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REVIEW

Does the medical literature remain inadequately described despite having reporting guidelines for 21 years? – A systematic review of reviews: an update

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Purpose: Reporting guidelines (eg, Consolidated Standards of Reporting Trials [CONSORT] statement) are intended to improve reporting standards and enhance the transparency and reproducibility of research findings. Despite accessibility of such guidelines, researchers are not required to adhere to them. Our goal was to determine the current status of reporting quality in the medical literature and examine whether adherence of reporting guidelines has improved since the inception of reporting guidelines.

Materials and methods: Eight reporting guidelines, such as CONSORT, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), STrengthening the Reporting of OBservational studies in Epidemiology (STROBE), Quality of Reporting of Meta-analysis (QUOROM), STAndards for Reporting of Diagnostic accuracy (STARD), Animal Research: Reporting In Vivo Experiments (ARRIVE), Consolidated Health Economic Evaluation Reporting Standards (CHEERS), and Meta-analysis of Observational Studies in Epidemiology (MOOSE) were examined. Our inclusion criteria included reviews published between January 1996 to September 2016 which investigated the adherence to reporting guidelines in the literature that addressed clinical trials, systematic reviews, observational studies, meta-analysis, diagnostic accuracy, economic evaluations, and preclinical animal studies that were in English. All reviews were found on Web of Science, Excerpta Medical Database (EMBASE), MEDLINE, and Cumulative Index to Nursing and Allied Health Literature (CINAHL).

Results: Among the general searching of 26,819 studies by using the designed searching method, 124 studies were included post screening. We found that 87.9% of the included studies reported suboptimal adherence to reporting guidelines. Factors associated with poor adherence included non-pharmacological interventions, year of publication, and trials concluding with significant results. Improved adherence was associated with better study designs such as allocation concealment, random sequence, large sample sizes, adequately powered studies, multiple authorships, and being published in journals endorsing guidelines.

Conclusion: We conclude that the level of adherence to reporting guidelines remains suboptimal. Endorsement of reporting guidelines by journals is important and recommended.

Keywords: guidelines, adherence, review, CONSORT

Introduction

Medical science is an evolving and dynamic field of research that impacts health care, disease outcomes, and health care systems in general. The evidence generated from millions of medical publications is meant to inform these dynamic changes

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and therefore has to be presented in a clear, consistent, and transparent fashion. There are more than 26 million citations for biomedical literature in the PubMed[1] database alone. To understand and evaluate the evidence presented in these citations, a harmonized method of reporting the research findings is needed to ensure clarity, consistency, and the uptake and dissemination of knowledge.[2] Tremendous efforts have been made to provide guidelines for different types of research designs to assist in the process of transparent and clear reporting, eg, Enhancing the QUAlity and Transparency Of health Research (EQUATOR) Network website.[3] However, despite the wide availability of such guidelines since the inception of the Consolidated Standards of Reporting Trials (CONSORT[4]) statement in 1996, the uptake remains suboptimal in the face of the exponential volume of medical literature leaving the readers confused. For example, some studies show positive harmful results from eating red meat on the risk of having colorectal cancer,[5] while others are showing inconsistent effect marked by substantial methodological differences, type of red meat investigated, and the population selection limitations.[6] Therefore, the reader is unable to decide whether red meat has an effect on bowel cancer risk. Poor reporting without using well-designed guidelines in primary studies may lead to a bias in the treatment effects found in systematic reviews. In addition, poorly conducted systematic reviews may not be able to detect the bias effect that the studies included. In a previous study, we conducted a scoping review and examined the level of adherence to six reporting guidelines and found the level of adherence to be suboptimal in 86% of the included studies.[7]

The aim of this review was to conduct a systematic review of reviews to update the state of adherence to guidelines since 2012 and to identify factors associated with improved adherence. Our hypothesis was that the reporting standards have improved since our last examination in 2012 given that a longer period has passed after guideline statements were first introduced for researchers and more journals started to endorse the guidelines. Our search was looking at reviews published between January 1, 1996, and September 30, 2016.

Materials and methods

This systematic review was performed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[8] A protocol for a series of three reviews including the current systematic review has been peer reviewed and published elsewhere.[9]

Study inclusion and exclusion criteria

Systematic reviews which investigated the adherence to commonly used reporting guidelines in medical literature that addressed clinical trials, systematic reviews, observational studies, meta-analysis, diagnostic accuracy, economic evaluations, and preclinical animal studies that have been reported in English were selected. Eight guidelines included in this review were as follows: CONSORT,[4] PRISMA,[8] STrengthening the Reporting of OBservational studies in Epidemiology (STROBE),[10] Quality of Reporting of Meta-analysis (QUOROM),[11] STAndards for Reporting of Diagnostic accuracy (STARD),[12] Animal Research: Reporting In Vivo Experiments (ARRIVE),[13] Consolidated Health Economic Evaluation Reporting Standards (CHEERS),[14] and Meta-analysis of Observational Studies in Epidemiology (MOOSE).[15]

The exclusion criteria included studies that 1) were not systematic reviews; 2) did not explore adherence to the aforementioned reporting guidelines; 3) did not provide data on guideline adherence; 4) were subsets of the included studies; 5) published abstracts, letters, editorials, or commentaries; and 6) reviews in languages other than English for feasibility and resource purposes.

Search strategy

The search strategy was based on the previously published review[7] and was updated for this systematic review. We searched four databases (Excerpta Medical Database [EMBASE], MEDLINE, Cumulative Index to Nursing, and Allied Health Literature [CINAHL], and Web of Science) from 1996 (CONSORT inception – first created guideline among all eight included guidelines) to September 30, 2016.

