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ABSTRACT

Background: The use of ACS-NSQIP has increased in pancreatic surgery (PS) research. The aim of this study is to critically appraise the methodological reporting of PS publications utilizing the ACS-NSQIP database.

Study design: PubMed was queried for all PS studies employing the ACS-NSQIP database published between 2004 and 2021. Critical appraisal was performed using the JAMA-Surgery Checklist, STROBE Statement, and RECORD Statement.

Results: A total of 86 studies were included. Median scores for number of fulfilled criteria for the JAMA-Surgery Checklist, STROBE Statement, and RECORD Statement were 6, 20, and 6 respectively. The most commonly unfulfilled criteria were those relating to discussion of missed data, compliance with IRB, unadjusted and adjusted outcomes, providing supplementary/raw information, and performing subgroup analyses.

Conclusion: An overall satisfactory reporting of methodology is present among PS studies utilizing the ACS-NSQIP database. Areas for improved adherence include discussing missed data, providing supplementary information, and performing subgroup analysis. Due to the increasing role of large-scale databases, enhanced adherence to reporting guidelines may advance PS research.

Introduction

Over the past decades, surgeons have begun developing a significant interest in improving quality of care to both reduce costs of treatment and improve surgical outcomes.[1] Newly implemented surgical standards and policies requiring physicians to track their performance via recognized quality indicators has encouraged the development of large databases such as the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP).[1] The database was conceived in 1998 and implemented in 2004.[2] The NSQIP remains to this day, the largest risk-adjusted, quality improvement database that is prepared, edited, and authenticated by surgeons.[3]

Participant user files (PUF) of the NSQIP comprises patient information detailing comorbidities, demographics, procedure characteristics, and outcome data from over 700 participating hospitals worldwide.[4] Contrary to other databases, the NSQIP has data on preoperative, intraoperative, and 30-day postoperative statistics collected via a standardized methodology. The NSQIP was initially developed to improve post-operative outcomes by decreasing the frequency of complications, but it has gained popularity among surgeons for research purposes.[5] Today, it is among the most frequently used databases for surgical outcomes research.[5]

The growing use of large databases such as the NSQIP in biomedical and surgical research has led to several concerns about the methodological quality of these studies.[6] Hence, statements on methodological reports have been devised to help authors abide by

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established standards of reporting and enhance the quality of their published works.[7–10] Though, compliance with these reporting statements has not always been optimal.[11,12] Accordingly, assessing the methodological reporting of studies utilizing these large databases is imperative to help understand the reasoning behind suboptimal compliance, highlight the inadequacies, and suggest novel solutions to improve the reporting and subsequently quality of surgical studies being published.

Although an increasing number of pancreatic surgery (PS) studies are being published using the NSQIP, no study has assessed the methodological quality of PS publications. Enforcing adherence to validated methodological reporting guidelines in surgical journal submissions should ensure improved quality in PS publications using the NSQIP. Hence, the aim of this study is to critically appraise the methodological quality of PS publications conducted using the ACS-NSQIP database and provide areas of improvement for future investigations.

Materials and methods

Eligibility and exclusion criteria

A search was performed for all the publications involving the ACS-NSQIP database from the time of its inception in 2004 to February 19th, 2021 using the PubMed search engine. The terms used for pancreas procedures were "pancreatoduodenectomy", "pancreaticoduodenectomy", "distal pancreatectomy", "total pancreatectomy", "central pancreatectomy", "pancreatectomy", "pancreas surgery", "pancreatic surgery", "pancreatic procedure", and "pancreas procedure". The Boolean operator "AND" was used with each term to add the terms "ACS NSQIP", "NSQIP", "American College of Surgeons National Surgical Quality Improvement Program", and "National Surgical Quality Improvement Program". No limits on languages were done. Only publications using the ACS-NSQIP database for patients undergoing PS were selected. Any studies using another major database such as the NSQIP Pediatric database, Surveillance, Epidemiology, and End Results (SEER), National Inpatient Sample or National Cancer Database were excluded. Articles comparing NSQIP results to institutional-based data were also excluded. Studies that did not present data such as commentaries, reviews, and editorials were also excluded.

Study selection

Two authors (HHK, MYF) independently screened the titles and abstracts of all identified publications for possible eligibility. Full texts of publications were retrieved if at least one of two authors judged them as eligible. Both authors independently reviewed the full texts for the study criteria. Any disagreements were resolved by a third independent author (HAS) in coordination with the other authors. The process is summarized using a PRISMA diagram in Fig. 1.

