MMSE, MoCA

INTRODUCTION

The overall prevalence of dementia is increasing with the global aging of populations,[1] associated with substantial societal, social, and economic challenges. Early identification of cognitive impairment is crucial to allow for early treatment and appropriate advance care planning.[2] In order to comprehensively identify, describe, and quantify cognitive deficits, extensive neuropsychological diagnostics must take place.[3] Usually, brief and reliable screening tests are used as an initial step in the process of assessing cognitive impairment.[4] Most prominent screening tools are the Mini-Mental Status Examination (MMSE)[5] and the Montreal Cognitive Assessment (MoCA).[6] These instruments are widely used instruments screening tools, both in everyday clinical practice and in research. They require little training, are easy to administer, and have demonstrated diagnostic utility[7] to differentiate patients with dementia from individuals with normal cognition.[8] The MMSE has been criticized for its low sensitivity in patients with mild dementia or mild cognitive impairment (MCI).[6] Thus, clinicians migrated to prefer the MoCA over the MMSE.[9] The MoCA, which was developed to identify patients with MCI, is better suited to detect patients in early stages of neurocognitive disorders (NCD).[10] However, the MoCA might be too difficult for patients in advanced stages of NCD. Scale conversion may facilitate the comparison and synthesis of cognitive data, enhance collaboration between clinicians, and inform clinical and policy decisions in the context of dementia.[11] There are well-established methods for scale conversions such as equipercentile equating methods. This method was used in most previous studies[3,12–24] and enables direct and easy comparison of scores.[25] Some of these publications provided an MMSE-MoCA conversion table.[12–16,26] However, these studies were generally small sampled, did not appropriately reflect the heterogeneity of patients encountered in daily clinical practice and, therefore, have limited generalizability. Thus, conversions are needed that reflect the relationship between MoCA and MMSE for a broad range of causes of cognitive impairment as (a) patient populations are usually heterogeneous; (b) the cause of cognitive impairment during screening is unclear; and (c) comorbid diseases and conditions are often present.[17] Moreover, only a few studies considered a bi-directional score equation.[17,23–24,27–28] In most score conversion studies the uni-directional MoCA to MMSE translation was performed,[3,9,12–16,19–21,26] which leads to gaps and overrepresentations in the MMSE score range, making it difficult to unambiguously assign an equivalent MoCA score.[18] Specifically, it was found that multiple MMSE scores could correspond to one MoCA score at higher levels of cognitive function, while one MMSE score could correspond to multiple MoCA scores at lower levels of cognitive function. For example, in a previous study,[3] MMSE scores of 1, 3, 6, 8, 10, 12, 15, and 17 were absent from the conversion table. Additionally, more than one

Key points

- Early and accurate detection of cognitive changes using simple tools is essential for an appropriate referral to a more in-depth neurocognitive assessment and for the implementation of therapeutic strategies.
- The Mini-Mental Status Examination (MMSE) and the Montreal Cognitive Assessment (MoCA) are two commonly used tests for cognitive screening and for an efficient and simple way to track cognition over time.
- We provide an easy-to-use table covering the entire ranges of both tools, which enables a direct comparison of cognitive scores at screening examinations and over the course of neurocognitive disorders.

Why does this paper matter?

Results from this study facilitate the comparison and synthesis of cognitive data from multicenter and longitudinal cohort research and thereby will enhance the communication between and within clinical and research settings.