We used the following search terms for each of the four databases: (Systematic reviews OR reviews OR quality of reporting OR completeness of reporting) AND (CONSORT OR STROBE OR QUOROM OR PRISMA OR MOOSE OR STARD OR ARRIVE OR CHEERS) OR adherence. Detailed search terms have been reported in the published protocol.[9] All stages of search, inclusion, exclusion, and data abstraction were performed independently in duplicate, and agreement was reached through team discussion and consensus.

Outcome measures

The primary outcome was the level of adherence to reporting guidelines and their checklists as reported in the systematic reviews. The secondary outcome included the factors that were associated with improved adherence to guidelines.

Data extraction

A specific data abstraction form was designed to include the following data: 1) general characteristics of the included studies (first author, publication year, country, journal, study field, search time frame, data sources, numbers of included primary studies, and study design), 2) main findings from the included studies, 3) authors' summaries and conclusions, and 4) factors reported to be related to improved guideline reporting adherence. Each assessment of the systematic reviews was conducted in duplicate. Calibration was performed on the data extraction form. If the pair of evaluators was unable to come to a conclusion, a third-party reviewer would have settled the dispute.

Quality evaluation

We used the modified Assessing the Methodological Quality of Systematic Reviews/Overview of Quality Assessment Questionnaire (Assessment of Multiple Systematic Reviews [AMSTAR]/Overview Quality Assessment Questionnaire [OQAQ]), a 10-item scale,[7] to assess the quality of the systematic reviews included in this review. We assigned a number out of a maximum of 20 points for each included study. The higher the number assigned, the better the quality of the systematic review.

Data synthesis

We provided a qualitative summary and characteristics of the included studies. We summarized the factors associated with adherence based on the included study results; no quantitative analysis was possible in this review. We also reported the percentage of studies in which the level of adherence to reporting each guideline was suboptimal. This was calculated by dividing the number of studies with this finding by the total number of studies evaluating the guideline.

Results

Our search resulted in a total of 9,123 publications, of which 124 systematic reviews that included 26,819 primary studies were included in this systematic review of reviews. Figure 1 shows the PRISMA flowchart for the included studies.

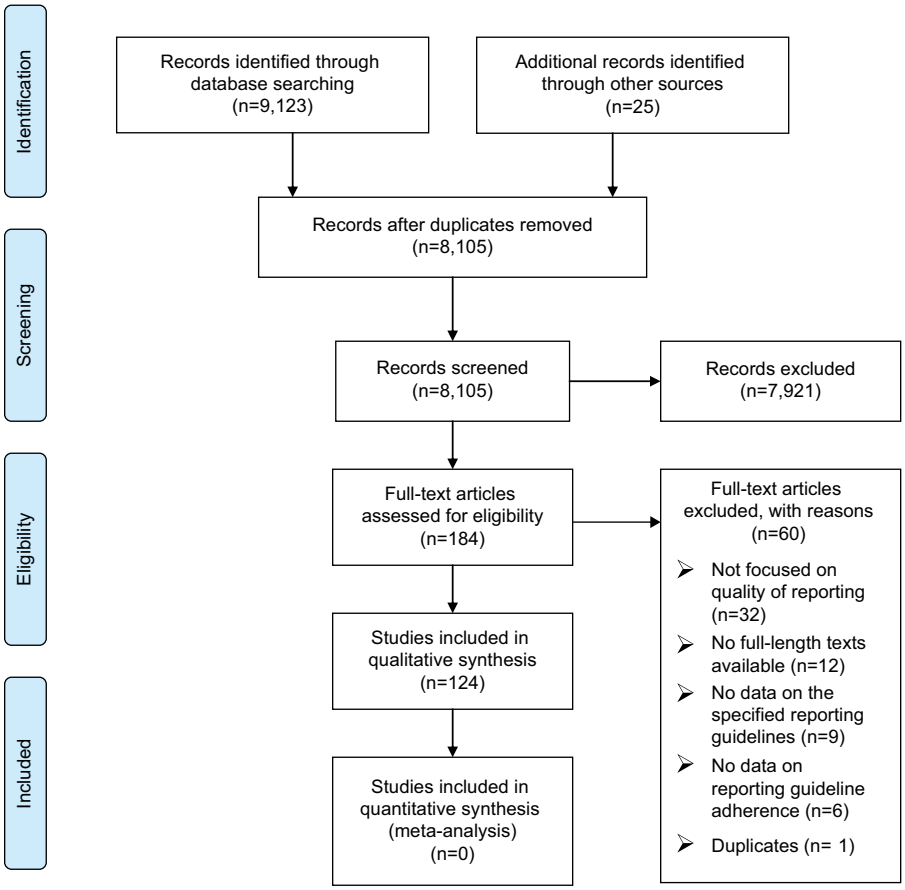

Figure 1 PRISMA flow diagram.
Abbreviation: PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

The characteristics of the included studies are described in Table 1. The majority of the studies (65% of the total 124 included studies) investigated the adherence to the CONSORT statement as expected since it is the first and oldest guideline. The second most commonly investigated guideline is the PRISMA with 19 studies (15%; Table 1).

The majority of studies used the guideline checklist to evaluate the level of adherence and generated a mean score as summarized in Table S1. Table S1 summarizes the studies' findings by guideline with authors' conclusions for each study. Most studies described the adherence to the different guidelines using the following qualitative descriptors:

> deficient, not adequately reported, generally poor, suboptimal, poor, medium, low, poor to moderate, lack of CONSORT adherence, bad, far from satisfactory, lack of standard reporting, improvement over the years has been minor, weak, quality of the articles varied substantially, insufficient, missed reporting some important factors, deficiencies in reporting, inconsistent, needs to be improved, inadequate, there is a need for improvement in quality of reporting, overall adherence is low.

A summary of the quantitative assessment of adherence to guidelines is presented in Table 2.

