Data in the *MMWR*

A purposive review with recommendations

Contents

1 Summary

The original purpose of this project was to develop and propose guidance for *MMWR* authors, reviewers of *MMWR* reports, and *MMWR* scientific editors. This version is adapted for sharing with learners, as a collection of examples of closely reviewing public health reports. We reviewed 56 full reports published between January 2019 and May 2022, to identify specific practices regarding presentations of data, analytic methods and results, tables and graphics, and interpretation of results. We also reviewed guidance from journals, the American Statistical Association, the International Committee of Medical Journal Editors, and related sources.

For this assessment, we adapted general principles regarding *style*, *accuracy*, and *significance* from existing norms for presenting and reviewing statistics in peer-reviewed articles. We focused on clarity, precision, and accuracy in presenting data, analysis, results, and interpretation. We consulted current practices for presenting data-oriented elements in narrative text, tables, and figures and considered how to balance important details with concise presentation formats. Finally, we recommended changes geared toward style, accuracy, and significance, mindful of *MMWR*'s purpose, orientation, and house style.

This assessment led with issues of clarity and style in text, tables, and figures as seen in 5 example reports, followed by issues of accuracy and significance seen in 3 published reports. The broader assessment of 56 reports was then organized around 4 themes:

- Design choices and constraints: What data were used?
- Analysis and formal results: What do the data show?
- Results in context and beyond: What do the data signify?
- Additional practices: How else might data presentation improve?

MMWR could clarify matters of style and precision, such as conditions for naming software and analytic methods in text, tables, and figures; practices for comparing values directly, usually as differences or ratios; improvements in use of statistical inference and shedding outmoded practices; and modernizing tables and figures. In addition, *MMWR* could clarify matters of accuracy and significance. Authors should emphasize public health significance, including how calculated values are interpreted in context, and they should deemphasize statistical significance, especially binary inferences. *MMWR* could also refine how reports place findings and context and link reports to recommendations.

2 Introduction and overview

The purpose of this project was to develop and propose guidance for (1) *MMWR* authors, (2) reviewers of *MMWR* reports before they reach *MMWR* scientific editors, and (3) *MMWR* scientific editors.We reviewed 56 full reports published between January 2019 and May 2022, to identify specific practices regarding presentations of data, analytic methods, analytic results, tables and graphics, and interpretation of results. We also reviewed guidance from journals, the American Statistical Association (ASA), the International Committee of Medical Journal Editors (ICMJE), and related sources.

This report is largely qualitative but informal. We sought a rich variety of topics and treatments published over a 41-month period before and during the Covid-19 pandemic. About half have a high Altmetric attention score relative to other reports published around the same time; scientific credibility is especially important in active social discourse. The other included reports had prompted methodological consultation by editorial staff or authors during review and production, so that these reports presented particular interest regarding correctness of methods and clarity in expression.

2.1 Principles

The *MMWR*'s weekly reports are CDC's "primary vehicle for scientific publication of timely, reliable, authoritative, accurate, objective, and useful public health information and recommendations." (MMWR 2025) Many *MMWR* reports, especially full reports, apply statistical and other data-analytic methods to describe, keep up with, and intervene on evolving issues in public health practice. This report assessed how reports present and interpret data and data analysis.

ICMJE recommendations (2025) urges authors to "[d]escribe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to judge its appropriateness for the study and to verify the reported results." For this assessment, we adapted general principles regarding *style*, *accuracy*, and *significance* from existing norms for presenting and reviewing statistics in peer-reviewed articles.

Style: Many elements of *MMWR*'s editorial style support the series' authority and consistency, such as article structures and format, the use of third-person voice, certain typographical conventions, and the application of scientific norms. Beyond authority and consistency, reports should strive for both precision and clarity, and they should avoid ambiguity. Since *MMWR* limits full reports to 1,400 words, authors must take special care to focus on important details and concise exposition. The principles of information design can guide editorial choices regarding tables and figures. (For a classic treatment of style, see Williams and Colomb (2009).)

Accuracy: *MMWR*'s authority is also rooted in its scientific integrity, reliability, and credibility, which in turn depend on accuracy and transparency. The principle of accuracy calls for data, methods, results, and interpretations to be technically correct and defensible. Data should be suited to the public health purpose of the report. Methods for managing and analyzing data should be suited to the purpose and the data. Results should be suited to the purpose, data, and methods. And interpretations should match the purpose, data, methods, and results.

Significance: *MMWR* seeks to publish timely and useful public health information and recommendations to save lives and protect people from health threats. As data-related practices, norms, and methods evolve—such as guidance from ICMJE and the ASA and practices in data visualization—the *MMWR*'s

house style should adapt in line with those external forces, much as it has with changes in digital technologies for communication and engagement. This report's recommendations were intended to guide those adaptations.

By examining a set of *MMWR* reports that motivate methodological consultations, high public engagement, or both, this report intended first to check how well published reports achieve clarity, demonstrate accuracy, and explain the real-world significance across a variety of topics. On consulting with outside norms for presenting and reviewing statistics in peer-reviewed articles, we looked for ways to improve how *MMWR* full reports present and interpret data and data analysis with ever greater clarity through style, integrity through accuracy, and impact through significance.

In this assessment we applied the following guiding principles:

- Focus on clarity, precision, and accuracy in presenting data, analysis, results, and interpretation
- Balance important details with concise presentation formats
- Consult current practices for presenting data-oriented elements, including inferences, in narrative text, tables, and figures
- Recommend changes geared toward style, accuracy, and significance, mindful of *MMWR*'s purpose, orientation, and house style

2.2 Scope of selected publications

To delineate the scope of reports for review, we used 2 data sources—*MMWR* online and Altmetric score data—to narrow the scope to no more than 60 articles. For this review, we limited consideration to volumes and issues published between 2016 (volume 65) and May 2022 (volume 71, issue 21), immediately before this project began. From volume 65, issue 1, through volume 71, issue 21, *MMWR* published 2,711 reports, including weekly reports, recommendations and reports, surveillance summaries, and supplements. Among 2,548 weekly reports, report categories include 1,437 full reports and 1,111 reports in other categories, including announcements, cover boxes, errata, grand rounds, notes from the field, notices to readers, outbreak reports, quick stats, retraction, and Vital Signs.

To focus on data and analyses while including substantive pre-Covid coverage, we further limited consideration to 845 full reports published between January 2019 and May 2022. We grouped contiguous issues, ranging in size from 16 to 28 full reports, from which we selected about 1 report per grouping. We considered 2 additional criteria: (1) reports that received higher Altmetric attention scores (Altmetric Glossary 2020) than other reports published within the same few weeks, and (2) reports on which an author, a clearance official, or an *MMWR* editor sought technical consultation during review or production. Taking these criteria together, we purposefully selected 56 full reports for review. Appendix 8 contains the complete list of reports included in this review.

2.3 Scope of auxiliary sources

We reviewed existing guidelines for statistical presentation in, and review of, scientific literature. Although the *MMWR* is not peer-reviewed, it is supported by a tiered sequence of reviews, including CDC clearance, ad hoc subject-matter review, and editorial review by *MMWR* staff. We considered lessons and advice on peer review processes to the extent that they might apply or be adapted to *MMWR*.