TABLE 1 Demographic characteristics, clinical test scores, and diagnoses

Group	NF	Mild NCD	Major NCD	Total
n	118	329	356	803
Age in years	63.1 (13.4)	66.6 (13.8)	77.5 (9.8)	71.0 (13.5)
Range	19–88	19–91	19–92	19–92
Education in years	14.4 (3.0)	12.7 (2.9)	11.9 (2.9)	12.6 (3.0)
Range	8–20	7–20	7–20	7–20
Female %	45.8	51.1	57.6	53.2
MMSE score	29.2 (1.0)	27.6 (2.1)	23.9 (3.6)	26.2 (3.5)
Range	26–30	19–30	6–30	6–30
MoCA score	27.0 (2.1)	23.2 (3.8)	17.7 (4.2)	21.3 (5.2)
Range	20–30	12–30	2–30	2–30
Diagnoses %				
Alzheimer's disease	-	16.4	77.8	48.3
Vascular disease	-	6.4	0.6	3.4
Frontotemporal lobar degeneration	-	2.4	2.5	2.5
Lewy Body disease	-	0.3	1.4	0.9
Parkinson's disease	-	1.5	0.6	1.0
Traumatic brain injury	-	0.9	0.6	0.7
Brain tumor	-	0.9	0.6	0.7
Substance and/ or medication use	-	1.8	1.1	1.5
Epilepsy	-	1.2	0.6	0.9
Multiple sclerosis	-	4.9	2.0	3.4
Depression	-	8.5	0.6	4.4
Multiple etiologies	-	13.1	5.1	8.9
Other	-	15.2	3.1	8.9
Unspecified	-	26.4	3.7	14.6

Note: Demographic data and clinical test scores are presented as mean (SD). Clinical diagnoses are presented as percentages. Years of education was defined as the total number of years in school plus any professional education (not counting years needed to repeat). The maximum education was set at 20 years. In case of multiple specialized educations, only the longest one was counted.

Abbreviations: MMSE, mini mental status examination; MoCA, montreal cognitive assessment; NCD, neurocognitive disorder; NF, normal findings.

MoCA value corresponded to each of the MMSE scores 20, 22, 24, 26, 27, 28, 29, and 30. Thus, these scores were overrepresented. In order to promote the MoCA in clinical practice as a brief cognitive screening test in different domains and to facilitate interpretation of results, several authors recommend translating the full range of MoCA and MMSE scores in the future to make them comparable.[3,18] Additionally, the majority of previous studies originated from English-speaking samples,[9,12–16,19,22,26–27] while only a few conversion studies were based on German-speaking participants.[3,16] At present, no study has attempted to compile a comprehensive bi-directional MoCA-MMSE conversion based on all currently available studies. Thus, we aimed to create tables allowing for the conversion of MoCA scores into MMSE scores and vice versa.

METHODS

Participants

In this retrospective observational cohort study, German-speaking patients were referred for neuropsychological assessment to the outpatient Memory Clinic at the University Department of Geriatric Medicine FELIX PLATTER, Basel, Switzerland (clinicaltrials.gov, Registration No. NCT03581643). The local ethics committee (Ethikkommission Nordwest- und Zentralschweiz [EKNZ]) approved the study (N° EKNZ 2018-00737). The study was conducted in accordance with the most recent version of Declaration of Helsinki. Inclusion criteria were: (a) education ≥7 years; (b) fluent in the German