The level of adherence to all included reporting guidelines was 87.9% of all guidelines combined showing a need for improvement in reporting. Factors associated with poor adherence to CONSORT guideline included trials with significantly positive results, trials with the categorical outcome, trials conducted in North America compared to Europe, and trials funded by nonindustry source. A summary of factors associated with adherence standards is summarized in Table 3. Several factors were associated with better reporting standards relating to authors, study design, outcome specifications, year of publication (recent years of publications are associated with better reporting standards), journal, funding source, and study/author country.

Factors associated with improved adherence to reporting guidelines

Author factors

The included studies reported that the expertise of the author team, for example, an epidemiologist, improved the quality of reporting the study. In addition, having multiple authors also improved reporting quality.

Study factors

Study design with detailed methods including allocation concealment, randomization, specific outcome measures, sample size and power calculations, acknowledgment of limitations and sources of bias, larger sample size, registration of clinical trials, pharmacological interventions, and detailed statistical analysis plan were associated with better reporting and adherence to reporting guidelines. Year of publication was also associated with adherence in which the more recently published articles had increased adherence.

Journal factor

Publications in journals endorsing reporting guidelines have better adherence to these guidelines than articles published in journals that do not endorse such guidelines. In addition, journals' impact factor, medical journals, and journals with restriction on the number of words per article also had articles with better reporting standards. Publication in a general medical journal was associated with better reporting quality than a specialty journal.

Ethics and funding factors

Articles that reported ethical approval, participants' consent, and the source of funding were associated with improved adherence to reporting guidelines.

Country of study factors

Geographic location of the study has an impact on the quality of reporting and adherence to reporting guidelines, for example, studies reported from Europe had better reporting standards compared to studies from North America. Studies reported from China had lower adherence to guidelines than elsewhere indicating geographical variations may directly or indirectly impact the level of adherence to reporting guidelines in the medical literature.

Quality assessment of included studies

For each included systematic review, we performed a quality assessment using the modified AMSTAR/OQAQ score. Table 4 provides the total score out of 20 for each study. The scores varied from 9 to 20. The average score for all the included studies is 16.14. The lowest scores were related to items 5 and 6 of the quality assessment related to the availability of the primary studies' characteristics similar to a previously reported study.[7] Items 5 and 6 were evaluated if there was information on included and excluded studies provided and if the characteristics of included studies provided, respectively.

Discussion

The medical literature is paramount to the progression of the understanding of health and disease and the establishment

Table 1 Characteristics of the included studies

Study	Year	Journal	Country	Statement assessed	Number of studies
Adie[28]	2013	*Annals of Surgery*	Australia	CONSORT	150
Adie et al[29]	2015	*Annals of Surgery*	Australia	PRISMA	150
Agha et al[30]	2015	*Annals of Plastic Surgery*	UK	STROBE	94
Agha et al[31]	2016	*International Journal of Surgery*	UK	CONSORT PRISMA STROBE	193
Aguiar et al[32]	2014	*Annals of Pharmacotherapy*	Brazil	PRISMA	7
Aguiar et al[33]	2016	*Journal of Clinical Pharmacy and Therapeutics*	Brazil	CHEERS	8
Al Faleh and Al-Omran[34]	2009	*BMC Pediatrics*	Saudi Arabia	QUOROM	61
Al-Namankany et al[35]	2009	*International Journal of Pediatric Dentistry*	UK	CONSORT	173
Alvarez et al[36]	2009	*British Journal of Dermatology*	France	CONSORT	98
Anttila et al[37]	2006	*Pediatrics*	Finland	CONSORT	15
Areia et al[38]	2010	*Endoscopy*	Portugal	CONSORT	120
Augestad et al[39]	2012	*Journal of the American Medical informatics Association*	Norway	CONSORT	32
Balasubramanian et al[40]	2006	*Annals of Surgery*	UK	CONSORT	69
Bath and Bath[41]	2000	*Stroke*	UK	CONSORT	114
Bereza et al[42]	2008	*Annals of Pharmacotherapy*	Canada	QUOROM	16
Bian et al[43]	2006	*Journal of Chinese Integrative Medicine*	People's Republic of China	CONSORT	66
Biondi-Zoccai et al[44]	2006	*BMJ*	Italy	QUOROM	10
Borg Debano et al[45]	2012	*BMC Anesthesiology*	Canada	CONSORT	23
Bousquet et al[46]	2011	*Journal of Allergy and Clinical Immunology*	France	CONSORT	94
Bramhall et al[47]	2015	*Inflammatory Bowel Diseases*	UK	ARRIVE	58
Cairo et al[48]	2012	*Journal of Clinical Periodontology*	Spain	CONSORT	276
Capili et al[49]	2010	*Clinical Journal of Pain*	USA	CONSORT	10
Cavadas et al[50]	2011	*International Urogyn J*	Portugal	CONSORT	41
Choi et al[51]	2014	*Trials*	South Korea	CONSORT	29
Chowers et al[52]	2009	*Journal of Antimicrobial Chemotherapy*	Israel	CONSORT	49
Cook et al[53]	2011	*Medical Education*	USA	STROBE	130
Daitch et al[54]	2016	*Journal of Pediatric Gastroenterology and Nutrition*	Israel	CONSORT	51
Dasi et al[55]	2012	*Journal of Clinical Pharmacology*	Spain	CONSORT	40
Delaney et al[56]	2010	*Transfusion*	USA	STROBE, CONSORT	47
DeMauro et al[57]	2011	*Pediatrics*	USA	CONSORT	179
de Vries and van Roon[58]	2010	*Archives of Diseases in Childhood*	The Netherlands	CONSORT	107
Dias et al[59]	2006	*Human Reproduction*	UK	CONSORT	164
Ethgen et al[60]	2009	*BMC Medical Research Methodology*	France	CONSORT	132
Eyawo et al[61]	2008	*Trials*	Canada	CONSORT	47
Fan et al[62]	2014	*PLoS One*	China	CONSORT	21
Farrokhyar et al[63]	2007	*Canadian Journal of Surgery*	Canada	CONSORT	50
Fidalgo et al[64]	2015	*Ophthalmic and Physiological Optics*	UK	STARD	58
Fleming et al[65]	2013	*Angle Orthodontist*	UK	PRISMA	109
Fontela et al[66]	2009	*PLoS One*	Canada	STARD	90
Freeman et al[67]	2009	*European Journal of Obstetrics & Gynecology and Reproductive Biology*	UK	STARD	27
Froud et al[68]	2012	*Community Dentistry and Oral Epidemiology*	UK	CONSORT	23
Fung et al[69]	2009	*Ophthalmology*	USA	CONSORT, STROBE	36
Gagnier et al[70]	2006	*American Journal of Medicine*	Canada	CONSORT	206
Gao et al[71]	2015	*Trials*	China	CONSORT	98
Gianola et al[72]	2013	*Physical Therapy*	Italy	PRISMA	88
Gohari et al[73]	2016	*Journal of Diabetes and Metabolic Disorders*	Iran	CONSORT	185
Gulin et al[74]	2015	*PLoS Neglected Tropical Diseases*	Argentina	ARRIVE	83
Halpern et al[75]	2004	*International Journal of Obstetric Anesthesia*	Canada	CONSORT	99
Hemels et al[76]	2004	*Current Medical Research and Opinion*	France	QUOROM	32