Data extraction and processing

The following information was obtained from each study: authors, title, year of publication, name of publishing journal, number of citations (as of February 23rd, 2021 on Google Scholar), and pancreatic surgery subspecialty. Impact factors (2020) of publishing journals were extracted from Journal Citation Reports (JCR).[13]

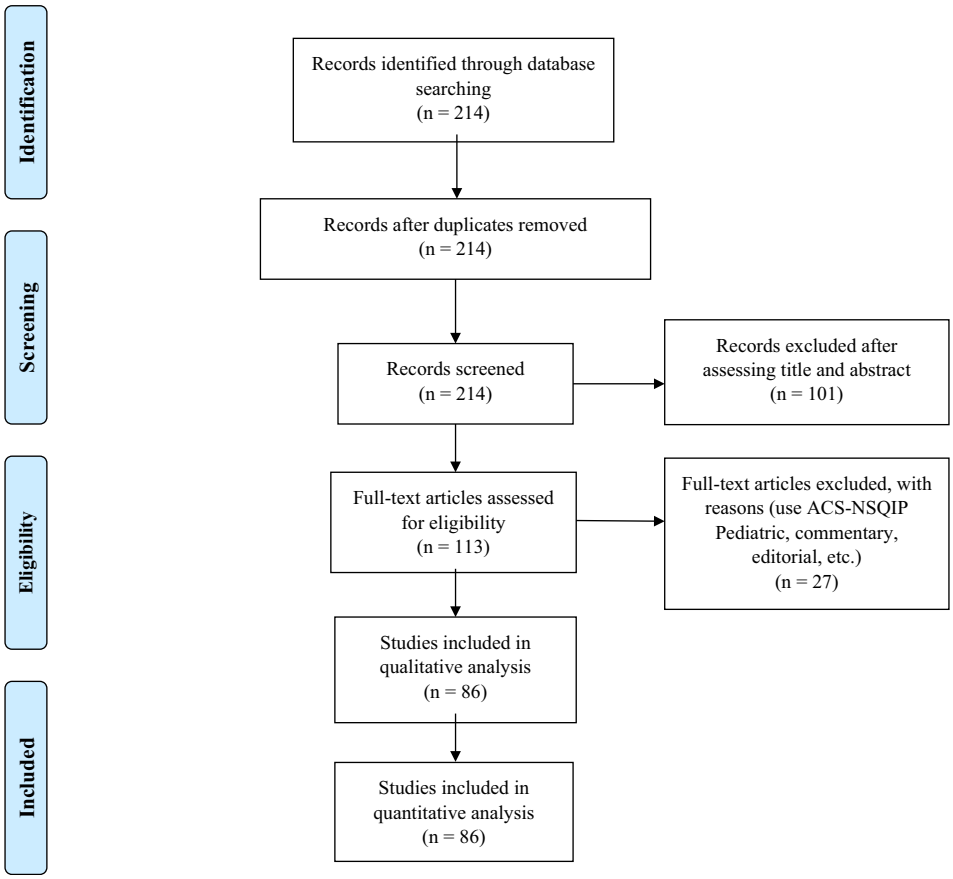

Fig. 1. Flow chart displaying the search strategy, literature review, and selection process in accordance with PRISMA guidelines.

Table 1
Observational study criteria according to the JAMA-Surgery checklist, STROBE statement, and RECORD statement.

Item Number	JAMA-Surgery[14]	STROBE[9]	RECORD[7]
1	Have a solid research question and clear hypothesis. Consider using the FINER or PICO criteria to develop these.	(a) Indicate the study's design with a commonly used term in the title or the abstract. (b) Provide in the abstract an informative and balanced summary of what was done and what was found.	Type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included.
2	Ensure compliance with IRB and data use agreements.	Explain the scientific background and rationale for the investigation being reported.	If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract.
3	Conduct a thorough literature review. Use a reference management program for ease in manuscript development	State specific objectives, including any prespecified hypotheses.	If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.
4	Make sure this is the best data set available and that it has the appropriate variables to answer your research question.	Present key elements of study design early in the paper.	Method of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided
5	Clearly define the inclusion criteria, exclusion criteria, and outcome variables. Use a flow diagram to describe final patient selection.	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, results should be provided detailed methods and
6	Identify potential confounders and use risk adjustment to minimize bias. Consider using a directed acyclic graph to represent potential associations. Avoid use of causal language in reporting results of these observational studies.	(a) Cohort study: Give the eligibility criteria and the sources and methods of selection of participants. Describe methods of follow-up. Case-control study: Give the eligibility criteria and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls. Cross-sectional study: Give the eligibility criteria and the sources and methods of selection of participants. (b) Cohort study: For matched studies, give matching criteria and number of exposed and unexposed. Case-control study: For matched studies, give matching criteria and the number of controls per case.	If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of data at each stage individuals with linked
7	Ensure that the data variables have not changed over time. If so, account for this.	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Complete list of codes and algorithms used to classify exposure, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided
8	Ensure that competing risks are identified and addressed	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group.	Authors should describe the extent to which the investigators had access to the database population used to create the study population.
9	Ensure that data issues, such as missing data, are discussed and that any sensitivity analyses or imputations performed are reported in a clear and cohesive way.	Describe any efforts to address potential sources of bias.	Authors should provide information on the data cleaning methods used in the study
10	Ensure that your article has a clear take-home message that addresses how your research advances current knowledge and has important policy or clinical implications.	Explain how the study size was arrived at.	State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.
11		Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.	Describe in detail the selection of the persons included in the study (ie study population selection), including filtering based on data quality, data availability, and linkage. Selection of included persons can be described in the text and/or by means of the study flow diagram.
12		(a) Describe all statistical methods, including those used to control for confounding. (b) Describe any methods used to examine subgroups and interactions. (c) Explain how missing data were addressed. (d) Cohort study: If applicable, explain how loss to follow-up was addressed. Case-control study: If applicable, explain how matching of cases and controls was addressed. Cross-sectional study: If applicable, describe analytical methods taking account of sampling strategy. (e) Describe any sensitivity analyses.	Discuss implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported
13		(a) Report the numbers of individuals at each stage of the study (eg, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed). (b) Give	Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code