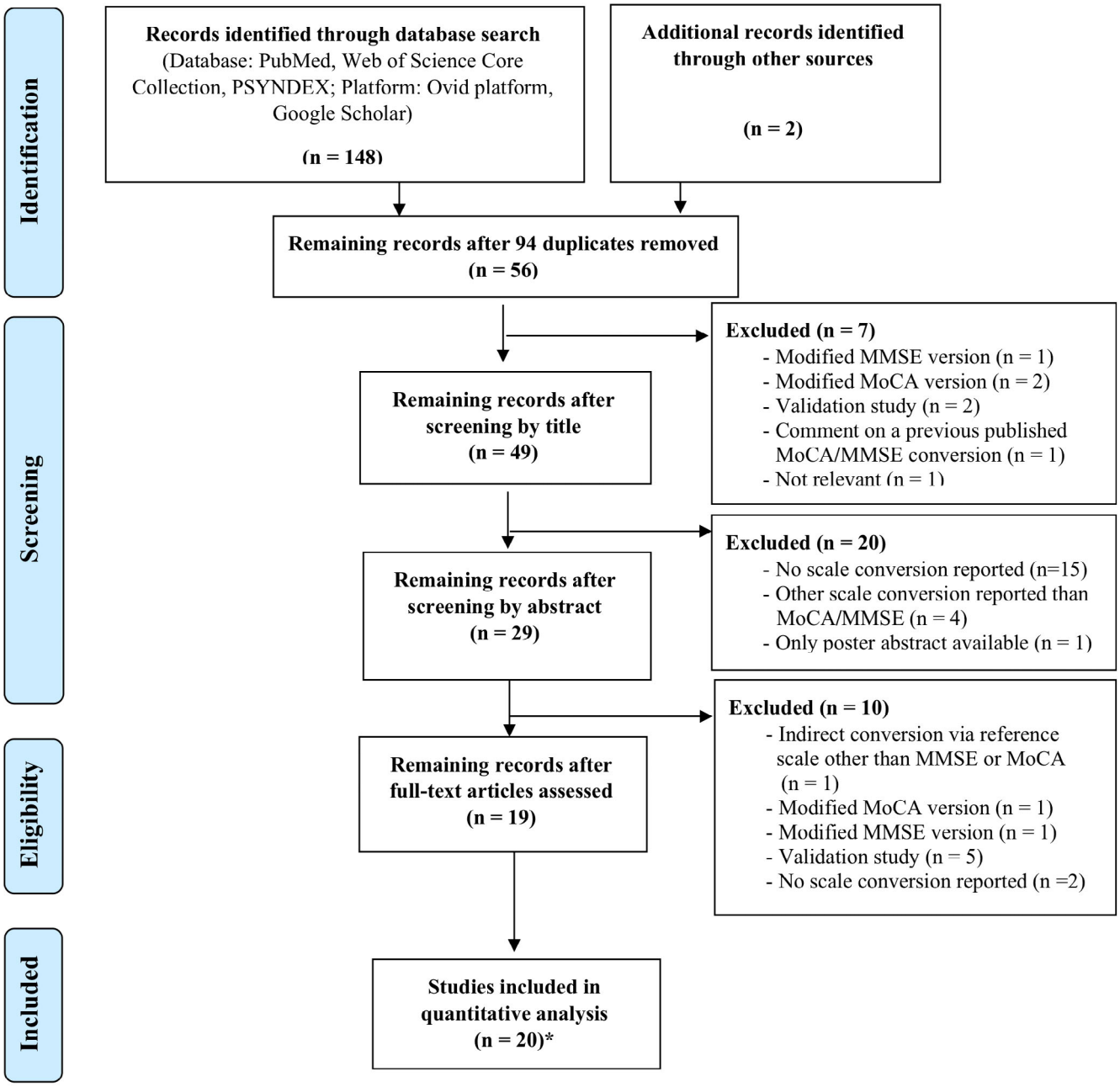

FIGURE 1 PRISMA flowchart for the selection of studies for the comprehensive MoCA-MMSE conversion table. *Including the current conversion study with 803 patients from the Memory Clinic FELIX PLATTER, Switzerland.

language; (c) initial neuropsychological testing in a clinical setting. This criterion was chosen to minimize the influence of learning effects from repeated testing on the relationship between MoCA and MMSE[29] and (d) availability of comprehensive neuropsychological assessment. Patients were excluded when cognitive performance was not validly quantifiable. Overall, 685 patients with mild or major NCD and 118 individuals with normal findings (NF) were included between March 2017 and May 2019. Table 1 depicts the demographic characteristics.