(*Continued*)

Table 1 (*Continued*)

Study	Year	Journal	Country	Statement assessed	Number of studies
Herdan et al[77]	2011	*Gynecological Surgery*	Germany	CONSORT	37
Huang et al[78]	2015	*Expert Review of Anticancer Therapy*	China	CONSORT	40
Hui et al[79]	2012	*Support Care Cancer*	USA	CONSORT	44
Junhua et al[80]	2007	*The Journal of Complementary and Alternative Medicine*	China	QUOROM	107
Karpouzis and Bonello[81]	2016	*Chiropractic and Manual Therapies*	Australia	CONSORT	35
Kiehna et al[82]	2010	*Journal of Neurosurgery*	USA	CONSORT	27
Kim et al[83]	2014	*BMJ Open*	South Korea	CONSORT	146
Kober et al[84]	2006	*Journal of the National Cancer Institute*	Australia	CONSORT	142
Ladd et al[85]	2010	*Addictive Behaviors*	USA	CONSORT	127
Lee et al[86]	2013	*Trauma Acute Care Surgery*	UK	CONSORT	83
Lee et al[87]	2016	*JAMA Facial Plastic Surgery*	UK	PRISMA	79
Li et al[88]	2011	*Evidence-based Complementary and Alternative Medicine*	USA	CONSORT	42
Li et al[89]	2014	*Systematic Reviews*	China	PRISMA	487
Li et al[90]	2014	*BMC Complementary and Alternative Medicine*	China	CONSORT	6994
Liu et al[91]	2015	*PLoS One*	China	PRISMA	72
Liu et al[92]	2013	*Transplant International*	UK	CONSORT	290
Liu et al[93]	2015	*Journal of Evidence-based Medicine*	China	CONSORT	76
Liu et al[94]	2014	*PLoS One*	China	PRISMA	476
Liu et al[95]	2016	*PLoS One*	China	ARRIVE	396
Lu et al[96]	2015	*Archives of Physical Medicine and Rehabilitation*	USA	CONSORT	105
Lu et al[97]	2011	*Expert Review of Anticancer Therapy*	China	CONSORT	46
Ma et al[98]	2011	*PLoS One*	China	PRISMA	369
Ma et al[99]	2012	*The Journal of Alternative and Complementary Medicine*	China	PRISMA	88
Marshman and Farid[100]	2010	*Community Dental Health*	UK	CONSORT	48
McCormick et al[101]	2013	*Journal of Shoulder and Elbow Surgery*	USA	CONSORT	54
Miller et al[102]	2009	*Academic Radiology*	Canada	STARD	18
Moberg-Mogren and Nelson[103]	2006	*American Journal of Occupational Therapy*	USA	CONSORT	14
Moher et al[104]	2002	*BMC Pediatrics*	Canada	CONSORT	251
Montané et al[105]	2010	*BMC Clinical Pharmacology*	Spain	CONSORT	92
Montgomery et al[106]	2011	*Trials*	UK	CONSORT	76
Nicolau et al[107]	2013	*The International Journal of Tuberculosis and Lung Disease*	Canada	PRISMA	137
Norton-Mabus and Nelson[108]	2008	*OTJR: Occupation, Participation and Health*	USA	CONSORT	30
Ntala et al[109]	2013	*Primary Care Respiratory Journal*	Greece	CONSORT	35
Panic et al[110]	2013	*PLoS One*	Italy	PRISMA	90
Parsons et al[111]	2011	*Journal of Bone and Joint Surgery, British Volume*	UK	CONSORT STROBE	100
Patel et al[112]	2014	*Psychological Medicine*	UK	CONSORT	31
Piggott et al[113]	2004	*Palliative Medicine*	UK	CONSORT	93
Péron et al[114]	2012	*Journal of the National Cancer Institute*	France	CONSORT	357
Peters et al[115]	2015	*PLoS One*	The Netherlands	PRISMA	80
Plint et al[116]	2006	*Medical Journal of Australia*	Canada	CONSORT	8
Prady et al[117]	2008	*PLoS One*	UK	CONSORT	90
Pratoomsoot et al[118]	2015	*PLoS One*	Thailand	CONSORT	71
Rao et al[119]	2016	*PLoS One*	UK	STROBE	37
Rice et al[120]	2016	*Journal of Psychosomatic Research*	Canada	PRISMA	21
Rios et al[121]	2008	*Journal of Clinical Endocrinology and Metabolism*	Canada	CONSORT	89
Rikos et al[122]	2016	*Multiple Sclerosis and Related Disorders*	Greece	CONSORT	102
Schwarz et al[123]	2012	*Journal of Clinical Periodontology*	Germany	ARRIVE	75
Scott et al[124]	2012	*The Pediatric Infectious Disease Journal*	Switzerland	CONSORT	70
Shawyer et al[125]	2015	*Journal of Pediatric Surgery*	Canada	STROBE	48
Shea et al[126]	2006	*BMC Medical Research Methodology*	Canada	QUOROM	53
Shea et al[127]	2006	*The Journal of Rheumatology*	The Netherlands	QUOROM	57
Stevely et al[128]	2015	*PLoS One*	UK	CONSORT	68

