SUBJECT: NCSES Statistical Standards for Information Products

DATE: November 04, 2021

Scope

These standards apply to any publicly available information product from the National Center for Science and Engineering Statistics (NCSES) that goes through a statistical review.

Purpose

These standards were written to ensure that publicly available information products from NCSES are of high quality and statistically robust. These standards include the following:

- Provide guidance for authors whose publications require statistical review;
- Codify standards for statistical review that are currently taking place;
- Meet statistical reporting requirements as established by the Office of Management and Budget (OMB)[1]; and
- Ensure internal consistency in how data and associated statistical conclusions are presented.

For products intended for broader distribution to a non-technical audience (e.g., presentations, workshop proceedings, and brochures), authors should consider the audience and use judgement when characterizing statistical conclusions. Depending on the audience, it is not necessary for authors to use statistical jargon to characterize a statistically significant difference, as long as the language used can accurately describe the comparison. NCSES mathematical statisticians are available to help authors with any language questions that may arise.

Overview

NCSES publications should be policy neutral, technically precise, error free, and well-written. Policy neutral means that NCSES publications must not contain policy recommendations. Technical precision means that the publication has used statistical analyses, comparative tests, and inferences that are based on appropriate statistical procedures. To help ensure technical precision, authors should consult with NCSES mathematical statisticians for technical guidance before developing an analysis plan to ensure that the analytic techniques and mathematical formulas used are appropriate for the goals of their publication. Error free means that the publication does not contain any

mathematical errors within the text or the table. Authors should consult the *NCSES Data Quality Checklist and Procedures Guide* for guidance on working toward high-quality and statistically robust publications.

Requesting Waivers to the Standards

If an author is not complying with these standards or if they anticipate that they may be unable to comply with any requirements of these standards, the author must apply for a waiver. Waivers to any of the listed standards may be granted when warranted. Waiver requests must include a written statement discussing the rationale for the deviation and any anticipated effects that may result from the deviation. The deviation must be approved by the program director with concurrence from the chief statistician.

NCSES Statistical Standards for Information Products

Subject: Statistical Review

Standard 1.1: Statistics in NCSES publications must be generated using verified data (i.e., data that have been checked for accuracy) and must also undergo internal review for accuracy in calculations, analytic conclusions, and presentation of information.

Standard 1.2: Authors must provide to their reviewers all the necessary information (e.g., underlying data tables, standard errors, and price deflators) to conduct a satisfactory review.

> **Guideline 1.2a:** Authors must provide to their reviewers detailed citation for each data source used in the publication. Data citations for review should include the data provider, title, year of publication, publisher or distributor, URL, identifier, or other access location.

> **Guideline 1.2b:** Authors must save and make available to their reviewers any copies of downloaded data, metadata, and associated documentation that was used for the publication.

> **Guideline 1.2c:** Authors must save codes, output, or spreadsheets containing interim analyses performed to produce the statistics, associated sampling errors, and statistical testing reported in the publication.

> **Guideline 1.2d:** Authors must fill and submit the attached checklist (see Appendix 1) with all other supporting documentation to the reviewer to facilitate an efficient statistical review.

> **Guideline 1.2e:** Summary of data checking

Standard 1.3: In rare occasions, if an author cannot meet one of these statistical review standards, they must provide to all reviewers the rationale for not doing so along with an approved waiver from the program director and chief statistician.

Subject: Data Sources and Limitations

Standard 2.1: Any subject matter or methodological literature referred to within the publication (e.g., references to pertinent theories or statistical techniques) must be cited in the document and be made available to the statistical reviewer, if requested.

Standard 2.2: For publications that include NCSES survey data, a link to the survey webpage and associated reference period (if applicable) must be included in the document.

Standard 2.3: For publications that use different data sources, check for consistency in definitions and note any definitional differences (e.g., which disciplines are included in science and engineering) between the sources and how they might affect conclusions.

Standard 2.4: The limitations of the data and an explanation of how the methodology and the data limitations may affect the results must be addressed.

Standard 2.5: Include general statements in the data sources and limitations section discussing sampling error (if applicable) and nonsampling error. Examples of nonsampling error sources include nonresponse, errors in processing, false information provided by respondents, errors in the questionnaire, coverage or frame errors, measurement errors, and other nonsampling errors suspected to be associated with a particular survey.