Procedures

All patients underwent comprehensive neuropsychological and medical assessments within the clinical setting.[30]

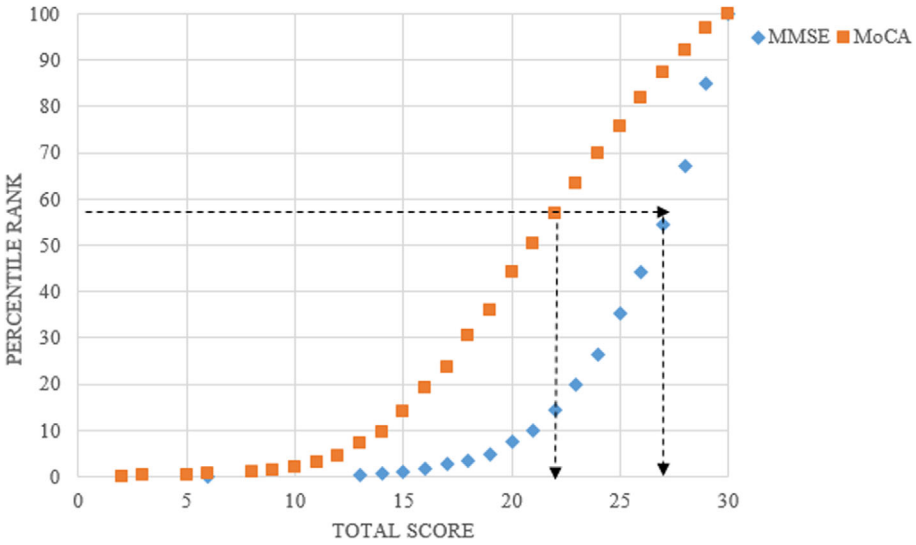

FIGURE 2 Equipercentile equating in MoCA and MMSE values in 803 patients from the Memory Clinic FELIX PLATTER, Switzerland. MMSE values are given in raw values. MoCA values correspond to education-adjusted values. The dotted lines indicate that MoCA and MMSE values are set equal when their corresponding percentile ranks are equal. MMSE, mini mental status examination; MoCA, montreal cognitive assessment.

For this, patients were assessed in the following order: (1) detailed patient and medical history; (2) neuropsychological screening including the MMSE and the clock drawing test; (3) the official German translation of the MoCA (Version 7, November 2004; http://www.mocatest.org); (4) assessment of symptoms of depression (15-item Geriatric Depression scale (GDS)[31] or Beck Depression Inventory (BDI))[32] and (5) one of two comprehensive neuropsychological test batteries assessing the patients' cognitive functioning, which have been described in detail elsewhere.[33] Briefly, for higher functioning patients the challenging battery was used and the standard battery for more impaired patients. A decision tree for choosing the appropriate neuropsychological battery is provided in Figure S1 (see Supplemental Material). The main difference in the two test batteries consists in the instruments assessing verbal and visual episodic memories. The comprehensive neuropsychological test battery was administered at the end of the assessment to avoid possible interference effects with the MoCA. Additionally, all patients were administered in a strictly standardized manner the MMSE followed by the MoCA (same version always, no alternate versions) on the same day to minimize extraneous influences upon cognitive performance at testing. Furthermore, the item concerning orientation, which is included in the MMSE as well as in the MoCA, was not performed twice in the same session. This means that if the patient answered the item in the MMSE incorrectly, it was also considered as incorrect in the MoCA. This also applied for correct answers. Education-adjusted MoCA scores (i.e., an additional point, when years of education was ≤12 years) were used for all analyses. Diagnostic consensus was reached in weekly held interdisciplinary diagnostic conferences of geriatricians, neurologists, neuropsychologists, psychiatrists, neuroradiologists, and nuclear medicine specialists within the clinical setting. The diagnoses were based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-5).[10]

Comparison with international MoCA-MMSE conversions

For the comparison of international MoCA-MMSE conversions, a systematic literature search was performed to identify relevant studies. The selection criteria and detailed search strategy are included as Supplementary Text under Systematic Literature Review (see Text S1). Figure 1 shows details of the selection process in the PRISMA flowchart.