(*Continued*)

Table 1 (*Continued*)

Study	Year	Journal	Country	Statement assessed	Number of studies
Strech et al[129]	2011	*Journal of Clinical Psychiatry*	Germany	CONSORT	105
Tan et al[130]	2014	*International Journal of Surgery*	UK	PRISMA	37
Thabane et al[131]	2007	*International Journal of Obesity*	Canada	CONSORT	63
Tunis et al[132]	2013	*Radiology*	Canada	PRISMA	130
Turner et al[133]	2012	*Cochrane Database of Systematic Reviews*	Canada	CONSORT	45
Vigna-Taglianti et al[134]	2006	*Annals of Oncology*	Italy	QUOROM	80
Walleser et al[135]	2011	*Journal of Clinical Epidemiology*	Switzerland	CONSORT	106
Wang et al[136]	2007	*Clinical Therapeutics*	China	CONSORT	7422
Wang et al[137]	2013	*PLoS One*	China	CONSORT	27
Wangge et al[138]	2010	*PLoS One*	The Netherlands	CONSORT	232
Weingärtner et al[139]	2016	*Expert Review of Clinical Pharmacology*	Germany	CONSORT	117
Weir et al[140]	2012	*International Journal of Medical Informatics*	USA	PRISMA QUOROM	13
Wen et al[141]	2008	*Journal of Clinical Epidemiology*	China	QUOROM	161
Willis and Quigley[142]	2011	*BMC Medical Research Methodology*	UK	PRISMA	236
Yao et al[143]	2014	*Eye*	UK	CONSORT	65
Zafar et al[144]	2008	*Clinical and Experimental Ophthalmology*	Pakistan	STARD	76
Zhang[145]	2015	*BMJ Open*	China	MOOSE	607
Zhao et al[146]	2016	*Medicine*	China	CONSORT	68
Zheng et al[147]	2016	*Open Heart*	UK	CONSORT	33
Zhong et al[148]	2011	*European Journal of Integrated Medicine*	China	CONSORT	153
Zintzaras et al[149]	2010	*Clinical Therapeutics*	Greece	CONSORT	18
Zintzaras et al[150]	2012	*BMC Musculoskeletal Disorders*	Greece	STARD	103
Ziogas and Zintzaras[151]	2009	*Annals of Epidemiology*	Greece	CONSORT	261

Abbreviations: ARRIVE, Animal Research: Reporting In Vivo Experiments; BMC, *BioMed central*; BMJ, *British Medical Journal*; CHEERS, Consolidated Health Economic Evaluation Reporting Standards; CONSORT, Consolidated Standards of Reporting Trials; *International Urogyn J*, International Urogynecology Journal; JAMA, *The Journal of the American Medical Association*; MOOSE, Meta-analysis of Observational Studies in Epidemiology; OTJR, *Occupational Therapy Journal of Research*; PLoS, Public Library of Science; PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses; QUOROM, Quality of Reporting of Meta-analysis; STARD, Standards for Reporting of Diagnostic Accuracy; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology.

Table 2 Summary of the included studies' conclusions

Type of guideline	Total number of studies	Studies reporting inadequate adherence[a]
CONSORT	81 (three combined studies with both CONSORT and STROBE; one combined study with STROBE, CONSORT, and PRISMA)	71 (88%)
PRISMA	19 (one combined study with both PRISMA and QUOROM; one combined study with STROBE, CONSORT, and PRISMA)	16 (84%)
STROBE	8 (three combined studies with both CONSORT and STROBE; one combined study with STROBE, CONSORT, and PRISMA)	7 (88%)
QUOROM	10 (one combined study with both PRISMA and QUOROM)	5 (50%)
STARD	6	5 (83%)
ARRIVE	4	4 (100%)
CHEERS	1	1 (100%)
MOOSE	1	1 (100%)
All guidelines	124 (distinct studies)	109 (87.9%)

Note: [a]The number of studies concluding that "some improvements are needed, reporting inadequate, poor, medium, suboptimal, etc."
Abbreviations: ARRIVE, Animal Research: Reporting In Vivo Experiments; CHEERS, Consolidated Health Economic Evaluation Reporting Standards; CONSORT, Consolidated Standards of Reporting Trials; MOOSE, Meta-analysis of Observational Studies in Epidemiology; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; QUOROM, Quality of Reporting of Meta-analysis; STARD, Standards for Reporting of Diagnostic Accuracy; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology.

of priorities and recommendations for prevention, diagnosis, treatment, and measurement of outcomes. To implement research findings, transparent and consistent reporting standards are needed to help make informed decisions. Such standards have been set by the CONSORT working group and others for the past 2 decades with the aim of improving the reporting standards in biomedical research. It is expected that the introduction of new change to the current practice will

Table 3 Factors associated with reporting quality of articles using the CONSORT guideline

