

MMAT Quality Appraisal Report for 83 Included Studies

Methods

We appraised the methodological quality of 83 included studies using the Mixed Methods Appraisal Tool (MMAT, 2018). Each study was assigned to a design category (quantitative descriptive, quantitative non-randomized, or mixed methods) based on title/abstract. For each study, five MMAT criteria (Q1–Q5) were rated as Yes/No/Can't tell (CT)/Possibly Yes. In accordance with MMAT guidance, no composite score was calculated. We report the number of criteria met per study.

Results

Most studies satisfied a high proportion of MMAT criteria. Common issues were representativeness of samples (Q2) and nonresponse bias (Q4) in survey-based studies, and incomplete reporting of confounder handling in non-randomized designs.

- Summary of appraisal findings:
- 45 studies (54.2%) met 4 of 5 criteria or more.
- 35 studies (42.2%) met 3 of 5 criteria.
- 3 studies (3.6%) met 2 of 5 or fewer criteria.

Table S1. MMAT

Study (Author, Year)	Study type	Q1	Q2	Q3	Q4	Q5	Criteria met
Aboubaker (2017)	Quantitative descriptive	Yes	No	Yes	CT	Yes	3/5
Abu El-Maaty et al. (2017)	Quantitative non-randomized	CT/ Possibly Yes	Yes	Yes	CT	Yes	4/5
Al-Hazim (2015)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	Yes	Yes	5/5
Anastasopoulos (2012)	Quantitative non-randomized	Yes	Yes	Yes	Yes	Yes	5/5
Andrić (2019)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	CT/ Possibly Yes	Yes	5/5
Ankit Vishwakarma (2016)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Fani Antoniou (2021)	Quantitative non-randomized	Yes	Yes	Yes	CT	Yes	4/5
Atibu Seboru (2015)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Ayeni (2022)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Azhagarsamy (2021)	Quantitative non-randomized	Yes	Yes	Yes	CT	Yes	4/5
Aziz (2016)	Quantitative non-randomized	CT/ Possibly Yes	Yes	Yes	CT	Yes	4/5
Bhargava (2011)	Quantitative non-randomized	Yes	Yes	Yes	Yes	Yes	5/5
Bypaneni (2018)	Quantitative non-randomized	Yes	Yes	Yes	CT/ Possibly Yes	Yes	5/5
Carbonara (2015)	Mixed methods	Yes	Yes	Yes	Yes	Yes	5/5

Castro-Nova (2018)	Quantitative descriptive	CT/ Possibly Yes	Yes	Yes	CT	Yes	4/5
Chapman (2024)	Quantitative non-randomized	Yes	Yes	Yes	CT/ Possibly Yes	Yes	5/5
Chileshe (2010)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	CT	Yes	4/5
Creedy (2010)	Quantitative non-randomized	CT	Yes	Yes	CT/ Possibly Yes	Yes	4/5
Cruz (2013)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	Yes	Yes	5/5
Danisworo (2019)	Quantitative non-randomized	CT/ Possibly Yes	Yes	Yes	CT	Yes	4/5
Diab (2017)	Quantitative non-randomized	CT/ Possibly Yes	Yes	CT	CT	Yes	3/5
Ekung (2015)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
El-Kholy (2021)	Quantitative non-randomized	CT/ Possibly Yes	Yes	CT/ Possibly Yes	CT/ Possibly Yes	Yes	5/5
El-Sayegh (2015)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Elawi (2016)	Quantitative non-randomized	CT	Yes	Yes	CT	Yes	3/5
Emam (2015)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Fabi and Awolesi 2015	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Gaikwad (2021)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
GaiN (2021)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Gharaibeh (2009)	Quantitative descriptive	Yes	CT	Yes	CT/ Possibly Yes	Yes	4/5
Ghorbani (2014)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	No	Yes	4/5
Gransberg (2009)	Quantitative non-randomized	Yes	Yes	Yes	CT	Yes	4/5
Grunow (1963)	Quantitative non-randomized	CT	Yes	Yes	CT	Yes	3/5
Hanna (2015)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	CT/ Possibly Yes	Yes	5/5
Hasan (2014)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	CT	Yes	4/5
Heravi (2012)	Quantitative non-randomized	CT/ Possibly Yes	Yes	Yes	CT	Yes	4/5
Honrao (2015)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Isah (2022)	Quantitative non-randomized	CT	Yes	Yes	CT	Yes	3/5
Ariyanto (2020)	Systematic literature review	N/A	N/A	N/A	N/A	N/A	N/A
Issa (2023)	Quantitative	Yes	CT	Yes	CT	Yes	3/5