(*continued on next page*)

Table 1 (*continued*)

Item Number	JAMA-Surgery[14]	STROBE[9]	RECORD[7]
		reasons for nonparticipation at each stage. (c) Consider use of a flow diagram.	
14		(a) Give characteristics of study participants (eg, demographic, clinical, and social) and information on exposures and potential confounders. (b) Indicate the number of participants with missing data for each variable of interest. (c) Cohort study: summarize follow-up time (eg, average and total amount).	
15		Cohort study: Report numbers of outcome events or summary measures over time. Case-control study: Report numbers in each exposure category or summary measures of exposure. Cross-sectional study: Report numbers of outcome events or summary measures.	
16		(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included. (b) Report category boundaries when continuous variables were categorized. (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.	
17		Report other analyses done—eg, analyses of subgroups and interactions and sensitivity analyses	
18		Summarize key results with reference to study objectives.	
19		Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	
20		Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	
21		Discuss the generalizability (external validity) of the study results	
22		Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.	

FINER: Feasible, Interesting, Novel, Ethical, Relevant.
PICO: Patient, Population, or Problem; Intervention, Prognostic Factor, or Exposure; Comparison or Intervention; Outcome.

Journal policies regarding author requirements to adhere to verified reporting statements such as RECORD, STROBE, JAMA, PRISMA, CONSORT, MOOSE, STARD, SPIRIT were also documented.

Critical appraisal of reporting methodology

Quality of reporting of the final eligible publications was assessed using three reporting guidelines:

1) JAMA-Surgery Checklist: The editors of *JAMA Surgery* developed "The Checklist to Elevate the Science of Surgical Database Research" in 2018 to help authors with a guide to follow when performing any research involving large databases such as the ACS-NSQIP.[14] This checklist is composed of 10 items found in Table 1.
2) STROBE Statement: The Strengthening the Reporting of OBservational Studies in Epidemiology (STROBE) Statement was devised in 2004 to guide researchers in the course of reporting observational studies. It is composed of 22 items that aim to appraise observational studies in terms of the writing and quality of reporting. The statement emphasizes on the methods of observational studies from data collection to analysis. More details are available in Table 1.
3) RECORD Statement: The REporting of Studies Conducted Using Observational Routinely Collected Health Data (RECORD) Statement was first devised in 2015 as an extension of the STROBE statement to close gaps found in the latter.[7] The RECORD statement is made of 13 items, and includes providing supplementary information, or accessibility of raw data, which are not found in the STROBE statement. Additional details on the statement are also detailed in Table 1.

In this study, the JAMA-Surgery Checklist, STROBE Statement, and RECORD Statement were used to appraise PS publications quantitatively. For each publication, assessment of the criteria being fulfilled as stated in the three mentioned appraisal tools was done by marking a criterion as 1, meaning fulfillment, or 0, meaning not fulfilled. This is consistent with the methodology used by Yolcu et al. Khera et al., and El Moheb et al.[6,15,16] As all criteria do not have the same impact, scoring of publications signifies the number of criteria satisfied, rather than the quality of the publication itself. Each publication is graded according to the total number of fulfilled criteria regarding the JAMA-Checklist (out of 7), STROBE Statement (out of 22), and RECORD Statement (out of 10). Three criteria were excluded from the JAMA-Surgery Checklist as evaluation was not feasible, and 3 criteria from the RECORD statement were not included as they were related to database comparison. The excluded criteria from the JAMA-Surgery Checklist were the ones

Table 2
Baseline characteristics of included studies.