ICMJE recommendations (2025) states that authors should "[d]escribe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to judge its appropriateness for the study and to verify the reported results." Bailar and Mosteller (1988) offered guidelines for statistical

reporting in articles for medical journals, comprising 15 numbered statements focusing on manuscript preparation. Many medical journals cite or have adapted Bailar and Mosteller's recommendations. Several, but not all, of their guidelines would apply to *MMWR* reports. Other authors have also adapted or expanded on guidelines for authors; see, for example, Lang and Altman (2016).

Altman (1998) advises statistical reviewers for medical journals: "The main reason for the plethora of statistical errors is that the majority of statistical analyses are performed by people with an inadequate understanding of statistical methods. They are then peer reviewed by people who are generally no more knowledgeable. … The main areas for the statistical reviewer to consider are design, methods of analysis, presentation of results, and interpretation."

2.4 Report identifiers

Each full report is identified by its digital object identifier (DOI) suffix consisting of an 8-10–character string of the form "mmXXYY[YY]wZ[Z]", where "mm" signifies a weekly report, *XX* is the 2-digit volume, *YY[YY]* is the 2-digit or 4-digit issue number, *w* is either "e" (for early release) or "a" (for reports published on-cycle), and *Z[Z]* is a 1-digit or 2-digit number indicating approximate pagination order and ensuring that each identifier is unique. This format goes back to volume 47, with regular use from volume 48, issue number 17 to the present.

The full DOI is of the form 10.15585/mmwr.mmXXYY[YY]wZ[Z].

2.5 Observations and recommendations

The epidemiological literature contains varied advice on how to report descriptive or causal analyses, including Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) in Vandenbroucke et al. (2007) and Lesko et al. (2022). This assessment applied broader components focusing on the uses and interpretation of data, organized in 4 main sections:

1. Section 4: What data are used in the report? What design choices and constraints influence how well those data might address the public health question of interest?
2. Section 5: What do the data show? What analytic methods did authors use, and how did they present the results of those methods, in narrative, tabular, or graphical form?
3. Section 6: What do the data signify? How did the authors place data, methods, and results into the context of public health, including discussion and any recommendations?
4. Section 7: What additional practices could improve the uses and presentation of data in reports?

Each section contains a more refined set of topics, along with principles, observations, and recommendations.

- **Principles**: Each topic addresses a principle or principles, citing sources where possible.
- **Observations**: Each topic lists specific observations from assessed reports (citing each report) or a general summary of issues seen in multiple reports.
- **Recommendations**: By comparing observed practices with motivating principles, each topic lists a recommendation or recommendations, which might be general or might be more narrowly directed to authors, reviewers, or editors.

3 Example issues in full reports

As a prelude to the more comprehensive review, this section describes 8 sample reports that present notable challenges in clarity, accuracy, or significance. The following sections place these examples in the context of reviews organized by how data, methods, analysis, results, and interpretation appear in the 56 full reports reviewed here.

3.1 Clarity and style in text, tables, and figures

3.1.1 Report mm6827a2 (Su et al. 2019)

2019-07-12;68(27):604-607. Workplace secondhand tobacco smoke exposure among U.S. nonsmoking workers, 2015.

In this report, staff of the National Institute for Occupational Safety and Health (NIOSH) analyze data from a NIOSH-sponsored component of the NCHS-coordinated National Health Interview Survey. The primary results concern the contrasts in workplace exposure to secondhand smoke between those with frequent exposure and those with any exposure. The report presents 16 industry categories and subcategories. For each of the 16 categories, the report tabulates the estimated percentage of workers, together with 95% confidence intervals (CIs), with any secondhand smoke exposure. Corresponding estimates of frequent secondhand smoke exposure are reported for a subset of 9 categories; for the other 7 categories, the result is given only as "NS", meaning that the estimated prevalence in the latter group was "not significantly different from reference group" at the 0.05 significance level.

This report's approach goes against preferred practices for presenting statistical inferences in at least 4 ways: First, point estimates and CIs should be presented for all 16 categories, not only those for which the contrast is on the wrong side of a binary cutoff. Second, since the report seeks to identify differences in exposure within industry categories, it should also include estimates for the contrasts in prevalence, such as the prevalence in the frequent-exposure group minus that in the any-exposure group, along with CIs for those differences. Third, the report should include *P*-values for each of those contrasts, not just a binary result. Finally, and most importantly, the report should go beyond listing industries with apparently significant difference in workplace exposure to secondhand smoke by interpreting or otherwise commenting on the magnitudes of those within-industry contrasts; without those assessments, a reader has a limited basis for seeing the public health relevance and significance of the currently implicit contrasts, much less the extent to which the differences might be attributed to a real phenomenon versus background sampling variation.

3.1.2 Report mm6841e3 (Siegel et al. 2019)

2019-10-18;68(41):919-927. Update: Interim guidance for health care providers evaluating and caring for patients with suspected e-cigarette, or vaping, product use associated lung injury — United States, October 2019.

This summary follows up on the summary of report mm7039e3 (Budzyn et al. 2021) (below) and focuses on the sole figure in report mm6841e3 (Siegel et al. 2019). The figure contains 2 panels. The left panel contains bars with superposed intervals, depicting percentages with CIs (of persons needing intubation). The right panel contains bars with superposed intervals, depicting means with CIs (of number of days in hospital). The figure does not describe the methods for constructing the CIs. Some authors call

this kind of graphic, where elements include error bars (segments with end caps) superposed on bars, "dynamite plots" (Irizarry, 2019). Empirical research shows that readers often misinterpret them.

Whereas readers often correctly interpret bar charts of counts, percentages, and counts per unit population, they frequently misinterpret these bar charts when coupled with error bars. Specifically, many readers exhibit "within-the-bar bias" (Pentoney and Berger 2016), in which they infer that values within the enclosed rectangle of the bar are more likely than values outside the bar. In the figure in this report, the issue is compounded by placing the lower limits of the error bars against the dark fill in the bars representing percentages, thereby obscuring them.

As mentioned above, readers have an even harder time with bars representing means of quantities other than counts. Thus, the righthand panel in the figure is even more challenging to interpret than the lefthand panel. The contents of each panel could be replaced by dot plots with error intervals, which have empirically demonstrated advantages over bar charts.

3.1.3 Report mm6924e1 (Czeisler, Tynan, et al. 2020)

2020-06-19;69(24):751-758. Public attitudes, behaviors, and beliefs related to COVID-19, stay-at-home orders, nonessential business closures, and public health guidance — United States, New York City, and Los Angeles, May 5–12, 2020.

This report summarizes results from web-based surveys of "attitudes, behaviors, and beliefs related to COVID-19, stay-at-home orders, nonessential business closures, and public health guidance" contrasted by geography (table 2: all United States, New York City, or Los Angeles) and by respondent characteristics (table 3: gender, age group, or ethnicity). The report does not adequately convey how the analysis accounted for a web-based convenience sample with a 59% response rate. Reported margins of error are not explained. Analytic methods are underexplained only as "chi-squared statistics". And analytic methods and software are omitted; Jupyter Notebook is not analytic software but an environment that accommodates many analytic programs (including Julia, Python, and R, together giving Jupyter its name).