Statistical analysis

Score conversion

Patients' demographic characteristics, diagnoses, and MoCA and MMSE scores of the Memory Clinic sample were computed. The correlation between MoCA and MMSE scores were evaluated using Spearman's coefficient. In accordance with previous studies, we used the equipercentile equating method to develop a score conversion table between the MoCA and the MMSE (and vice versa).[12–15,25] A detailed explanation of this method is provided elsewhere.[34] Briefly, scores from two different measures are considered as equivalent within the same population if their corresponding percentile ranks are equal. For instance, if an individual with a score of 22 on the MoCA achieves a percentile rank of 55%, this means that 45% of individuals in that cohort performed better

TABLE 2 Conversion table for MoCA and MMSE scores based on equipercentile equating with log-linear smoothing in 329 mild NCD, 356 major NCD, and 118 NF

MoCA score	Equivalent MMSE	95% CI	MMSE score	Equivalent MoCA	95% CI
0	-	-	0	-	-
1	-	-	1	-	-
2	7	[2, 12]	2	-	-
3	9	[3, 15]	3	-	-
4	10	[5, 16]	4	-	-
5	12	[6, 17]	5	-	-
6	13	[8, 18]	6	2	[−1,4]
7	14	[10, 18]	7	2	[−1,5]
8	15	[12, 18]	8	2	[−1,6]
9	16	[14, 18]	9	3	[−1,7]
10	17	[15, 19]	10	4	[0,8]
11	18	[17, 19]	11	5	[1, 9]
12	19	[18, 20]	12	5	[1, 9]
13	20	[19, 21]	13	6	[3, 10]
14	21	[20, 22]	14	7	[4, 10]
15	22	[21, 23]	15	8	[6, 11]
16	23	[22, 23]	16	9	[7, 11]
17	24	[23, 24]	17	10	[8, 12]
18	25	[24, 25]	18	11	[10, 12]
19	25	[25, 26]	19	12	[11, 13]
20	26	[26]	20	13	[12, 14]
21	27	[26, 27]	21	14	[13, 15]
22	27	[27, 28]	22	15	[14, 16]
23	28	[28]	23	16	[15, 17]
24	28	[28, 29]	24	17	[17, 18]
25	29	[29]	25	19	[18, 19]
26	29	[29]	26	20	[19, 21]
27	30	[29, 30]	27	21	[21, 22]
28	30	[30]	28	23	[23, 24]
29	30	[30]	29	25	[25, 26]
30	30	[30]	30	28	[28, 29]

Note: MoCA was adjusted for the years of education (i.e., +1 point when years of education was ≤12 years).
Abbreviations: CI, confidence interval; MMSE, mini-mental status examination; MoCA, montreal cognitive assessment; NCD, neurocognitive disorder; −, values were not reported.

(i.e., achieved a score of 23 or higher on the MoCA). In the same cohort, the percentile rank distribution for the MMSE may be different: Here, an individual might score 27 and thus achieve the same percentile rank (55%) because the MMSE is cognitively less demanding. Thus, for both test scores in this example (MoCA: 22, MMSE: 27) 45% of the cohort performed above the rank achieved by this individual. In this way, MoCA scores are transformed to equivalent MMSE scores (Figure 2). The strength of this method is that the equated scores always fall within the range of possible scores; which is not always true when using traditional mean and linear equating methods. However, this method can lead to an irregular distribution of scores. We therefore implemented a log-linear transformation to smooth the raw scores of MoCA and MMSE into a regular distribution.[3,12] This ensures a higher equating accuracy. 95% confidence intervals (CI) were calculated