Variable	Total ACS-NSQIP PS Studies (n = 86)
Year of Publication	N (%)
2010	1 (1)
2011	5 (6)
2013	2 (2)
2014	5 (6)
2015	6 (7)
2016	4 (5)
2017	10 (12)
2018	14 (16)
2019	15 (17)
2020	21 (24)
2021	3 (3)
Journals	**N (%)**
American Journal of Surgery	5 (6)
The American Surgeon	3 (3)
Annals of Surgery	3 (3)
Annals of Surgical Oncology	1 (1)
BMC Surgery	1 (1)
Digestive Diseases and Sciences	1 (1)
HPB (Oxford)	20 (23)
Indian Journal of Surgical Oncology	1 (1)
Journal of the American College of Surgeons	3 (3)
Journal of Gastrointestinal Surgery	23 (27)
Journal of Pancreatic Cancer	1 (1)
Journal of Surgical Oncology	6 (7)
Journal of Surgical Research	4 (5)
JAMA Surgery	1 (1)
Pancreatology	1 (1)
PLOS One	1 (1)
Surgical Endoscopy	4 (5)
Surgery	3 (3)
Transplantation Proceedings	1 (1)
World Journal of Surgery	2 (2)
World Journal of Surgical Oncology	1 (1)
Reporting Statement Scores	**Median (IQR)**
JAMA-Surgery Checklist	6 (5–6)
STROBE Statement	20 (19–20)
RECORD Statement	6 (5–7)
JCR Impact Factor, Median (IQR)	2.9 (2.1–3.7)
Journal policy requiring adherence to reporting guidelines, N (%)	17 (80)
Reported Compliance with reporting guidelines, N (%)	6 (7)
Citation of articles, Median (IQR)	7 (2–24)

ACS-NSQIP: American College of Surgeons National Surgical Quality Improvement Program.
PS: Pancreatic Surgery.
IQR: Interquartile Range.
STROBE: Strengthening the Reporting of OBservational Studies in Epidemiology.
RECORD: REporting of Studies Conducted Using Observational Routinely Collected Health Data.
JCR: Journal Citations Reports.

relating to conducting a thorough literature review, making sure the data used is the best one available, and ensuring that data variables have not changed over time (items 3, 4, and 7 in Table 1). The excluded criteria from the RECORD Statement were the ones relating to if linkage between databases or institutional level data was done (items 3, 6, and 10 in Table 1). Three authors (HHK, HAS, and MYF) scored each publication independently according to the JAMA-Surgery Checklist, STROBE statement, and RECORD statement criteria. Any disagreement was resolved by discussion or via consultation of a fourth author (JRH). Interrater reliability was done by pooling the Cohen's Kappa scores across all criteria.[17] The agreement rates for the JAMA-Surgery Checklist, STROBE statement and RECORD statement were 95%, 91%, and 92% respectively. Due to the nature of this study, no institutional review board (IRB) approval was needed.

Statistical analysis

Categorical variables were presented using frequencies and percentages, while continuous data was presented as medians and interquartile ranges (IQR). Analysis was done to compare the total checklist scores and individual criteria fulfilled of publications in high and low impact factor (IF) journals. High IF was defined as a journal IF ranking in the 90th percentile of all other surgical journals indexed in the Journal Citation Reports as performed by El Moheb et al.[16] Whether or not a journal required authors to adhere to a reporting statement was also considered and a comparison of publications on the basis of adherence was completed. A subanalysis comparing the type of PS (pancreatoduodenectomy vs. distal pancreatectomy vs a combination) was also performed. Continuous variables were compared using Wilcoxon's rank sum test, while categorical variables were compared using Pearson's Chi square test. A two-sided *t*-test was also performed for testing hypotheses. A p-value of <0.05 was considered statistically significant. All statistical analyses were conducted using the IBM SPSS statistical package (version 25, IBM Corp., Armonk N·Y., USA).

Results

Search results and study characteristics

Our electronic query generated a total of 214 articles. After

performing a thorough review of the titles and abstracts of the publications, we identified 113 articles for possible inclusion. After excluding an additional 27 articles, a final number of 86 studies were included in our final appraisal. The process is detailed in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) in Fig. 1. The majority of articles were published in 2020 (n = 21), followed by 2019 (n = 15), and 2018 (n = 14) (Table 2). The Journal of Gastrointestinal Surgery (n = 23) was the most common publishing journal (Table 2), and the mean IF of all publishing journals was 3.67. Seven articles were published in high IF journals. The median number of citations per article was 7 (2.00–24.75) (Table 2). Of the 77 articles published in journals with a policy on adhering to reporting guideline, only 6 were compliant (Table 2). The number of ACS-NSQIP PS publications showed a significant increasing trend (p-value = 0.029) from 2010 to 2021 (Fig. 2). Among the PS subtypes, studies on pancreaticoduodenectomy (Whipple procedure) were the most common (n = 47)