Tables 2 and 3 contain 108 significance test results, reporting 3 tests for each of 36 contrasts. Among those test results, *P*-values are reported as follows: 43 as "<0.05", 1 as a quantified value <0.05, and 64 as quantified values >0.05 (either as "1.0" or with 4 decimal places). As presented, these results do not give the reader a basis for assessing the extent to which various contrasts are incompatible with a null hypothesis of no difference. Thus, beyond the ambiguities in its methodological issues, the report's presentation of statistical inferences inverts preferred practices for presenting statistical inferences, in which, if *P*-values are reported, they should be most informative at lower values (e.g., <0.05 or 0.1). Thus, the report should have specified *P*-values under, say, 0.10 with 3 decimal places; values above 0.10 could have been expressed using 2 decimal places.

3.1.4 Report mm6939e2 (Leeb et al. 2020)

2020-10-02;69(39):1410-1415. COVID-19 trends among school-aged children — United States, March 1–September 19, 2020.

This report summarizes 6.5 months of Covid-19 cases, demographic characteristics, underlying conditions, hospitalizations, ICU admissions, and deaths among children, stating, "These results can provide a baseline for monitoring trends and evaluating mitigation strategies." The report also says, "Analyses are descriptive; statistical comparisons were not performed." The report omits structured inferences based on a probability model.

The second figure in this report, which superposes line graphs on stacked bars, runs afoul of at least 3 preferred practices for statistical graphics. First, by superposing elements that correspond to distinct vertical scales, the graphic sets up an arbitrary visual relationship between elements following one scale (line graphs for percentage positive, tracking 0-16 percent) in relation to elements following the other scale (stacked bars tracking total number of tests, tracking 0-350,000). Dual scales present a well-known problem with the potential to manipulate relationships, confuse a reader, or both. Furthermore, the quantities depicted do not have a direct relationship to each other; they encode different kinds of information related only through their connection to SARS-CoV-2 tests. Indeed, the line graphs independently depict percentages over time within 2 age groups, but the bar elements stack to depict cumulative frequencies over time. Second, the vertical axis on the left-hand side breaks between 16 and 100. This practice hypercorrects for the opposite consideration: that somehow a graphic depicting percentages is prone to manipulation if the scale does not include both 0 and 100. Third, by superposing line graphs on filled bars, the graphic makes it difficult to see the lines where they overlay bars, especially when rendered in grayscale.

3.1.5 Report mm7039e3 (Budzyn et al. 2021)

2021-10-01;70(39):1377-1378. Pediatric COVID-19 cases in counties with and without school mask requirements — United States, July 1–September 4, 2021.

This brief report (about 750 words with only 1 figure) presented an early look at apparent trends in Covid case counts among children, contrasting counties by requirements for masks in schools, with the primary intention to assess whether masking policies might have discernible impact on Covid epidemiology over a 2-month period—a causal evaluation.

As an attempt early in the pandemic, the report includes limited information in an evolving situation, in a limited number of counties over a limited time duration. This report raises at least 4 concerns regarding methods for analysis, presentation, and interpretation: First, the ecological, county-based analysis applies linear regression to case counts, adjusting for several county-level characteristics obtained from the American Community Survey and other sources. The authors do not explain their choice of a linear model rather than a loglinear model; nor do they reckon with the consequences of that choice. Second, the report presents the overall effect as follows: "After controlling for covariates, school mask requirements remained associated with lower daily case rates of pediatric COVID-19 ($\beta = -1.31$; 95% confidence interval = −1.51 to −1.11) ($p<0.001$)." Apart from noting a statistically significant negative association, the authors do not interpret the magnitude in terms of public health relevance or significance. The reader is not told, for example, if this result means that mask-requiring counties saw an average reduction of 1.3 pediatric cases (or cases per 100,000 children) per week compared to counties that did not require masks. In contrast, the authors do interpret other observed rate patterns earlier in the report. The authors go on to claim, "The results of this analysis indicate that increases in pediatric COVID-19 case rates during the start of the 2021–22 school year were smaller in U.S. counties with school mask requirements than in those without school mask requirements."

Third, the graphical presentation in the figure violates several preferred practices for statistical graphics. Foremost, the graphic uses bars to represent differences of means, which could be negative. The field of data visualization has generally moved away from bar elements in most graphics, motivated by empirical evidence that readers misinterpret many kinds of bar charts—especially those representing means and those representing values that are not inherently positive. The graphic ambitiously attempts to set up for many contrasts in county-level case counts per unit population: between weeks before and after the

start of school, between shorter and longer time durations, and between counties with and without school mask requirements. Nonetheless, the figure does not quantify the contrast between counties, which is the main effect of interest. An improved graphic, or set of graphics, would both avoid the flaws of bar charts for the intended effect and accommodate the contrasts of primary interest.

Fourth, the authors note that "this was an ecologic study, and causation cannot be inferred." Nonetheless, they go on to state, "School mask requirements, in combination with other prevention strategies, including COVID-19 vaccination, are *critical to reduce the spread* of COVID-19 in schools. [emphasis added]" While this is an important talking point that might be supported by other data, it was not supported by the analysis in this report.

3.2 Accuracy and significance

3.2.1 Report mm7006e2 (Joo et al. 2021)

2021-02-12;70(6):212-216. Decline in COVID-19 hospitalization growth rates associated with statewide mask mandates — 10 states, March–October 2020.

This report applies a regression model and method rooted in econometric literature (Courtemanche et al. 2020). Report mm7010e3 (Guy et al. 2021) uses the same method. Although both reports interpret the regression model coefficient as the "percentage point change" between modeled time points, this interpretation does not follow mathematically from the stated model. Thus, the report is unable to state the public health interpretation and significance of the derived results.

3.2.2 Report mm705152a3 (Wanga et al. 2021)

2021-12-31;70(5152):1766-1772. Characteristics and clinical outcomes of children and adolescents aged 18 years hospitalized with COVID-19 — six hospitals, United States, July–August 2021.

In its discussion section, this report on clinical outcomes of children hospitalized with Covid-19 asserts strong claims about the value of Covid vaccination: "[T]his study demonstrates that unvaccinated children hospitalized for COVID-19 could experience severe disease and reinforces the importance of vaccination of all eligible children to provide individual protection and to protect those who are not yet eligible to be vaccinated. These data highlight the importance of COVID-19 vaccination for those aged ≥5 years and other prevention strategies to protect children and adolescents from COVID-19, particularly those with obesity and other underlying health conditions." A similar statement appears in the opening paragraph: "[F]ew vaccine-eligible patients hospitalized for COVID-19 were vaccinated, highlighting the importance of vaccination for those aged ≥5 years …." The analysis as presented does not support these claims, despite their public health significance.

The report opens by noting that vaccines were recommended for those 12 years and older in mid-May 2021 and for those 5-11 years as of early November 2021. The data cover children hospitalized during July and August 2021. Among 713 children admitted for Covid-19 without multisystem inflammatory syndrome, 441 were under age 12 years (hence ineligible for vaccine) and 272 were between 12 and 17 years (13 fully or partially vaccinated, 196 not vaccinated, and 63 unknown). No children aged 5-11 years were vaccinated.