TABLE 3 Comprehensive conversion table for each possible MoCA and MMSE scores

	Equivalent MMSE score ($N = 9425$)			Equivalent MoCA score ($N = 4262$)	
Raw MoCA score	**Weighted mean score**	**Range**	**Raw MMSE score**	**Weighted mean score**	**Range**
0	5	0–15	0	0	0–1
1	7	2–15	1	0	0–1
2	9	2–16	2	0	0–1
3	10	5–16	3	0	0–1
4	11	6–17	4	0	0–1
5	12	8–17	5	0	0–2
6	13	10–18	6	0	0–3
7	14	11–19	7	1	0–4
8	15	12–19	8	1	0–4
9	16	14–20	9	2	0–5
10	17	15–20	10	3	0–5
11	18	16–21	11	4	0–6
12	19	17–21	12	4	0–7
13	20	18–22	13	5	0–8
14	20	19–22	14	6	0–8
15	21	20–23	15	7	0–9
16	22	21–23	16	8	2–10
17	23	22–24	17	9	4–11
18	24	22–25	18	10	6–12
19	25	23–26	19	11	8–13
20	25	24–26	20	12	10–14
21	26	25–27	21	13	12–17
22	27	26–28	22	14	13–18
23	27	26–29	23	16	15–18
24	28	27–30	24	17	16–19
25	28	28–29	25	19	18–20
26	29	28–30	26	20	20–21
27	29	29–30	27	22	21–23
28	29	29–30	28	23	22–25
29	30	30–30	29	26	23–27
30	30	30–30	30	28	24–29

Abbreviations: MMSE, mini mental status examination; MoCA, montreal cognitive assessment.

using 1000 bootstrap samples.[35] The upper limit of the 95% CI was censored at 30/30 points to facilitate clinical interpretation.[17] All estimating scores were rounded to the nearest integer, which restricted the range of the score from 0 to 30. Analyses were performed using R 3.6.3 software with its appropriate packages (The R Foundation for Statistical Computing, Vienna, Austria).[34] Continuous variables are expressed as means and standard deviations (SD) or median. Categorical variables are expressed as percentages.

Data extraction and data synthesis of the international MoCA-MMSE conversions

Key data were extracted from full-text studies by two authors (JSF, ASW) using a standard template. The formulas or tables for MoCA-MMSE conversion were extracted from each study (including our own conversion table) to build a comprehensive table in Excel (Microsoft, Redmond, WA, USA) as follows: (1) a range of all equivalent MMSE scores (min-max) was calculated for each

possible MoCA score; (2) the weighted mean method was used to provide one single score across all studies. This method took into account that some values contribute more than others due to the underlying sample size. We weighted the equivalent MMSE scores according to the sample size of each study before calculating a sum score. For the conversion from MMSE to MoCA, the same procedure as in step (1) and (2) was carried out.

RESULTS

Demographic and clinical characteristics

A detailed overview of patients' characteristics and test scores are provided in Table 1. The Spearman rank correlation coefficient between MoCA and MMSE total scores was significant ($rs = 0.80$, $p < 0.001$).

Accuracy of converted scores

Table 2 demonstrates the score conversion from MoCA to MMSE and vice versa. Data show that the 95% CI spans 3.24 MMSE points on average when predicting MMSE from the MoCA. For MoCA scores ≥11 points, the 95% CIs are much closer with 0–2 points in each direction than in the lower score range with more than 6 points. The MMSE to MoCA prediction is overall less accurate with an average span of the 95% CI of 3.68 MoCA points. For MMSE scores ≥18 points, the 95% CI included score points between 1 and 2.

Conversion table

Figure 2 presents the plot of equipercentile equivalents of MoCA and MMSE. For instance, a MoCA score of 22 points is equivalent to an MMSE score of 27 points, with both of these scores falling at approximately the same percentile rank of 55.

Comprehensive MoCA-MMSE conversion table

Table S1 (see Supplemental Material) presents a detailed overview of the demographic and clinical characteristics of the included transformation studies. Table 3 shows the comprehensive MoCA-MMSE conversion table. On the left side of the table, each possible MoCA score is presented with its equivalent weighted mean MMSE score and the range of equivalent MMSE scores. For instance, a MoCA score of 25 points is equivalent to a MMSE score between 28 and 29 points. The weighted mean MMSE score is 28 points. The MMSE and their equivalent MoCA scores (range and weighted mean score) are shown on the right side of Table 3.