> **Guideline 2.5a:** If the author finds that detailing the errors associated with a publication creates an overly lengthy data limitations section, the author may refer readers to the survey webpage for more details.

Standard 2.6: Errors that could influence the results of the analysis must be explicitly addressed (e.g., high imputation rate or editing rate for a variable used in the analysis).

Standard 2.7: Sources of error specific to the publication must also be addressed.

Subject: Statistical Inference

Standard 3.1: The minimum significance level for statistical testing is 0.10.

> **Guideline 3.1a:** Deviations that exceed the minimum level must be justified and approved by the program director with concurrence from the chief statistician.

Standard 3.2: Significance levels must be stated in the methodology (or comparable) section of the publication.

> **Guideline 3.2a:** Blanket statements about the significance level are acceptable: "All statistical tests were conducted at the 10% significance level unless specifically noted."

> **Guideline 3.2b:** Within the same publication, the author can switch to a different significance level, but this must be explicitly stated in the text.

Standard 3.3: All inferences based on sample surveys should consider sampling error associated with reported estimates. Comparisons of estimates must be supported by statistical testing. Comparison statements include, but are not limited to, equal to, higher, lower, bigger, smaller than, greater than, and exceeds.

Standard 3.3a: Text must clearly state whether each comparison is statistically significant.

Guideline 3.3a: Where possible, use a blanket statement, indicating the significance level for all comparisons made in the text. Please see standard 7.3 for instructions on tabular data.

- For example: "All comparative statements in this report have undergone statistical testing, and unless otherwise noted, all comparisons are statistically significant at the 0.10 significance level".

- If the blanket statement is used, authors must note any comparative statements that do not meet the significance criteria established in the blanket statement directly in the text.

Standard 3.3b: Results that are not statistically significant cannot be discussed in a way that indicates statistical significance.

- For example, the following statement is not acceptable for a non-statistically significant result: "Among employed SEH doctorate holders in 2008, there were higher percentages of Blacks (58%) and Asians (55%) than other racial groups (34%–47%) employed in education.

- An accurate way to write the above statement would be: "The percentages for doctorate holders employed in education in 2008 were 58% Black, 55% Asian, and other race groups ranged from 34% to 47%."

Standard 3.3c: For comparisons where the point estimate is statistically the same, it is acceptable to say that the estimates are "statistically unchanged" or "statistically the same."

- For example, "The percent of Hispanic doctoral recipients is statistically the same as the rate of Black doctoral recipients."

Standard 3.3d: For comparisons where the point estimates are different, but not statistically significant, avoid making statements about the equality of population estimates that are based on sampling. It is not acceptable to say, "The poverty rate remained unchanged." It is acceptable to say, "not statistically different." Similarly, presenting a list of items ranked on sample-based point estimates (i.e., ranked) represents a set of statistical comparisons. All comparisons among the ranked items must be statistically significant to allow publication.

Standard 3.4: Any tables or figures included in a publication must note statistically significant differences between the point estimates displayed in the graph.

Guideline 3.4a: Blanket statements summarizing the results of statistical tests within a table or figure are acceptable: "The point estimates in this figure have undergone statistical testing, and unless otherwise noted, all comparisons are statistically significant at the 0.10 significance level."

Subject: Assumptions and Methodology

Standard 4.1: A discussion of any assumptions used in conducting the analysis must be included within the text or as a footnote.

Standard 4.2: A description of any statistics that differs from our standard measures—means, medians, totals, ranking, percentages, ratios, percentiles (25th, 75th, etc.)—must be included within the text or as a footnote.

Standard 4.3: Any methodology that differs from our standard methodology with respect to weighting procedures or to handling of nonresponse must be investigated and justified. A description of the methodology must be included within the text or as a footnote.

Subject: Constant vs. Current Dollars

Standard 5.1: If dollar amounts are presented in a time-series table or graph, specify whether the amounts are in current or constant dollars. Include a note defining how the dollars were adjusted to reflect constant dollars.

> **Guideline 5.1a:** The decision to use current or constant dollars is made on a case-by-case basis. Some factors to consider when making this decision are (1) the duration of the analysis, (2) the inflation rate across the duration of the analysis, and (3) the country of interest for the analysis.

Standard 5.2: A sentence explaining the differences in making comparisons between current and constant dollars should be included as well (e.g., comparisons in constant dollars are adjusted for inflation and deflation and provide a more accurate picture of expenditure trends).