Although the report goes on to contrast children's characteristics by age group (table 2) and certain morbid conditions (table 3), no further analysis directly addresses vaccination status. Furthermore, this study contains no information about the health status and outcomes of nonhospitalized children by

Covid status, age group, or comorbidity. Therefore, the study contributes nothing to the evidence regarding vaccination among children and hospitalization or other health outcomes—*neither* whether vaccinated children are more or less likely to be hospitalized *nor* whether, among hospitalized children, those who are vaccinated are more or less likely to experience comorbid ("underlying") conditions. Thus, while the claims in the discussion might be borne out by other information, they are not supported by the report itself. The report might show "that unvaccinated children hospitalized for COVID-19 could experience severe disease", but it does not link the occurrence or severity of that disease to vaccination status. This report might show that <95% of eligible hospitalized children were not vaccinated and therefore highlight the value of continuing to expand vaccine coverage, but it neither "reinforces the importance of vaccination of all eligible children to provide individual protection and to protect those who are not yet eligible to be vaccinated" nor "highlight[s] the importance of COVID-19 vaccination … to protect children and adolescents from COVID-19."

3.2.3 Report mm7121e1 (Bull-Otterson et al. 2022)

2022-05-27;71(21):713-717. Post–COVID conditions among adult COVID-19 survivors aged 18–64 and ≥65 years — United States, March 2020–November 2021.

This report received substantial public engagement, in part because of its visual abstract. The topline message proclaimed, "The absolute risk difference between the percentage of case-patients and controls who developed an incident condition was 20.8 percentage points for those aged 18–64 years and 26.9 percentage points for those aged ≥65 years. This finding translates to one in five COVID-19 survivors aged 18–64 years and one in four survivors aged ≥65 years experiencing an incident condition that might be attributable to previous COVID-19."

This message does not match the methods in the report, in that the time at risk (that is, over follow up from index date to event or terminal date) varies, and the analysis provides no information about the influence of this variable follow-up. The value that the report calls an "absolute risk difference" is instead a difference in cumulative incidence, which is not the same. The report should either state additional, strong hypotheses about differential follow-up or, better, apply analytic methods that are tailored for differential follow-up, namely time-to-event or survival methods. In contrast, 2 similar *MMWR* reports do use time-to-event methods: Report mm7102e2 (Barrett et al. 2022) uses IQVIA and HealthVerity data to assess risk for newly diagnosed diabetes in children, and report mm7131a3 (Kompaniyets et al. 2022) uses HealthVerity data to assess post-Covid symptoms and conditions among children.

Beyond the mismatch between methods and message, this report also asserts that, by subtracting the nominal frequency among control patients from the nominal frequency among case patients, the result yields the frequency of "incident conditions that might be attributable to previous COVID-19." Despite acknowledgements of possible selection bias—where it might be more likely to find incident conditions in case-patients—and that the magnitude of the presented result is consistent with other literature, the topline claim is not directly supported by the analysis in this report.

4 Design choices and constraints: What data were used?

4.1 Describe data sources in anticipation of analysis and interpretation

Principle: Clearly describe data sources (whether commercial or noncommercial), sizes, and structures, including information about choices and constraints. Include information that will influence analysis and interpretation, such as selection criteria and biases, quality, completeness, missingness, inclusions, exclusions, and losses.

Observations: Reports consistently describe data in sufficient detail. Reports from web-based surveys include mm6924e1 (Czeisler, Tynan, et al. 2020), mm6932a1 (Czeisler, Lane, et al. 2020), and mm6949a2 (Gilbert et al. 2020). Reports from electronic health records include mm6802a1 (García et al. 2019), mm6911a5 (Schieber et al. 2020), mm7114e1 (Block et al. 2022), and mm7121e1 (Bull-Otterson et al. 2022).

Recommendations:

1. Current practice is strong. *MMWR* or CDC could develop guidance for authors on how to relate characteristics of data to analysis and interpretation, especially for emerging and nontraditional data sources and types, such as web-based surveys and other convenience samples; administrative, claims, and electronic health records; fusion of multiple data sources; and wastewater and other ecological measures.
2. Reports do not typically need to indicate data management technology, such as REDCap, dplyr (R package), or pandas (Python library), unless data management practice or technology substantively influences analysis, interpretation, or potential reproducibility.

5 Analysis and formal results: What do the data show?

This section covers methods of analysis, including basic descriptive summaries and model-based approaches, as well as presentation and basic interpretation of results in textual narratives, tables, and figures. By formal results, we mean qualitative and quantitative values and their mathematical interpretations. The next section addresses interpretation of results within the context of public health.

5.1 Describe methods, including software

Principles:

1. A report should give enough information about data-analytic methods—including purpose, name, and software implementation—that a knowledgeable reader can confidently trace workflow from data sources through analytic methods to formal results. (Bailar and Mosteller 1988)
2. Assumptions behind statistical methods should be provided in sufficient detail to justify, and if possible to replicate, the analysis. Consequences of assumptions should be acknowledged.
3. Specify software used for analysis, including the main program(s) and important specialized packages, libraries, or modules. (Compare Bailar and Mosteller (1988).)

Observations:

1. In some cases, a report describes its analytic purpose without directly naming the method. For example, mm6802a1 (García et al. 2019) describes the STL procedure without naming it: "smooth temporal trends were statistically separated from annual seasonal components using locally weighted regression". This example predates the MMWR practice of reporting analytic software.
2. Analytic software (e.g., SAS, R, Python, Stata, SUDAAN) is consistently reported since early 2019. In some cases, data management software (e.g., REDCap) and analytic environments (e.g., Jupyter Notebooks and RStudio) are also reported. For REDCap examples, see reports mm6920e2 (James et al. 2020), mm6936a5 (Fisher, Tenforde, et al. 2020), mm7021e1 (Gettings et al. 2021), and mm705152a3 (Wanga et al. 2021). For Jupyter Notebooks and RStudio, see mm6924e1 (Czeisler, Tynan, et al. 2020) and mm7121e1 (Bull-Otterson et al. 2022), respectively.

Recommendations:

1. For each substantive method, a report should state an unambiguous name or its general purpose; if space permits, report both. Recommended wording appears with specific examples below.
2. Guidance should clarify which software to report, namely, software that is directly relevant to analytic methods: main analytic software and important procedures, packages, or libraries (e.g., GLIMMIX in SAS, randomForest in R, sklearn in Python). Reports need not name computing environments (e.g., Jupyter or RStudio) unless these substantively affect analysis.

5.2 Describe quantities, including outcomes

This section covers summary quantities that can be calculated without a regression (or similar) model. Examples include mean, proportion, rate, ratio, variance, range, and standard error.