Study	Year	Sample size	Factors associated with adherence (↑↓)
Adie[23]	2013	150	Outcome specification (↑)[a] At least one author with a degree in epidemiology (↑)[a] Length of article in words (↑)[a] Allocation concealment (↑)[a] Random sequence (↑)[a] Power calculation (↑)
Agha et al[31]	2016	193	Greater details on study design (↑) Detailed outcome definitions and measurements (↑) Indication of how quantitative variables were handled during analyses (↑) Discussion of limits and potential sources of bias (↑)
Al-Namankany et al[35]	2009	173	Year of publication (↑)
Alvarez et al[36]	2006	98	Pharmaceutical industry funding (↑)[a] Year of publication (↑)[a] Sample size (↑)[a]
Areia et al[38]	2010	120	Publication in CONSORT-endorsing journals (↑) Year of publication (↑)
Balasubramanian et al[40]	2006	69	Number of authors (↑)[a] Multicenter studies (↑)[a] Declared funding sources (↑)[a] Reporting in medical journals (↑)[a]
Bath and Bath[41]	2000	114	Trial quality (↑)[a] Trials with positive outcome (↓)[a] Year of publication (↑)[a]
Borg Debano et al[45]	2012	23	Impact factor (↑) Funding reported (↑) Journal adopted CONSORT statement at the time of data collection (↑) Sample size (↑)
Cairo et al[48]	2012	64	Year of publication (↑)[a] Statistically significant clinical outcomes – positive study results (↓)[a]
Capili et al[49]	2010	10	Journal requiring the use of CONSORT (↑)
Chowers et al[52]	2009	49	Industry-sponsored trials (industry-sponsored vs. nonindustry-sponsored trial) (↑) Year of publication (↑)[a]
de Vries and van Roon[58]	2010	107	Sponsoring (↑)
DeMauro et al[57]	2011	179	Time trend (↑)[a] Journal type – general medical journals vs. pediatric journals (↑)[a]
Ethgen et al[60]	2009	132	Impact factor (↑)[a] Publication in CONSORT-endorsing journals (↑)[a]
Farrokhyar et al[63]	2007	50	Sample size (↑)[a] Year of publication (↑)[a] Location of the study (↑)[a] Source of funding (↓) Type of primary outcome in the study (categorical) (↓)
Gao et al[71]	2015	98	Supported by funding (↑)[a]
Herdan et al[77]	2011	37	Year of publication (↑)[a]
Karpouzis and Bonello[81]	2016	35	Year of publication (↑)[a] Larger sample size (↑)[a]
Kiehna et al[82]	2010	27	Publication in CONSORT-endorsing journals (↑)[a]
Kim et al[83]	2014	146	Year of publication (↑)[a]
Ladd et al[85]	2010	127	Year of publication (↑)[a]
Lee et al[86]	2013	83	Higher impact factor of journal (↑)[a] Journals requiring submission of CONSORT checklist (↑)[a]
Liu et al[92]	2013	290	Reporting of funding (↑) Journal endorses CONSORT (↑)[a] Good-quality RCTs (high Jadad scores) (↑)[a] Allocation concealment (↑)[a] Data analysis by randomized group (↑)[a] Sample size>100 (↑)[a]

(*Continued*)

Table 3 (*Continued*)

Study	Year	Sample size	Factors associated with adherence (↑↓)
Liu et al[93]	2015	76	Journal adopting CONSORT guidelines (↑)[a] Later publication year (↑)[a]
Lu et al[96]	2015	105	Year of publication (1976–2001, 2002–2010, 2011–2013) (↑)[a]
McCormick et al[101]	2013	54	High Jadad score (↑)[a]
Moberg-Mogren and Nelson[103]	2006	14	Year of publication (↑)[a]
Montané et al[105]	2010	92	Impact factor (↑)[a] Year of publication (↑)[a]
Montgomery et al[106]	2011	76	Year of publication (↑)[a]
Ntala et al[109]	2013	35	Impact factor (↑) Country with high income (↑)[a]
Péron et al[114]	2012	357	Trials with positive results (↓) Year of publication (↑)[a] Impact factor (↑)[a] Geographic region – North American compared to European trials (↓)[a] Sample size (↑)
Plint et al[116]	2006	8	Overall consort items (↑) Reporting method of sequence generation (↑)[a] Allocation concealment (↑)[a]
Prady et al[117]	2008	90	Standardized page length (↑) Year of publication (↑)[a]
Pratoomsoot et al[118]	2015	71	Country of publication (ASEAN[b] vs. plus six) (↑ for some factors for ASEAN; ↑ for some factors for plus six)
Rikos et al[122]	2016	102	After the publication of CONSORT (↑) Impact factor (↑)[a] Year of publication (↑)[a]
Rios et al[121]	2008	89	Sample size (↑)[a] Industrial funding (↑)[a] Journal of publication (publication in JCEM) (↑)[a]
Scott et al[124]	2012	70	Trial registration (↑) Year of publication (↑) Trial size (↑)
Thabane et al[131]	2007	63	Type of intervention (pharmacological intervention vs. non-pharmacological intervention) (↑)[a] Sample sizes (↑)[a] Year of publication (↑)[a]
Turner et al[133]	2012	45	Time trend (↑)[a]
Yao et al[143]	2014	65	Number of authors (↑) Impact factor (↑)
Zhao et al[146]	2016	68	Year of publication (↑) Reporting of funding (↑) Reporting of informed consent form (↑) Reporting of ethical approval (↑)
Zheng et al[147]	2016	33	Number of authors (↑)[a] Number of patients (↑)[a] Impact factor (↑)[a] Time trend (↑)[a] Number of participants (↑) Treatment duration (↑) Reporting of funding (↑)
Zhong et al[148]	2011	153	Non-Chinese reports (compared to those published in mainland China) (↑)[a] Publication in CONSORT-endorsing journals (↑)[a]
Ziogas and Zintzaras[151]	2009	261	Year of publication (↑)[a] Impact factor (↑)[a]

Notes: [a]Statistically significant increase/decrease, $p \leq 0.05$; (↑), positively associated with adherence; (↓), negatively associated with adherence. The number of studies concluding that "some improvements are needed, reporting inadequate, poor, medium, suboptimal, etc". [b]Association of Southeast Asian nations, Association of Southeast Asian Nations (ASEAN) plus six groups, which composed of the members of the ASEAN plus Australia, China, India, Japan, New Zealand, and South Korea.
Abbreviations: CONSORT, Consolidated Standards of Reporting Trials; JCEM, *The Journal of Clinical Endocrinology and Metabolism*; RCT, randomized control trial.