Fulfilment of criteria in reporting guidelines

The median scores for the JAMA-Surgery Checklist, STROBE statement, and RECORD statement were 6 (5–6) out of 7, 20 (19–20) out of 22, and 6 (5–7) out of 10, respectively. The results of fulfilment of reporting criteria are found in Table 3. Among the JAMA-Surgery checklist, the overwhelming majority of articles had a valid research question and hypothesis (n = 85), defined inclusion/exclusion criteria (n = 86) and discussed advancement in knowledge and clinical implication (n = 86). However, only a little over half described compliance with IRB (n = 51), and less than half discussed the effect of missing variables (n = 38). Among the RECORD statement items, most studies specified selection strategy (n = 75) and detailed which codes were used in selection process (such as Current Procedural Terminology code) (n = 72). Only 18 articles provided access to supplemental information or raw data. As for the STROBE statement items, only 30 studies described study design in the title or abstract. Most criteria in the statement were fulfilled by almost all studies. However, less than half reported subgroup analysis (n = 40) and slightly more than half gave unadjusted and adjusted estimates (n = 52).

High impact factor vs low impact factor journals

Of the 86 included articles, only 7 (8%) were published in high IF journals. Comparison of checklist item fulfilment is shown in Table 4. Articles published in low IF journals had a significantly higher (p-value <0.001) access to supplemental information (23% vs 0%). They also provided significantly more (p-value = 0.04) sources of funding than studies published in high IF journals (81% vs 57%).

Journals with vs without Policy for Reporting Statements.

Of the 86 included articles in our study, 77 (89%) were published in journals with policies for authors to follow reporting statements. Studies published in journals with such requirements had significantly more access to supplemental information (23% vs 0%, p-value <0.001). A comparison of checklist item fulfilment according to journal policy requirements is summarized in Table 5.

Reporting over time

We categorized the 86 publications in our study into three-time groups: before 2015, between 2015 and 2018, and after 2018. The average JAMA-Surgery, STROBE and RECORD scores for the before 2015 group were 5.4, 19.1, and 6.1, respectively. For the 2015–2018 group, the JAMA-Surgery, STROBE and RECORD scores were 5.7, 19.5, and 5.4, respectively. As for the after 2018 group, the average JAMA-Surgery, STROBE and RECORD scores were 5.6, 19.5, and 8.6, respectively. RECORD scores in the after 2018 group were significantly greater than (p-value = 0.03) both other groups.

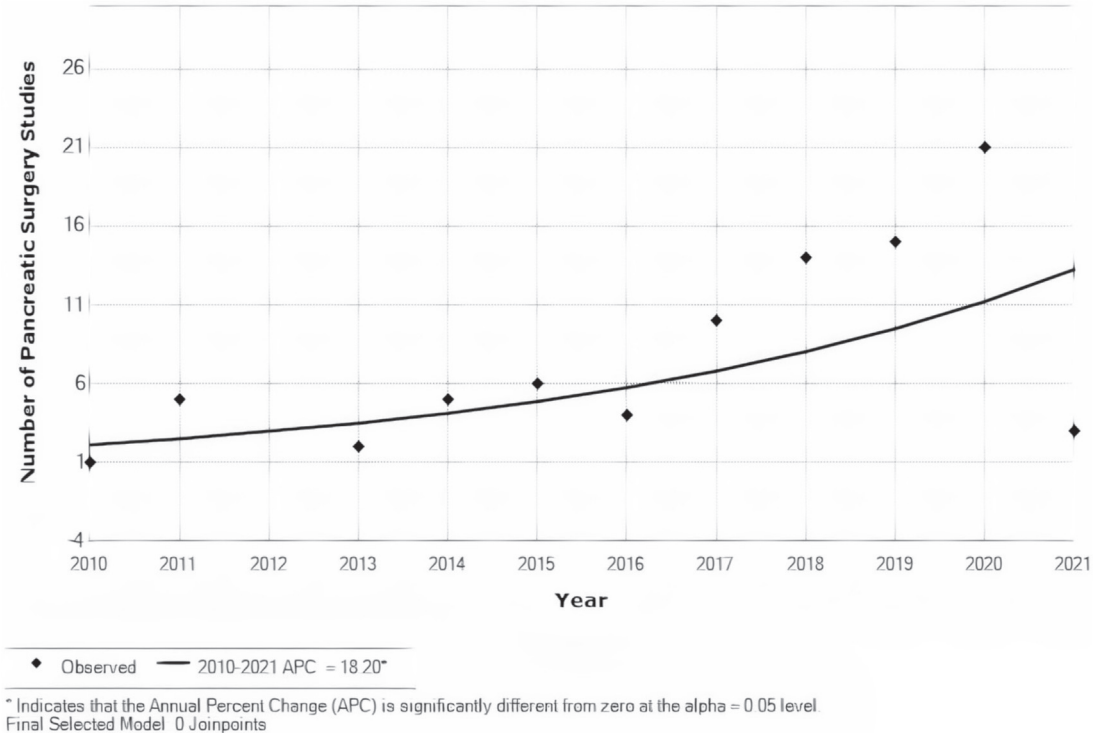

Fig. 2. Distribution and annual percentage change of ACS-NSQIP pancreatic surgery studies from 2010.