Principles:

1. Descriptive quantities are properly named.

2. Descriptive quantities are formatted with sufficient precision—the number of significant digits and number of decimal places—to offer meaningful distinctions but no more than supported by the resolution of the data. Format precision is consistent across quantities of similar type. (NEJM)

Observations:

1. In some cases, the word "rate" is used for a proportion. For example, mm6817a3 (Kariisa et al. 2019) reports the number of deaths per 100,000 population, standardized to the 2000 Census population, as "death rates"; the authors might be implicitly treating the unit as 100,000 person-years. Report mm7037e1 (Scobie et al. 2021) does the same. In contrast, report mm7043e2 (Xu et al. 2021) presents standardized mortality rates as the number of deaths per 100 person-years.
2. Some reports use as many as 9 significant digits, typically for count values in large datasets or populations; see reports mm6802a1 (García et al. 2019), mm6911a5 (Schieber et al. 2020), and mm7104e1 (León et al. 2022). Report mm7121a2 (Sapkota et al. 2022) formats mean weekly counts and corresponding CIs with up to 7 significant digits.
3. No reviewed reports regularly format numeric values with 3 or more decimal places (except for *P*-values, discussed below).
4. Some reports have large variation in the number of significant digits, in part because of rounding practices. For example, the table in mm7023e2 (Christie et al. 2021) has a column with values ranging from 0.2 (1 significant digit, 1 decimal place) to 9,008 (4 significant digits, 0 decimal places).

Recommendations:

1. Ensure consistent use of the terms *proportion*, *rate*, and *ratio*, each of which pertains to the result of dividing one number (the numerator) by another (the denominator).

   Proportion: The numerator and denominator have the same units, both are typically nonnegative integers, and the numerator is typically smaller than the denominator. A proportion is unitless and typically expressed as a fraction or percentage.

   Rate: The numerator and denominator have different units, both are typically nonnegative, the numerator is typically smaller than the denominator, and the denominator unit typically incorporates time or space. A rate is not unitless, e.g., *X* incident cases per person-year.

   Prevalence is typically a proportion, so "prevalence rate" would not make sense. When incidence is a proportion, "cumulative incidence" is a better descriptor. As a rate (e.g., infections per person per year), either "incidence" or "incidence rate" is acceptable.

   Ratio: See below.

2. Develop a house style that considers *both* the number of decimal places when rounding *and* the number of significant digits.

   a. The number of significant digits is mathematically of deeper importance and should therefore take primary consideration. In general, we recommend preserving 2-4 significant digits throughout a report. Exceptions might include large, precisely quantified sample and subsample sizes and some official statistics. Derived values should generally be reported with 4 or fewer significant digits.
   b. The number of decimal places, typically 0-2, should be chosen in a way that generally preserves the intended number of significant digits. Where reported values, especially derived values, vary by 2 or more orders of magnitude, some smaller values should be formatted with additional decimal places. Terminal zeroes should be preserved when consistent with the number of significant digits and number of decimal places.

c. Recommendations for formatting ratios, model-based estimates, *P*-values, and confidence intervals appear below.

5.3 Compare quantities: differences and ratios

Principles: When a set of quantities is to be compared, it is best to contrast them directly, usually as a difference or a ratio, and to assess the contrast. In practice, the difference or ratio can be constructed either empirically, such as by taking the difference of 2 means or the ratio of 2 prevalence estimates, or in a model, such as the difference between 2 coefficients in a regression model. Formal inference procedures, if any, are then applied to the contrast.

Observations:

1. Report mm7023e2 (Christie et al. 2021) is an example with at least 4 kinds of contrast in a single table: rate ratios comparing rates between age groups (with confidence intervals) and absolute change in proportion, relative change in rate, and relative change in rate ratio—3 comparisons between time points, with binary significance test results but not CIs.
2. Report mm6817a3 (Kariisa et al. 2019) presents absolute and percent changes in rate between time points, with binary significance test results but not CIs.
3. Reports mm6827a2 (Su et al. 2019) and mm7039e3 (Budzyn et al. 2021) present measures of primary effects and statistical tests for whether those primary effects differ (beyond statistical variation), but neither report directly quantifies the actual contrasts that are being tested.
4. Report mm7041a2 (Bohm et al. 2021) presents model-based, age-standardized prevalence, median, 75th centile, and 90th centile, each accompanied by a 95% CI. Some comparisons between values, such as the prevalence, frequency, and intensity by sex, are described as statistically significant, but the numerical differences between values are not presented, with or without CIs or a measure of the variability of the difference.
5. Report mm7121e1 (Bull-Otterson et al. 2022) presents cumulative incidence and point incidence as event rates per 100 person-months. Cases and controls are compared in terms of differences in cumulative incidence (described in the report as absolute risk difference) and incidence rate ratios (RRs). These contrasts are only informally compared between 2 age groups. For example, the report states, "The RR [incidence rate ratio] for cardiac dysrhythmia was significantly higher among patients aged 18–64 years (RR = 1.7) compared with those aged ≥65 years (1.5)." It does not directly quantify the contrast between these ratios, nor does it quantify the variability in the ratio of ratios.
6. Report mm7047e1 (DeSisto et al. 2021) analyzes the risk for stillbirth among women with and without Covid-19 at delivery hospitalization, overall and among subsets of mothers with various cooccurring conditions. Adjusted risk ratios for stillbirth are presented in each of 2 time periods (before and during periods where the delta variant predominated), and interaction terms in regression models support formal comparison and significance testing between the RRs before and during the delta-predominant period. The report does not, however, quantify or interpret the interactions. For example, the report states, "During the pre-Delta period [stillbirths involved] 0.98% of deliveries with COVID-19 compared with 0.64% of deliveries without COVID-19 (aRR = 1.47; 95% CI = 1.27–1.71). During the Delta period [stillbirths involved] 2.70% of deliveries with COVID-19 compared with 0.63% of deliveries without COVID-19 (aRR = 4.04; 95% CI = 3.28–4.97). … the risk for stillbirth was significantly higher during the period of Delta predominance than during the pre-Delta period (p<0.001)." The reader is not told, however, that the relative risk was 2.75 times as high during the later period as compared to the earlier period, much less given a CI for the 2.75 interaction term. Nor are any other before-during contrasts formally quantified.

7. Report mm7037e1 (Scobie et al. 2021) presents age-standardized incidence rate ratios (IRRs) together with 95% CIs, and it qualitatively compares pairs of IRRs without either a formal significance test or CI. For example, "Age-standardized IRRs for cases in persons not fully vaccinated versus fully vaccinated decreased from 11.1 (95% CI = 7.8–15.8) during [period 1] to 4.6 (95% CI = 2.5–8.5) during [period 2] …." Although the reader is given a sense of the variability in each individual IRR estimate, the contrast between the paired IRRs is neither quantified nor its variability described.

Recommendations:

1. Ensure that differences, such as the (absolute) risk difference are labeled, described, and interpreted correctly.
2. Ensure that ratios are labeled, described, and interpreted correctly.

   Ratio: one number divided by another, typically capturing a relative measure, such as prevalence ratio, odds ratio, and hazard ratio.

   Both a prevalence ratio and an odds ratio can be interpreted qualitatively as indicating that one event is more or less likely than another event. Only a prevalence ratio can be interpreted quantitatively as "Event *X* is 1.2 *times more likely* than event *Y*." An odds ratio must be interpreted as"Event *X* has 1.2 *times the odds* of event *Y*."