Standard 5.3: If the author switches between current and constant dollars in the same product, then it must be made clear which metric is being used.

Standard 5.4: The price deflator used to convert current to constant dollars should be explicitly stated either in the text or as an endnote.

Subject: Consistency of Reporting within a Publication

Standard 6.1: Calculations in data products performed to produce summary statistics (e.g., percentages or percent changes between values) must be calculated using numbers reported in the publication.

> **Guideline 6.1a:** Data products where rounding is used to prevent disclosure must adhere to the above standard.

> **Guideline 6.1b:** If the author chooses to report precise percentages based on unrounded numbers not shown in the publication, they must include a footnote describing this. For example, "Reported percent changes are based on unrounded data not shown here."

Subject: Tabular Data

Standard 7.1: All tabulations generated from sample surveys must present weighted estimates.

Standard 7.2: All tabulations must account for missing or invalid data items (e.g., footnotes for missing items due to confidentiality and unreliability).

>**Guideline 7.2a:** A single footnote that combines confidentiality and unreliability suppressions is acceptable.

Standard 7.3: Within a table, if any differences are identified as statistically significant, then all statistically significant differences must be similarly identified in all tables. Authors are not required to identify statistically significant differences in the table.

Standard 7.4: Tabulations must be formatted to promote clarity and comprehension of the data presented.

>**Guideline 7.4a:** Examples of formatting practices that promote clarity include the following:
>
>- Presenting at most four dimensions in a cross-tabulation.
>
>- Labeling all variables.
>
>- Labeling the type of statistics being presented (e.g., frequency, percentage, means, and standard errors)
>
>- Presenting totals and subtotals when appropriate.
>
>- Labeling columns for each page in multi-page tabulations.
>
>- Indicating when a value is suppressed for disclosure or unreliability issues.
>
>- Providing a title of the table.
>
>- Specifying the units of measured used within the table.
>
>- Providing a source or citation for the table.
>
>- Specifying the time period of the data within the table.
>
>- Tables and figures should avoid misleading differences (e.g., ranking, differences between population groups) if uncertainty measures are not presented.

Subject: Writing Results

Standard 8.1: Authors must avoid using subjective language (e.g., feel, think, or believe) and avoid using normative language (i.e., statements that include a value judgement) when reporting the results of their analyses.

Standard 8.2: Descriptive statistics should not be presented as statements that imply they are the result of a random event. Thus, authors must avoid characterizing comparative frequencies or proportions with statements such as more likely, likely, or less likely.

Subject: Official Statistics

Official statistics are NCSES products that are subject to the National Science Foundation (NSF) Information Quality Guideline (IQG).[2] The NSF IQG is designed to ensure and maximize the quality, objectivity, utility, and integrity of information, including statistical information. The IQG also establishes administrative mechanisms allowing affected persons to seek and obtain correction of information maintained and disseminated by the agency that does not comply with the OMB guidelines or NSF guidelines. InfoBriefs and Data Tables are common vehicles that NCSES uses to disseminate official statistics.

Standard 9.1: To acquire data for producing NCSES official statistics, the author must consult the chief statistician during the design phase and the post-data collection evaluation phase to ensure the source data meets the quality standards in the NSF IQG.

> **Guideline 9.1a:** The author must consult stakeholder requirements and expectations to identify the intended official statistics and provide detailed description including the following:
>
> • Definition of top-line estimates
>
> • Key data items and key estimates
>
> **Guideline 9.1b:** The author must consult mathematical statisticians or the chief statistician to ensure the study designs or survey design is aligned to support the target precision and accuracy of the intended official statistics.
>
> **Guideline 9.1c:** Close adherence to what was documented in the Information Collection Request previously approved by OMB. Any significant deviations should be highlighted and justified.

Standard 9.2: The statistical quality of official statistics must undergo rigorous program review, statistical review, and receive approval by the chief statistician for releasing.

> **Guideline 9.2a:** The reliability of official statistics must meet the following quality criteria:
>
> • The estimated coefficients of variation for top-line estimates are less than 5%.
>
> • The estimated coefficients of variation for the majority of the key estimates are less than or equal to 30%.
>
> **Guideline 9.2b:** The indicators of accuracy of official statistics must meet the following quality criteria:
>
> • Unit response rates > 60%.
>
> • Item response rates > 70%.
>
> • Coverage ratios for population groups associated with key estimates are > 70%.
>
> At the discretion of the chief statistician, the above thresholds may not apply if the results from an appropriate nonresponse bias analyses are at an acceptable level.