Table 3
Criteria fulfillment of included pancreatic surgery studies.

Checklist Criteria	N	%
JAMA-Surgery Checklist		
Research question and hypothesis	85	99
Compliance with IRB	51	59
Defined inclusion/exclusion criteria, outcome variables and included flowchart diagram	86	100
Discussed process to deal with confounders	63	73
Identified and addressed competing risk	72	84
Discussed effect of missing variables	38	44
Discussed advancement in knowledge and clinical implication	86	100
RECORD Statement		
Discussed type of data or name of dataset in title or abstract	32	37
Specified geographical region and timeframe in title or abstract	1	1
Specified population selection strategy	75	87
Provided validation of population selection	60	70
Specified codes to classify exposure	72	84
Discussed extent of data access	82	95
Discussed data cleaning methodology	52	60
Described population selection process	80	93
Discussed implication of using data not available to answer the specific research question	36	42
Provided access to supplemental information	18	21
STROBE Statement		
Study design described in title or abstract	30	35
Explain background for investigation performed	86	100
State specific objectives and hypotheses	86	100
Present key elements of design early in manuscript	86	100
Describe setting, locations, exposure, follow-ups, and data collection	86	100
Define eligibility criteria, and sources of selection of participants	84	98
Define all outcomes, exposures, predictors potential cofounders, and effect modifiers	86	100
Give sources of data and measurement for all variables	86	100
Addressing potential sources of bias	85	99
Explain how study size was arrived at	86	100
Describe all statistical methods and how missing data was addressed	86	100
Report number of individuals in each stage of study	26	30
Provided characteristics of study participants	86	100
Report number of outcome events or summary measure	85	99
Give unadjusted and adjusted estimates	52	69
Report subgroup analyses done	40	47
Discuss limitations	86	100
Give overall interpretation	86	100
Discuss generalizability of results	82	95
Give sources of funding	83	97

Surgery subtype

The 86 publications included in our study, were categorized according to 7 different combinations of pancreatic surgery subtypes. Of these subtypes, pancreaticoduodenectomy (PD), distal pancreatectomy (DP), and comparison of both PD and DP had at least 10 publications with 47, 13 and 12 articles describing each respectively.

Discussion

The ACS-NSQIP database has provided researchers with a framework to conduct studies regarding a vast diversity of surgical topics. The ability to leverage these large datasets to adequately power studies, develop outcome predictors, and report nationwide annual trends has been of immense benefit. Pancreatic surgeons have also come to utilize this large database in efforts to improve pancreas surgery outcomes. As such, it is important to track the increased use and monitor it to ensure high quality research. Herein, we assessed the methodological fulfilment of PS studies utilizing the ACS-NSQIP database. Our findings suggest that these studies fulfilled most of the criteria suggested by 3 established reporting guidelines (JAMA-Surgery, STROBE, RECORD) for reporting requirements. However, there is a lack of reporting in terms of type of data and specific methodology in the titles and abstracts, discussion on missing data, providing supplementary/raw information, reporting adjusted and unadjusted estimates/outcomes, and performing subgroup analysis. Accordingly, this study calls for an improvement in the quality of PS studies utilizing large databases such as the NSQIP to increase their credibility.

The first quantitative analysis of a study using a large database was done by Khera et al., in 2017.[6] The authors performed their report on the National Inpatient Sample (NIS) database. This was followed by Yolcu et al. who performed the first analysis using the ACS-NSQIP database in 2020.[15] They examined neurosurgical publications and scored the studies according to the three established reporting guidelines used in this work.[15] Similar to our study, the most commonly unfulfilled criteria they found was “supplementary information”. Their findings also found that failure to discuss missing data was also common theme in neurosurgery articles. This was consistently found in PS studies as well. El Moheb et al. later performed the first analysis on general surgery related research with their study focused on emergency general surgery (EGS) publications utilizing the ACS-NSQIP database as well.[16]

As an increasing number of studies employ large datasets to answer research questions, a parallelly growing body of literature is critically scrutinizing these studies.[6,15,18] Oravec et al. recently recommended that studies involving large-scale data have certain limitation that researchers should consider before reporting.[19] Our study showed that all PS studies (100% fulfilment) reported limitations. One such limitation is the balance between clinical and statistical significance when studying very large datasets. Although the

Table 4
Criteria Fulfillment of Pancreatic Surgery Studies Published in High vs Low Impact Factor Journals.