   With odds ratios, it is acceptable to provide a qualitative interpretation of "more likely than" (if the OR > 1) or "less likely than" (if the OR < 1). It is incorrect, however, to provide a quantitative interpretation of an OR using the word "likely". For example, an OR of 1.3 *does not* mean that some event is 30% more likely than the contrasting event; rather, it means that the event has 30% greater odds. In limited circumstances, especially with rare events, an OR may be interpreted as approximating a prevalence ratio. When this is done, the approximating interpretation should be explicitly acknowledged. "Because cancer *X* is rare, we may interpret the OR of 1.04 from our case-control study as indicating that event *A* occurs about 4% more often [or was about 4% more likely] than event *B*."
3. Where analysis compares quantities, it is best to present differences or ratios directly, even if the components being compared are also presented. The practical significance of a result typically pertains to these quantified contrasts moreso than the values being compared.
4. Adopt terminology that is unambiguous. The terms "risk ratio" and "relative risk" can be used for several kinds of ratios. A more specific term should be used, such as "prevalence ratio" or "hazard ratio", where such usage aids clarity.

5.4 Adjust quantities: standardization and regression models

Principles:

1. Standardization methods should indicate, and ideally justify, the reference population or distribution used for standardization. In 1998, the Department of Health and Human Services issued a policy (ASPE 1998) directing that "the population standard used for age adjusting death rates [be] the year 2000 projected population."
2. Each type of regression model should be sufficiently described and justified. Details might include model form and family (e.g., linear, logistic, loglinear; Gaussian, Poisson, negative binomial), important variations in curve types (e.g., linear, quadratic, joinpoint, segmented, and fractional polynomials), extensions to handle correlation (e.g., generalized estimating equations [GEE] or

mixed-effects models, along with their clustering factors and correlation or covariance structures), or other salient features and underlying assumptions.

Observations:

1. Many reports in this review standardize mortality and other measures to the age distribution of the 2000 Census; see mm7034e5 (Griffin et al. 2021), mm7037e1 (Scobie et al. 2021), mm7041a2 (Bohm et al. 2021). This method is called indirect standardization. In contrast, report mm6911a5 (Schieber et al. 2020) standardized to each of 11 specific years (2008-2018) and report mm7043e2 (Xu et al. 2021) standardized to an internal distribution, called direct standardization.
2. A large proportion of the reports that are reviewed here present regression models. Reports generally adequately describe values that are standardized (as in the previous observation) or adjusted through a regression model. Model-based results typically include only elements of focus (outcome and a few predictors or covariates), commenting on ancillary covariates but not tabulating them; this is consistent with preferred practice for selectively repeating only a subset of tabulated values in narrative text. When both unadjusted and adjusted values are presented, reports generally adequately describe them.

Recommendations:

1. When standardizing ratios or rates, the reference population should be stated and justified explicitly.
2. Describe how continuous predictors are included, including functional form (such as quantized values) and methods for detecting linearity and nonlinearity.
3. Describe efforts to select models through iteratively adding or removing predictor terms, and describe the implications for interpreting results.
4. Important model parameters should be interpreted correctly and in context. Focus on the main association of interest. Scale model components to aid in interpretation (e.g., age in decades rather than years).
5. Develop basic guidance on how to present and interpret common or recurring procedures, such as generalized estimating equations (GEE), joinpoint, and interrupted time series.
6. Annual percent (not percentage) change (APC) and its variants, such as the average annual percent change (AAPC), can be calculated empirically or from a loglinear regression model. Therefore, when an APC is reported, the method for calculating it should also be stated.
7. Terminology
    a. Instead of "crude", use "unadjusted" or "empirical"; these terms correspond to "adjusted" or "model-based".
    b. Instead of "modified Poisson regression", use "Poisson regression with robust variance [or standard error] estimates".
    c. Reserve "dose-response" for situations where an intervention is doses. Alternatives include "exposure-response" (when appropriate) and "functional association [or relationship]" where the notion of dose, exposure, or response does not apply.

5.5 Draw conclusions under incomplete information

This section covers the use of statistical significance tests, *P*-values, and confidence intervals. These are conventional frequentist procedures for drawing inferences from statistical analysis, typically relative to a null hypothesis. We do not cover Bayesian inference here, as Bayesian methods remain rare in *MMWR* full reports.

Principles: The ASA and ICMJE, as well as other professional organizations and numerous journals, have commented extensively on the use and interpretation of *P*-values and confidence intervals. In current practice, ASA and ICMJE recommend the following:

"Scientific conclusions and business or policy decisions should not be based only on whether a p-value passes a specific threshold. … Proper inference requires full reporting and transparency." (Wasserstein and Lazar 2016)

"Distinguish between clinical and statistical significance." (ICMJE recommendations 2025)

1. "Avoid sole reliance on statistical hypothesis testing, such as the use of *P*-values, which fails to convey important quantitative information." (Bailar and Mosteller 1988)
2. "In general, *P*-values larger than 0.01 should be reported to 2 decimal places; those between 0.01 and 0.001 to 3 decimal places; and *P*-values smaller than 0.001 should be reported as *P*<0.001." (NEJM) Exceptions exist, such as intention to support multiple comparisons.
3. Appeals to nonoverlapping CIs "should not be used for formal significance testing unless the data analyst is aware of its deficiencies and unless the information needed to carry out a more appropriate procedure is unavailable." (Schenker and Gentleman 2001) This heuristic is an unnecessary and weak shortcut that overemphasizes a binary significance result, against prevailing guidance from professional societies and journals. Thus, the method should be used only in the rare circumstances when there is no feasible alternative; when it is used, it should be strongly justified.

Observations:

1. The full reports in this review consistently state the intended level for statistical significance (almost always 0.05) and coverage probability for confidence intervals (almost always 95%).
2. The report text usually states the specific methods for constructing significance tests and confidence intervals, or they give information from which a reader can determine how inferential procedures were applied.
3. In contrast, tables and figures do not consistently state the specific methods for constructing significance tests and confidence intervals. See the subsequent discussion of tables and figures for specific examples.
4. When the slope of a line segment is not statistically significantly different from 0, it might or might not be appropriate to interpret the segment as indicating no appreciable change over time. Reports mm6817a3 (Kariisa et al. 2019) and mm6844a1 (O'Neil et al. 2019) use the word "stable" in this context. For example, "Joinpoint regression examining changes in trends [in rates] were considered to increase if APC >0 (p<0.05) and to decrease if APC <0 (p<0.05); otherwise rates were considered *stable*[emphasis added]." This conclusion ignores how series can exhibit variation that is noisy or nonlinear but still yield $P > 0.05$.
5. The table in report mm6827a2 (Su et al. 2019) contains cell values marked "NS", with no further quantitative content, described in the table footnote as "not significantly different from reference group". Other cells in the same column contain point estimates with 95% confidence intervals.
6. The table in report mm6911a5 (Schieber et al. 2020) contains 95% confidence intervals, together with footnote marks indicating "Pearson's chi-squared test was significant (p<0.001) compared with [a specified referent]".
7. Tables 2 and 3 in report mm6924e1 (Czeisler, Tynan, et al. 2020) report *P*-values as either "<0.05" with footnote "*P*-value is statistically significant (p<0.05)" or as a number greater than 0.05 formatted to 4 decimal places.
8. Report mm7034e5 (Griffin et al. 2021) incorrectly interprets the Kruskal-Wallis test: "Differences in the percentages of infections by vaccination status were calculated using … Kruskal-

Wallis tests *for medians*. [emphasis added]" Kruskal-Wallis does not, in general, compare medians, unless the shapes of the respective distributions under comparison are also the same. Instead, the Kruskal-Wallis test compares whether one distribution tends to take on lesser or greater values than another.