Distribution, Enforcement, and Cancellation

These standards were distributed by the NCSES Chief Statistician, apply to all NCSES employees, replace the Statistical Standards for Information Products released on September 1, 2020, and are effective until replaced or cancelled.

Revision History

Version	Date	Section	Description	Approver
1.0	09/01/2020	Throughout	Initial version	Samson Adeshiyan
2.0	11/04/2021	Throughout	Incorporated format and editorial revisions. Revised text in standards 1.1, 8.1, and 9.2. Added standard 8.2.	John Finamore

Appendix 1: Statistical Publication Standards Checklist

Standard/ Guideline	Check	Yes	N/A	Notes
1.1	NCSES publication estimates have been generated using verified data that has undergone internal review for accuracy.			
1.2	All necessary documentation to conduct a statistical review has been supplied to the reviewer.			
1.2a	Authors must provide to their reviewers detailed citation for each data source used in the publication. Data citations for review should include the data provider, title, year of publication, publisher or distributor, URL, identifier, or other access location.			
1.2b	Authors must save and make available to their reviewers any copies of downloaded data, metadata, and associated documentation that was used for the publication.			
1.2c	Authors must save codes, output, or spreadsheets containing interim analyses performed to produce the statistics, associated sampling errors, and statistical testing reported in the publication.			
1.2d	Authors must fill and submit the attached checklist with all other supporting documentation to the reviewer to facilitate an efficient statistical review.			
1.2e	Summary of data checking.			
1.3	Any requested exceptions have been approved by the author's program director and the NCSES chief statistician and documentation granting the approval has been submitted in support of the statistical review.			
2.1	All subject matter or other methodological literature referred to within the publication has been cited within the document.			
2.2	If NCSES survey data is used in the publication the links to the survey webpage are included in the document.			
2.3	For publications that use a variety of data sources, any differences in construct definition or other variables are noted within the document.			
2.4	Any data limitations and its potential impact on the publication's results are addressed within the publication.			
2.5/2.5a	The publication includes any necessary statements about both sampling and nonsampling error.			
2.6	Any errors that significantly influence the results of the analysis have been addressed within the publication.			
2.7	Any error sources that are specific to the publication under review must be addressed in the publication.			
3.2	The statistical significance level for any testing has been stated in the methodology section.			

Standard/ Guideline	Check	Yes	N/A	Notes
3.3/3.3a	Comparison statements based on sample surveys must be supported by statistical testing. The publication's text clearly states which tests are statistically significant.			
3.4	Statistically significant differences in tables/figures have been clearly stated in the graph or text.			
4.1	Any assumptions made when conducting the analysis have been discussed in the publication.			
4.2	Any non-standard statistics have been described within the publication and been discussed during a consultation phase with a math-stat.			
4.3	Any non-standard methods used during statistical processing (e.g., weighting, imputation) have been discussed within the publication.			
5.1	The publication clearly states if constant vs. current dollars have been used in any time-series graph.			
5.2/5.3	Any price deflators that were used in a publication must have been explicitly discussed in the publication. Any switches between current and constant dollars are explicitly stated within the document.			
5.4	The price deflator that was used to convert current to constant dollars has been explicitly stated in the publication.			
6.1	Any calculations made in data products performed to produce summary statistics have been calculated using numbers reported in the publication.			
6.2	Percentages used the minimum number of significant digits to communicate the point.			
7.1	Tables generated from sample surveys have been presented weighted estimates.			
7.2	All tabulations account for missing or invalid data items (e.g., confidentiality, unreliability).			
7.3	Statistically significant differences are consistently noted in tables			
7.4	Table formatting has been completed in accordance with these standards.			
8.1	The publication does not include subjective language and does not include normative language when reporting the results of the analysis.			
8.2	The publication does not include comparison statements that use the term 'likely' when presenting descriptive statistics.			

Notes

[1] https://www.whitehouse.gov/omb/information-regulatory-affairs/statistical-programs-standards/

[2] https://www.nsf.gov/policies/docs/nsfinfoqual.pdf