Table 4 Reporting quality of the 124 included systematic reviews, assessed by the modified AMSTAR/OQAQ (10 items, score out of 20)

Study	Global score
Adie[28]	17
Adie et al[29]	18
Agha et al[30]	15
Agha et al[31]	14
Aguiar et al[32]	14
Aguiar et al[33]	19
Al Faleh and Al-Omran[34]	16
Al-Namankany et al[35]	15
Alvarez et al[36]	10
Anttila et al[37]	15
Areia et al[38]	18
Augestad et al[39]	20
Balasubramanian et al[40]	16
Bath and Bath[41]	16
Bereza et al[42]	20
Bian et al[43]	15
Biondi-Zoccai et al[44]	15
Borg Debano et al[45]	9
Bousquet et al[46]	18
Bramhall et al[47]	10
Cairo et al[48]	19
Capili et al[49]	15
Cavadas et al[50]	17
Choi et al[51]	17
Chowers et al[52]	12
Cook et al[53]	18
Daitch et al[54]	17
Dasi et al[55]	19
Delaney et al[56]	14
DeMauro et al[57]	17
de Vries and van Roon[58]	18
Dias et al[59]	17
Ethgen et al[60]	13
Eyawo et al[61]	18
Fan et al[62]	18
Farrokhyar et al[63]	19
Fidalgo et al[64]	18
Fleming et al[65]	15
Fontela et al[66]	17
Freeman et al[67]	11
Froud et al[68]	16
Fung et al[69]	17
Gagnier et al[70]	16
Gao et al[71]	13
Gianola et al[72]	12
Gohari et al[73]	15
Gulin et al[74]	14
Halpern et al[75]	14
Hemels et al[76]	19
Herdan et al[77]	15
Huang et al[78]	12
Hui et al[79]	18
Junhua et al[80]	13
Karpouzis and Bonello[81]	16
Kiehna et al[82]	16
Kim et al[83]	16
Kober et al[84]	17
Ladd et al[85]	19
Lee et al[86]	16
Lee et al[87]	17
Li et al[88]	18
Li et al[89]	15
Li et al[90]	14
Liu et al[91]	19
Liu et al[92]	16
Liu et al[93]	14
Liu et al[94]	17
Liu et al[95]	19
Lu et al[96]	18
Lu et al[97]	18
Ma et al[98]	19
Ma et al[99]	16
Marshman and Farid[100]	14
McCormick et al[101]	16
Miller et al[102]	17
Moberg-Mogren and Nelson[103]	16
Moher et al[104]	14
Montané et al[105]	15
Montgomery et al[106]	17
Nicolau et al[107]	16
Norton-Mabus and Nelson[108]	10
Ntala et al[109]	18
Panic et al[110]	11
Parsons et al[111]	17
Patel et al[112]	13
Piggott et al[113]	14
Péron et al[114]	15
Peters et al[115]	17
Plint et al[116]	18
Prady et al[117]	19
Pratoomsoot et al[118]	15
Rao et al[119]	18
Rice et al[120]	19
Rios et al[121]	20
Rikos et al[122]	17
Schwarz et al[123]	10
Scott et al[124]	16
Shawyer et al[125]	15
Shea et al[126]	13
Shea et al[127]	19
Stevely et al[128]	18
Strech et al[129]	18
Tan et al[130]	14
Thabane et al[131]	19
Tunis et al[132]	18
Turner et al[133]	20
Vigna-Taglianti et al[134]	15
Walleser et al[135]	19
Wang et al[136]	15
Wang et al[137]	17

Table 4 (*Continued*)

Study	Global score
Wangge et al[138]	12
Weingärtner et al[139]	17
Weir et al[140]	20
Wen et al[141]	18
Willis and Quigley[142]	20
Yao et al[143]	16
Zafar et al[144]	16
Zhang[145]	18
Zhao et al[146]	17
Zheng et al[147]	18
Zhong et al[148]	17
Zintzaras et al[149]	18
Zintzaras et al[150]	14
Ziogas and Zintzaras[151]	15

Abbreviations: AMSTAR, Assessment of Multiple Systematic Reviews; OQAQ, Overview Quality Assessment Questionnaire.

take time to adopt and disseminate. However, the uptake of the widely available guidelines has been less than ideal. We define suboptimal and less than ideal as <100%. The whole idea of a systematic review is to have completely transparent methods reported, so everyone can follow and reproduce the results. Inherently, systematic reviews are meant to be a more rigorous study design. This allows them to produce meaningful results than individual studies. Thus, when reviews fail to adhere to reporting guidelines, it calls into question the consistency of their results. Given the weight that systematic reviews have in the scientific community, it is imperative that we hold reviews to a high standard.

Five years ago, we investigated the level of adherence to reporting standards in the medical literature, and we identified 86% of the systematic reviews conducted on the level of adherence to reporting guidelines of the medical literature to be less than ideal.[7] Since our previous scoping review, many new revisions and updates to reporting guidelines have been introduced. Currently, there are 358 reporting guidelines on the EQUATOR Network website[16] for many study types that are freely available. However, endorsement of reporting guidelines by journals still remains low.