DISCUSSION

Conversion table

This study revealed a positive correlation with a strong effect of MoCA and MMSE scores points. This is in line with the existing literature,[3,9,26] suggesting that both tests measure similar aspects of cognitive performance. However, a non-linear relationship was found between the two tests (Figure 2). This is not surprising, as the MMSE allocates more points for orientation (10 of 30 points) compared to only 6 of 30 points in the MoCA. In contrast, the MoCA places greater emphasis on visuospatial domains (4 of 30 points) compared to only 1 of 30 points with the MMSE.[7] As previously reported,[14] our data also showed a pronounced ceiling effect of the MMSE (Table 2). MoCA scores ≥21 points were translated into MMSE scores of 27–30 points, corresponding to the range of *normal* cognition in the MMSE. Overall, MoCA scores are consistently lower than MMSE scores, because visuospatial and executive domain items may be more difficult for most participants than items assessing orientation. This is consistent with other existing conversion tables.[3,12,17–18] Previous studies documented lower reliability for the MMSE-MoCA conversion than for the reverse equation.[17,36] In the present analysis, prediction of MoCA scores from MMSE data was also less accurate. Overall, the MMSE-MoCA conversion table presented here replicates existing tables for clinically heterogeneous samples with different neurodegenerative[17,24] and neurological diseases.[3] As previously reported,[3,17] the distribution of MoCA and MMSE scores was left-skewed, indicating the comparatively lower number of patients with severe cognitive impairment. Conversion scores in the lower score range should therefore be interpreted with caution, due to wide 95% CIs. In contrast with previous studies,[3,17] we could determine conversions for MoCA scores above 1 point and MMSE scores above 5 points based on actual data. This increases the generalizability of MoCA-MMSE conversion in clinically heterogeneous patient populations.[16] In addition, we used education-adjusted MoCA scores, since previous research found that MoCA scores are affected by education as the strongest non-cognitive factor.[6]

Comprehensive MoCA-MMSE conversion table

The 19 studies included from the literature show that MoCA scores are consistently lower than MMSE scores. Eleven[3,9,12–16,19–21,26] of 19 conversion studies have addressed the conversion from MoCA to the MMSE, while two studies[18,22] have converted MMSE to MoCA scores. Another six studies[17,23–24,27–28,36] have provided bi-directional conversions. The studies differed in the demographic and diagnostic composition of the patient cohort (see Table S1), making a direct comparison difficult. However, our review of existing MoCA-MMSE conversion tables suggested a high level of agreement for the higher score range. In the lower score range, both conversions showed a larger difference between the equivalent scores of the individual studies. Therefore, conversions in the lower part of the tests must be used with caution and the range should serve as a measure of uncertainty. Additionally, when applying the comprehensive MMSE-MoCA conversion table we recommend using the weighted mean, where each data point contributes equally to the final mean. However, there are various explanations for the large difference of equivalent scores in the lower score range: First, the number of patients with severe cognitive impairment was low in some studies, which increases the risk for sampling errors and reduces equating accuracy.[25] Three studies have reported extrapolated data for equivalent MMSE scores for raw MoCA scores <10[3,13] points or <8 points.[16] Other studies did not mention whether extrapolations have been made in the lower score range to correct for scarcity of data.[9,12,14–15,18–19,21,23–24,26–28] Second, different statistical conversion methods have been used. Scale equating using linear regression analysis does not adequately represent test-to-test differences in difficulty that vary along the scores,[9,27] which can reduce prediction accuracy, particularly in the lower and upper score ranges. In addition, the equivalent scores do not fall within a range of possible scores, as is the case with the equipercentile equating method.[14] Equivalent MMSE scores >30 points[9,27] and equivalent MoCA scores <0[27] must be set to 0/0 points and 30/30 points to facilitate clinical interpretation. Another point to mention is, that the majority of existing studies provide conversion tables for specific patient populations.[12–14,16,18–19,27,36] This is based on the assumption that the association between MoCA and MMSE is expected to differ between patients with primarily mnestic disorders and patients with executive dysfunction, since executive functions are not assessed in the MMSE.[13,17,24] It is possible that etiology-specific conversion tables are more reliable when the cause of the cognitive disorder is known.[24] A previous study demonstrated that the association between MoCA and MMSE is influenced by clinical diagnosis.[17] Nevertheless, the majority of authors have concluded that their results are comparable to previously published tables.[3,13,17,26] Additionally, it has been shown that tables created in patients with Parkinson's disease are comparably valid for use in patients with other causes of cognitive impairment.[37] Moreover, since screening procedures are only a snapshot of cognitive performance, variations in scores are possible due to factors other than etiology, such as fatigue, motivation, and anxiety.