	descriptive						
Jahanger (2013)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Kaliba (2009)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Kamanga (2013)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Karaman (2021)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Karunakaran (2018)	Systematic literature review	N/A	N/A	N/A	N/A	N/A	N/A
Katkar (2015)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Kelly Strong and Shane (2012)	Mixed methods	Yes	Yes	Yes	CT/ Possibly Yes	Yes	5/5
Khodeir (2019)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Lam (1999)	Systematic / narrative literature review of case studies	N/A	N/A	N/A	N/A	N/A	N/A
Le (2009)	Quantitative non-randomized	CT/ Possibly Yes	Yes	Yes	CT/ Possibly Yes	Yes	5/5
Li and Madanu (2009)	Quantitative non-randomized	Yes	Yes	Yes	CT/ Possibly Yes	Yes	5/5
Mahamid (2013)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Makam (2015)	Quantitative non-randomized	CT	Yes	Yes	CT	Yes	3/5
Manavazhi (2002)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Mashal (2023)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Ghazali (2009)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Molenaar (2005)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Mousavi (2011)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Msomba (2018)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Nguyen (2018)	Mixed Methods	Yes	Yes	Yes	CT	Yes	4/5
Ogbu (2019)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Pantelidis (2011)	Qualitative descriptive (critical review)	Yes	Yes	Yes	Yes	N/A	4/5
Pathan and Pimplikar (2013)	Quantitative non-randomized	Yes	Yes	Yes	CT/ Possibly Yes	Yes	5/5
Patil (2013)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Perera (2009)	Mixed Methods	Yes	Yes	Yes	CT/ Possibly Yes	Yes	5/5
Rajput (2020)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Ramirez (2018)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Razi (2019)	Quantitative descriptive	Yes	CT	Yes	Yes	Yes	4/5
Rivera (2020)	Quantitative descriptive	Yes	CT	Yes	Yes	Yes	4/5

Sharaf (2015)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Shiraki (2007)	Quantitative non-randomized	Yes	Yes	Yes	Yes	Yes	5/5
Thapanont (2018)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Thombare (2019)	Quantitative non-randomized	CT	Yes	Yes	CT	Yes	3/5
Tian (2021)	Quantitative non-randomized	CT	Yes	Yes	CT	Yes	3/5
Tran (2014)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	CT/ Possibly Yes	Yes	5/5
Tran (2016)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	CT/ Possibly Yes	Yes	5/5
Tummalapudi (2022)	Mixed methods	Yes	Yes	Yes	CT	Yes	4/5
Deshpande and Valunekar (2020)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Vasishta (2018)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Vidalis (2002)	Quantitative descriptive	Yes	CT/ Possibly Yes	Yes	Yes	Yes	5/5
Wafa and Singh (2016)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Wubet (2023)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5
Zayed (2008)	Quantitative descriptive	Yes	CT	Yes	CT	Yes	3/5

MMAT Criterion Legend (placed for reader clarity)

Quantitative descriptive (surveys / case series):

Q1: Is the sampling strategy relevant to address the research question?

Q2: Is the sample representative of the target population?

Q3: Are the measurements appropriate?

Q4: Is the risk of nonresponse bias low?

Q5: Is the statistical analysis appropriate to answer the research question?

Quantitative non-randomized:

Q1: Are the participants representative of the target population?

Q2: Are measurements appropriate (outcome and exposure)?

Q3: Are there complete outcome data?

Q4: Are confounders accounted for in design/analysis?

Q5: Was the intervention/exposure administered as intended?

Mixed methods:

Q1: Adequate rationale for mixed methods design?

Q2: Effective integration of components?

Q3: Integration outputs adequately interpreted?

Q4: Divergences/inconsistencies addressed?

Q5: Components meet quality criteria of their traditions?

Traffic-Light Visualization

The following chart summarizes the MMAT appraisal results across all 83 studies, using a traffic-light style (green = ≥ 4 criteria met, yellow = 3 criteria met, red = ≤ 2 criteria met).

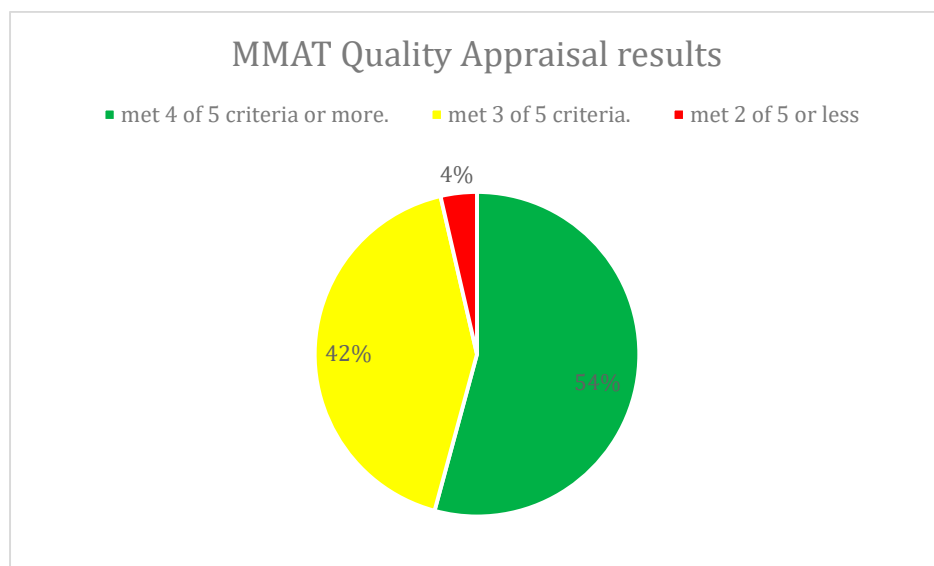


Figure S1. MMAT appraisal results