Checklist Criteria	Low IF Journal (n = 79)	High IF Journal (n = 7)	p-value
JAMA-Surgery Checklist, n (%)			
Research question and hypothesis	78 (99)	7 (100)	0.32
Compliance with IRB	48 (61)	3 (43)	0.42
Defined inclusion/exclusion criteria, outcome variables and included flowchart diagram	79 (100)	7 (100)	–
Discussed process to deal with confounders	57 (72)	6 (86)	0.39
Identified and addressed competing risk	68 (86)	4 (57)	0.20
Discussed effect of missing variables	33 (42)	5 (71)	0.16
Discussed advancement in knowledge and clinical implication	79 (100)	7 (100)	–
Median (IQR)	68 (52.5–78.5)	6 (4.5–7.0)	
RECORD Statement, n (%)			
Discussed type of data or name of dataset in title or abstract	29 (37)	3 (43)	0.77
Specified geographical region and timeframe in title or abstract	1 (1)	0 (0)	0.32
Specified population selection strategy	69 (87)	6 (86)	0.91
Provided validation of population selection	56 (71)	4 (57)	0.53
Specified codes to classify exposure	67 (85)	5 (71)	0.51
Discussed extent of data access	75 (95)	7 (100)	0.06
Discussed data cleaning methodology	48 (61)	4 (57)	0.86
Described population selection process	73 (92)	7 (100)	0.07
Discussed implication of using data not available to answer the specific research question	32 (41)	4 (57)	0.45
Provided access to supplemental information	18 (23)	0 (0)	< **0.001**
Median (IQR)	52 (29.9–68.5)	4 (3.3–5.8)	
STROBE Statement, n (%)			
Study design described in title or abstract	27 (34)	7 (100)	0.69
Explain background for investigation performed	79 (100)	7 (100)	–
State specific objectives and hypotheses	79 (100)	7 (100)	–
Present key elements of design early in manuscript	79 (100)	7 (100)	–
Describe setting, locations, exposure, follow-ups, and data collection	79 (100)	7 (100)	–
Define eligibility criteria, and sources of selection of participants	77 (97)	7 (100)	–
Define all outcomes, exposures, predictors potential cofounders, and effect modifiers	79 (100)	7 (100)	–
Give sources of data and measurement for all variables	79 (100)	7 (100)	–
Addressing potential sources of bias	78 (99)	7 (100)	0.15
Explain how study size was arrived at	79 (100)	7 (100)	–
Describe all statistical methods and how missing data was addressed	79 (100)	7 (100)	–
Report number of individuals in each stage of study	23 (29)	3 (43)	0.32
Provided characteristics of study participants	79 (100)	7 (100)	–
Report number of outcome events or summary measure	79 (100)	7 (100)	–
Give unadjusted and adjusted estimates	47 (59)	5 (71)	0.32
Report subgroup analyses done	37 (47)	3 (43)	0.53
Summarize key findings	79 (100)	7 (100)	–
Discuss limitations	75 (95)	7 (100)	0.55
Give overall interpretation	76 (96)	7 (100)	0.85
Discuss generalizability of results	79 (100)	7 (100)	–
Give sources of funding	64 (81)	4 (57)	**0.04**
Median (IQR)	78.5 (75.3–79.0)	7 (7–7)	

IRB: Institutional Review Board.
IQR: Interquartile Range.

limitations themselves may be concerning, it is reassuring that authors of PS publications are aware of the need to report these limitations when using large scale databases such as the ACS-NSQIP.

Only a few differences were noted between articles published in low and high IF journals. In terms of reporting compliance with IRB, identifying competing risks, and providing supplementary information, studies in low IF journals had higher reporting. Gluud et al. previously reported that in terms of hepatobiliary randomized clinical trials, articles published in high IF journals are methodologically flawed, and that the IFs should only serve a role as an estimation to trial quality. Yolcu et al. found similar results with no significant difference between articles published in core vs non-core neurosurgery journals.[15]

Although the overall compliance to methodological reporting in PS studies using the NSQIP database is adequate, there is still room for meaningful improvement. Adhering to guidelines helps optimize surgical research and provides higher quality publications.[20] Thus, requiring authors to adhere to established guidelines should be incorporated in the manuscript submission and editorial review process. Moreover, a concerted effort by organizations such as the International Committee of Medical Journal Editors (ICMJE) should be implemented to enforce stricter adherence. Further research is needed on publications using other well established national databases such as the Nationwide Readmissions Database, National Cancer Database, and Surveillance, Epidemiology and End Results Program database. Also, although the JAMA-Surgery checklist, STROBE statement and RECORD statement are widely acknowledged tools to appraise reporting methodology, they are limited by lack of topic specificity. A new checklist formed by multi-expert general surgeons would help elevate the level of general surgery research involving large scale databases.[21,22] In addition, integrating the study of reporting standards into surgical research training and including a completed checklist (such as one of the tools utilized in this study) with submission would ensure proper compliance to methodological reporting. This in turn will enhance the quality of surgical research and limit the chances of underreporting certain results or findings. Future studies should also investigate impact of these new instruments on the quality of studies over time.