The overview of existing conversion tables suggests that the ranges of equivalent scores (min-max) overlap across the scale range and are consistent with the conversions published to date.

Our study is not without limitations. First, the distribution of MoCA and MMSE scores in the current Memory Clinic sample was left-skewed, consistent with previous studies.[3,13] As previously highlighted, this increases the risk for sampling errors. Obtaining conversion scores based on actual data for MoCA scores <6 points is problematic from a practical and ethical perspective. Patients with such advanced cognitive impairments are rarely included in research.[16] Second, 48.3% of the current Memory Clinic sample were patients with Alzheimer's disease, potentially limiting clinical heterogeneity. However, this is not very likely to be clinically relevant, given that Alzheimer's disease is the most common cause of dementia, and thus, the most frequently encountered diagnosis in clinical practice. Third, according to standard institutional procedures[30] MMSE was performed followed by the MoCA in a strictly standardized manner and in the same order in all patients at our Memory Clinic. This may lead to a bias in MMSE-MoCA conversion.[17] Nevertheless, our results are comparable to a previous study, where the test administration did not take place in a fixed order to prevent exhaustion effects.[36] Fourth, the MMSE and MoCA in this study were both administered in a specific language and in specific versions, which can lead to a limited generalizability. However, the generalizability of the score conversion compared with other languages seems to have some consistency.[17,20–21] But for a more in-depth look, further research is needed in this regard, as this was beyond the scope of our paper. Fifth, MoCA and MMSE data were collected from baseline neuropsychological assessments. Since brief cognitive tests are also used in clinical practice to assess disease progression, the association between MoCA and MMSE should also be studied in patients with follow-up assessments to consider potential learning effects.[17] A previous study demonstrated that the correlation of MoCA and MMSE did not differ significantly

between baseline and follow-up examinations.[19] Nevertheless, this finding should be replicated in further studies.

AUTHOR CONTRIBUTIONS

Jael S. Fasnacht: conception design; acquisition of data; analysis and interpretation of data; drafting the article; revising the article critically for important intellectual content; final approval. Alexandra S. Wueest: acquisition of data; analysis and interpretation of data; drafting the article; revising the article critically for important intellectual content; final approval. Manfred Berres: interpretation of data; statistical analysis; revising the article critically for important intellectual content; final approval. Sabine Krumm: analysis and interpretation of data; revising the article critically for important intellectual content; final approval. Alessandra E. Thomann, Klemens Gutbrod, Luzius A. Steiner, and Nicolai Goettel: revising the article critically for important intellectual content; final approval. Andreas U. Monsch: conception design; revising the article critically for important intellectual content; final approval.

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CONFLICT OF INTEREST

Alessandra E. Thomann is a full-time employee and shareholder of F. Hoffmann-La Roche Ltd., her contribution to the submitted publication is related to work done at a previous employment. Nicolai Goettel has received consultancy fees from PIPRA AG, Zurich, outside the submitted work. The other remaining authors have no conflicts of interest to report.

SPONSOR'S ROLE

None.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Figure S1. Decision tree used in the Memory Clinic FELIX PLATTER for choosing the appropriate neuropsychological battery (Standard or Challenging Battery).
Text S1. Systematic literature review.
Table S1. Demographic and clinical characteristics of the included transformation studies.

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