Among all the factors that can improve the reporting quality, such as author factors, study factors, journal factors, ethics and funding factors, and country of study factors, author factors as well as their limitations have been studied in other researches. The author factors were the number of the authors of the publication and the level of expertise in the different research methods. Multiple authorships were shown to be an important determinant of the impact of the research being produced and its likelihood of being cited.[17] The complexity and cost of medical research today requires multiple levels of expertise in various disciplines as well as accountability and oversight by study team members, institutions, and funding bodies. It is known that the number of authors per article has increased over the past few decades[18,19] with a concern posed to question the roles of multiple authors and the most senior academics holding senior authorship at the expense of others in the team.[20] Other studies have reported that the research produced by teams rather than single authors was impactful and more frequently cited, at least in certain fields.[21] It is likely that multiple authorships arising from collaborative efforts have advantages of producing good quality impactful research; however, multiple authorships also have limitations and may not be feasible at every setting due to geographical limitations or strict timeline to follow as bringing more authors is time-consuming.[22] In this review, we found that having multiple authorships is important to have publications with better adherence to reporting guidelines. However, the role of each author and the hierarchy of authorship should be clarified for successful collaborations and research impact as discussed earlier.

Study factors that improved adherence to reporting guidelines included well-designed, detailed study methods and adequately powered studies. Study results could be altered regarding trial designs, qualities, and methods.[23] Therefore, guidelines such as CONSORT statement that is designed for randomized control trials (RCTs), STROBE guideline for observational studies, and PRISMA guideline for systematic reviews were invented accordingly based on different study designs. RCTs are also considered as the highest level of primary evidence in the clinical practice, and therefore it is vital that these trials are reported according to the expected standards.[24]

Other factors reported that might improve the level of adherence to reporting guidelines included journals endorsing these guidelines. The Internal Committee of Medical Journal Editors (ICMJEs) recognized the importance of reporting guidelines in ensuring study details that are described adequately to be evaluated appropriately and encouraged journals to request these reporting standards from authors.[25] The EQUATOR Network has valuable resources and tool kits to assist authors and journal editors to adopt the reporting guidelines and provide case studies of journals endorsing the guidelines. Since journals that endorsed reporting guidelines often ask authors to submit a completed checklist regarding the guidelines, it improves the quality of reporting for those journals endorsing these guidelines. Yet, not all journals currently endorse the guidelines. According to the CONSORT website, there are 585 journals that endorse CONSORT,[26]

while there are about 30,000 journals indexed in PubMed.[27] While not all of these indexed journals publish RCTs, many of them do publish them, but do not adhere to CONSORT guidelines.[27]

The EQUATOR Network also has tool kits for ethics boards and study sponsors to ensure that the reporting guidelines are considered when these agencies review research submissions for ethical approval or funding requests. It is therefore important that all stakeholders take part in the use and dissemination of the reporting guidelines to enhance the quality of medical research and biomedical literature.

Limitations

The included studies are limited to only eight of the reporting guidelines, and therefore the current study lacks the generalizability to other guidelines that may have a better adherence standard. In addition, there was no comparison between studies to ensure that they are using qualitative descriptors such as "inadequate" or "suboptimal" with the same operational definition. The studies do not provide sufficient information regarding the operationalization of qualitative descriptors to allow us to adequately compare descriptors across studies.

In addition, the study was limited to systematic reviews that present with its own set of limitations. The most notable limitation is the low mean score on the quality assessment since each systematic review follows different reporting guidelines or does not follow guidelines at all and the lack of detailed data on the included studies' characteristics. Furthermore, a quantitative analysis was not conducted, as not all included studies provided relevant data. Strict inclusion criteria may have allowed a quantitative analysis. However, for the sake of a more representative sample, such criteria were not implemented.

The inclusion of studies in English only is also a limitation to a selected section of the medical literature and did not include other reporting guidelines that may be in use in other languages.

Despite the limited scope of inclusion criteria and quality limitation of the included studies, this review provides an insight into the limited uptake of reporting guidelines and calls for exploring barriers to such uptake. Future studies may include broad surveys of authors, journal editors, funding agencies, ethics boards, and readers to solicit opinions and understanding of the role of reporting guidelines in the medical research and literature.

Conclusion

Current adherence to reporting guidelines in the medical literature is suboptimal. However, there are factors associated with better reporting upon which we can develop strategies for better reporting. Reporting guidelines are an imperative tool in the endeavor to improve the consistency of reporting in the medical literature. However, the suboptimal uptake and correct usage of reporting guidelines demonstrate the need for further emphasis in the scientific community to encourage the use of reporting guidelines. The responsibility for improving the transparency, quality, and reproducibility of medical literature lies with all stakeholders from the research participants to regulatory authorities and everyone in between including authors, readers, educators, funders, academic and health care institutions, editors, peer reviewers, and guideline developers. Future studies may include broad surveys of authors, journal editors, funding agencies, ethics boards, and readers to solicit opinions and understanding of the role of reporting guidelines in the medical research and literature.

Data sharing statement

Unpublished study data are available upon request.

Author contributions

Contributed to the conception and design of the study, development of data extraction forms, search strategy, analysis of results, manuscript writing, and final review of the manuscript: YJ, NS, IS, CL, HS, and GL. Contributed to the methodological design, critical revision, and final review of the manuscript: MB, LZ, BB, MW, LPFA, IN, AL, LM, MM, YC, GS, MAHL, JDA, and LT. Substantially contributed to the conception and design of the study, critical revision, and final approval of the manuscript: ZS. All the authors read and approved the final manuscript. All the authors consented and approved the manuscript for publication. All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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