Table 5
Criteria fulfillment of pancreatic surgery studies published in journals with and without policy requiring adherence to reporting statements.

Checklist Criteria	Journal without Reporting Statement Policy (n = 9)	Journal with Reporting Statement Policy (n = 77)	p-value
JAMA-Surgery Checklist, n (%)			
Research question and hypothesis	9 (100)	76 (99)	0.32
Compliance with IRB	3 (33)	48 (62)	0.13
Defined inclusion/exclusion criteria, outcome variables and included flowchart diagram	9 (100)	77 (100)	–
Discussed process to deal with confounders	7 (78)	56 (73)	0.75
Identified and addressed competing risk	5 (56)	67 (87)	0.11
Discussed effect of missing variables	4 (44)	34 (44)	0.98
Discussed advancement in knowledge and clinical implication	9 (100)	77 (100)	–
Median (IQR)	7 (4.5–9.0)	67 (52.0–76.5)	
RECORD Statement, n (%)			
Discussed type of data or name of dataset in title or abstract	4 (44)	28 (36)	0.67
Specified geographical region and timeframe in title or abstract	0 (0)	1 (1)	0.32
Specified population selection strategy	8 (89)	67 (87)	0.87
Provided validation of population selection	6 (67)	54 (70)	0.84
Specified codes to classify exposure	8 (89)	64 (83)	0.63
Discussed extent of data access	8 (89)	74 (96)	0.54
Discussed data cleaning methodology	6 (67)	46 (60)	0.70
Described population selection process	8 (89)	72 (94)	0.69
Discussed implication of using data not available to answer the specific research question	5 (56)	31 (40)	0.42
Provided access to supplemental information	0 (0)	18 (23)	< **0.001**
Median (IQR)	6 (4.3–8.0)	50 (28.8–66.3)	
STROBE Statement, n (%)			
Study design described in title or abstract	4 (44)	26 (34)	0.57
Explain background for investigation performed	9 (100)	77 (100)	–
State specific objectives and hypotheses	9 (100)	77 (100)	–
Present key elements of design early in manuscript	9 (100)	77 (100)	–
Describe setting, locations, exposure, follow-ups, and data collection	9 (100)	77 (100)	–
Define eligibility criteria, and sources of selection of participants	9 (100)	75 (97)	0.15
Define all outcomes, exposures, predictors potential cofounders, and effect modifiers	9 (100)	77 (100)	–
Give sources of data and measurement for all variables	9 (100)	77 (100)	–
Addressing potential sources of bias	9 (100)	76 (99)	0.32
Explain how study size was arrived at	9 (100)	77 (100)	–
Describe all statistical methods and how missing data was addressed	9 (100)	77 (100)	–
Report number of individuals in each stage of study	1 (11)	25 (32)	0.32
Provided characteristics of study participants	9 (100)	76 (99)	0.11
Report number of outcome events or summary measure	9 (100)	77 (100)	–
Give unadjusted and adjusted estimates	5 (56)	47 (61)	0.32
Report subgroup analyses done	4 (44)	36 (47)	0.77
Summarize key findings	9 (100)	77 (100)	–
Discuss limitations	8 (89)	74 (96)	0.54
Give overall interpretation	8 (89)	75 (97)	0.47
Discuss generalizability of results	9 (100)	77 (100)	–
Give sources of funding	5 (56)	63 (82)	0.18
Median (IQR)	9 (8–9)	76.5 (74.3–77.0)	

IRB: Institutional Review Board.
IQR: Interquartile Range.

To the best of our knowledge, this is the first study to critically appraise the reporting methodology of PS studies using the ACS-NSQIP database. Nevertheless, our study has several limitations. First, we scored items on the JAMA-Surgery Checklist, STROBE Statement, and RECORD Statement on a "one-point" fulfilment basis. Although this method is necessary to provide objective quantitative assessments, these items do not necessarily have equal importance in a study's reporting quality. Second, the journals assessed for the presence of policy on reporting adherence, journal IFs, and citations of included articles were based on the time this study was conducted. Next, a high quality of reporting does not necessarily translate to an enhanced research quality. Yet, we believe that adherence to reporting guidelines can help in augment the quality of surgical research. Finally, as we could only assess for published articles, there still remains manuscripts that were rejected from editorial offices based on various reasons. These manuscripts could have held different findings such as adequate reporting or suboptimal reporting.

Conclusions

The methodological reporting of PS studies using the ACS-NSQIP database is overall satisfactory according to three established guideline checklists. However, studies mostly lacked a discussion on the effect of missing data, supplementary/raw information, unadjusted and adjusted estimates, and subgroup analysis. National databases such as the ACS-NSQIP play an important role in today's surgical research and adhering to reporting guidelines when utilizing these databases may help enhance the quality and credibility of PS research utilizing large databases.

Declaration of competing interest

The authors report no conflict of interest. This study did not receive any funding.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2021.06.012.

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