9. Table 1 in report mm705152a2 (Lutrick et al. 2021) formats all *P*-values to 3 decimal places, ranging from 0.002 to 0.941, with a single *P*-value formatted as ">0.999".
10. The table in report mm7121a2 (Sapkota et al. 2022) formats mean weekly counts of emergency department visits and their 95% CIs as full precision with 4-7 significant digits and 0 decimal places. Mean counts range from 1,413 to 1,451,717, and CI limits range from 1,356 to 1,463,581.
11. Reports mm6817a3 (Kariisa et al. 2019), mm7041a2 (Bohm et al. 2021), and mm7121e1 (Bull-Otterson et al. 2022) all appeal to nonoverlapping CIs.
12. Several reports include dozens or hundreds of simultaneous confidence intervals or significance tests.

Recommendations: Since the criticized practices are deeply entrenched, these recommendations focus primarily on placing inferential procedures in context and emphasizing other aspects of drawing conclusions and reporting them. The following recommendations pertain to both significance tests and CIs.

1. Follow ICMJE and ASA guidance on use of inferential procedures
    a. Avoid emphasizing binary conclusions.
    b. Prefer confidence intervals or other interval estimates over *P*-values.
    c. Don't conclude absence of an effect when it is not "significant" (e.g., "stable" for slope not significantly different from 0), unless the conclusion also appeals to adequate statistical power or other justification.
2. It is acceptable to report both a CI and a *P*-value. If only 1 is reported, favor the CI. Not every method admits an interpretable CI, such as Fisher and Pearson tests for contingency tables.
    a. When reporting both a CI and a significance test result, it is acceptable to state whether or not the test is statistically significant at a specified level. It is better to report both the CI and *P*-value.
3. Ensure that the interpretation of a *P*-value or CI is correct. Both the *P*-value and the CI are calculated based on a specific dataset and can therefore be interpreted as characterizing results from data relative to a hypothesis—whether the observed data are compatible with that hypothesis—not whether a given hypothesis is supported, proven, or disproven.
    a. In general practice, a significance test result that is negative may not be interpreted as indicating the absence of a meaningful effect. For example, a slope parameter that is not statistically significantly different from 0 may not be interpreted as indicating being constant, flat, or stable, unless additional assumptions or analyses are presented to support the stronger claim.
4. A test or a CI for a comparison should be applied directly to the comparison itself, such as a difference or ratio.
5. Appeals to overlapping or nonoverlapping CIs should be reserved for exceedingly rare cases where they are the only option.
6. When a report includes a large number of significance test results or CIs, address the potential for spurious significance, sometimes called *P*-hacking. As with other inferential procedures, multiple simultaneous procedures should be interpreted for both their public health significance and in the context of statistical variability and potential bias.

Recommendations specific to significance testing: The following recommendations pertain to significance testing and *P*-values.

1. Mention the testing procedure by its correct, unambiguous name on the first occurrence of a *P*-value from that procedure.
    a. Since there are several chi-squared tests, ensure that tests for independence or homogeneity specify "Pearson" or "Pearson's", as in "Pearson's chi-squared test" (both of which are preferable to "Pearson's X^2 [or χ^2] test").
2. A *P*-value should typically be reported to 2 significant digits unless its value is less than 0.001. Specifically, for $P > 0.10$, report no more than 2 decimal places, and for *P* strictly between 0.001 and 0.10, report no more than 3 decimal places unless a result is meant to support adjustment for simultaneous inferences.
    a. Never report only "$P < 0.05$" for a specific text result.
    b. Never report merely that a result was "nonsignificant" (nor "NS"); always report a *P*-value or the intended test size.
3. If a result is described as statistically significant or nonsignificant, then state the size of the test, also known as type I error probability or "alpha". In *MMWR* reports, 0.05 is the most common. For example, "*X* has a *P*-value of 0.03, which is statistically significantly different from 0 at the 0.05 level."
4. Any test that is not 2-sided or 2-tailed should be explicitly described and justified. It is conventional to halve the significance level for 1-tailed tests (e.g., 0.025 when the 2-tailed test would be at 0.05 significance).
5. Never describe a test result whose *P*-value slightly exceeds the type I value as a "trend" or "approaching significance". Reserve "trend" for actual tests of trend (e.g., Cochran-Armitage or slope of a regression). (No reports in our review used the word "trend" as a hedge on statistical significance.)
6. When comparing continuous distributions, one may use the nonparametric Wilcoxon (or Mann-Whitney) and Kruskal-Wallis methods with normal or nonnormal data. It is incorrect to describe these tests as comparing medians without further assumptions.

Recommendations specific to confidence intervals: The following recommendations pertain to CIs.

1. Mention the CI construction procedure by name on the first occurrence of a CI from that procedure.
2. Format CI endpoints with the same precision as the corresponding point estimate. *MMWR* house style the lower and upper confidence limits in parentheses, delimited by an en dash when both values are nonnegative, as "(1.5–2.5)", or the word *to* when the lower limit is negative, as "(−2.5 to −1.5)". All CIs in a table should use the same format. See an example of the latter in report mm6911a5 (Schieber et al. 2020).
3. State the confidence level (i.e., intended coverage probability). In *MMWR* reports, 95% coverage is the most common.

5.6 Tables

Principles:

1. Tables in a main report should balance density against utility.
2. Data and analytic concepts are described with enough detail that the table can stand apart from its report. Analytic and inferential procedures are correctly named, often in a table's footnote.
3. Within a table, a reader should be able to cross-reference cells that are compared, e.g., with row or column percentages.

Observations:

1. Several tables densely format a large number of numeric values or footnote marks.
    a. Table 2 in report mm7041a2 (Bohm et al. 2021) contains over 1,500 numbers in 528 cells (88 rows and 6 columns of point estimates with 95% CIs). Table 2 in report mm7104e1 (León et al. 2022) contains 930 numbers (62 rows and 5 columns of point estimates with 95% CIs).
    b. The table in report mm6817a3 (Kariisa et al. 2019) contains 250 cells (among 66 rows and 4 columns) to which a significance test is applied, of which 184 have a footnote mark "†††". Table 2 in report mm6932a1 (Czeisler, Lane, et al. 2020) contains 112 cells to which a significance test is applied, of which 74 have a footnote mark "**". The table in report mm7023e2 (Christie et al. 2021) contains a large number of cells with footnote marks.
    c. The table in report mm6844a1 (O'Neil et al. 2019), table 2 in report mm6903a1 (Peterson et al. 2020), and the table in report mm6911a5 (Schieber et al. 2020) present both a large number of table cells and a large number of cells with footnote marks.
2. Tables rarely specify the name of significance tests, with a few notable exceptions.
    a. Table 2 in report mm6802a1 (García et al. 2019) indicates "multiplicity-adjusted Wald tests" and annotates some 95% CIs as "$p < 0.05$", "$p < 0.01$", or "$p < 0.001$".
    b. The table in report mm6817a3 (Kariisa et al. 2019) reports p "< 0.05" based on nonoverlapping CIs. (See separate comment about nonoverlapping CIs.)
    c. The table in report mm6911a5 (Schieber et al. 2020) annotates 95% CIs for which "Pearson's chi-squared test was significant ($p<0.001$) compared with [referent]". The same table also annotates when the average annual percentage change (AAPC) "was significantly different from zero at the alpha = 0.05 level", but the footnote does not indicate how AAPC point estimates or CI limits were calculated.
    d. The footnotes to tables 2 and 3 in report mm6924e1 (Czeisler, Tynan, et al. 2020) indicate that reported *P*-values were "calculated with Chi-squared test of independence".
    e. The footnote to table 1 in mm6930e1 (Tenforde et al. 2020) states that *P*-values are based on comparisons "using the chi-square test or Fisher's exact test."
3. No tables fully describe methods for CIs, though many partially describe regression procedures.
    a. Among 17 tables that report significance test results but not CIs, 2 tables record only dichotomous results; 2 tables in report mm6924e1 (Czeisler, Tynan, et al. 2020) record 4 digits if $P>0.05$ but "<0.05" otherwise; and, 13 tables record *P* with 2-3 digits. Among these 17 tables, 12 state the test method and 5 do not.
    b. Among 21 tables that report CIs but not significance tests, 5 report the CI method, and 16 do not.
    c. Among 21 tables that report both significance tests and CIs, 5 report *P* with 2-3 digits, 14 report dichotomous test results with stated significance level, only report mm6844a1 (O'Neil et al. 2019) records dichotomous results without a stated significance level, and only mm6802a1 (García et al. 2019) records a mix of quantified *P*-values and dichotomous test results with stated significance. The CI methods are stated for 1 table out of 21: mm7023e2 (Christie et al. 2021) indicates a parametric bootstrap but not which parametric model.
    d. Reports mm6802a1 (García et al. 2019), mm6844a1 (O'Neil et al. 2019), and mm6911a5 (Schieber et al. 2020) include tables that present APCs without indicating the source or method for APC estimates. Report mm6906a3 (Divers et al. 2020) table partially states the APC method.

Recommendations: These recommendations pertain to tables as a whole. See the recommendation specific to numerical format elsewhere in this report.

1. Balance table density against utility.
    a. A sparse table might work better as prose in lieu of a table.
    b. A dense, large, or complex table should be thinned out, simplified, or otherwise reduced in complexity, so that the reader knows what to focus on and how to connect the results in the table with the overall narrative, while preserving the transparency and integrity of the analysis.
    c. In some cases of complex data, a figure might be more suitable than a table.
    d. Where the full extent of a dense, large, or complex table is important—for example, as comprehensive documentation or as an official record—place the table in a supplement and alert the reader to the value and location of the more extensive tabulation.
2. Always name inferential procedures (how *P*s and CIs were obtained), typically in a footnote.
    a. It is preferred to state whether inferences are adjusted for multiple comparisons or simultaneous inferences. If it is stated, then the method must be named (e.g., Bonferroni or Holm).
3. Where contrasts are presented, explicitly note the reference value or category for the contrast. These often appear in table cells for categorical constructs with more than 2 values. For binary or dichotomous constructs, the referent may be stated in a label or a table footnote rather than its own table cell. For example, where 2 genders are analyzed and a contrast value is labeled as "female", it should be noted that the contrast is against "male".

5.7 Figures

Principles:

1. Figures follow modern visualization practices for statistical graphics, which include "Maximize the data-ink ratio" and "Forgo chartjunk." (Tufte 2018)
2. Bar charts, dot plots, and other graphic elements, with or without error bars, are used based in part on empirical research regarding their effectiveness. (Cleveland 1984; Correll and Gleicher 2014; Pentoney and Berger 2016; Irizarry 2019; Kerns and Wilmer 2021)
3. Axis scales and superposed elements are principled. (Few 2008; Healy 2016; Knaflic 2016; Ellis 2016; Muth 2018; Vigen 2024)
4. As with other figure elements, data and analytic concepts are described with enough detail that the figure can stand apart from its report. In particular, analytic and inferential procedures are correctly named, often in a figure's footnote.

For a more comprehensive treatment of composition and graphics, see Cleveland (1989), Cleveland (1993), Wilkinson (2005), and Wickham (2010).

Observations: This section summarizes salient characteristics of figures in the reviewed reports. section 8 contains detailed commentary on all 63 figures in the 41 reports that contain figures.

1. 6 figures use dual-scale axes, meaning that the scale on one side differs from the scale on the other.
2. 10 figures use broken axes, meaning that an axis has a visible gap meant to replace an even larger gap, as a way of reducing the total extent if the axis were unbroken. In most cases, the breaks allow the range of percentages to include 100, although not all figures with percentage scales include 100, and some other graphic types include breaks.
3. 2 figures are bar charts *without* intervals.
4. 3 figures are bar charts *with* intervals, also known as dynamite charts.

5. 14 figures exemplify issues of scale, including the extent of the axis relative to the extent of depicted data, the overall use of space, and the use of transformations like the logarithm.
6. 14 figures exemplify the use of visual reference features that do not directly depict data elements, including frames around graphic panels and fields as well as grids and other guides.
7. 6 figures use, or could use, scatterplot smooths.
8. 10 figures depict several intervals, either around dots or around points on a line graph. In most cases, a single interval around a dot need not have end cap; see, e.g., report mm7018e1 (Tenforde et al. 2021). Where the intervals appear at a sequence of locations on a line graph, the set of intervals could be replaced by shading a polynomial that covers the extent from the lower limits of the intervals (connected dot to dot) to the upper limits. Then the line graph appears in the interior of the pointwise confidence region. Overlap between shaded polygons can appear as a blended shade.
9. 7 figures contain partial information on estimation or inferential procedures.

Recommendations:

1. Maximize the data-ink ratio and forgo chartjunk.
    a. Render panels with 1 or 2 axes rather than 4-sided frames.
    b. Use bar charts sparingly and correctly. (See further details below.)
    c. Avoid using grids. If grids or other visual cues are used, such as a vertical line for visual reference, then deemphasize these elements relative to data elements. Typical methods include using thinner lines or lighter shades. Ensure that these elements appear in the background, with data elements in the foreground.
    d. Allow direct labeling of graphic components as an alternative to a legend.
    e. Adapt the vertical and horizontal extents of a graphic to the scale of the data.
2. Always name inferential procedures to say how *P*s and CIs were obtained, typically in a footnote.
3. Favor dot plots over bar charts.
    a. Reserve bar charts for counts or proportions, such as histograms and counts of incident events by date.
4. Where a graphic element, especially a dot plot, is presented with intervals, it is typically unnecessary to include end caps on the intervals.
    a. An exception: intervals where additional values outside intervals may appear as dots, as with conventional box-and-whisker plots.
    b. Where line graphs have multiple, pointwise intervals, use polygons with shading, giving the appearance of the main line graph appearing within a field between 2 outer line graphs.
5. Adapt the vertical and horizontal extents of a graphic to the scale of the data. Limiting axis extent helps to make better use of available space and reader focus.
    a. Allow axis extents to follow the empirical range of graphed elements more closely and on useful scales. For example, if graphed values extend vertically between 49 and 71, then it would be appropriate to construct a vertical axis from 50 to 70. The same concept applies to horizontal extents.
    b. It is not necessary to include an origin or reference value (e.g., 0 or 1) or maximum value (e.g., 100%) if the graphic can otherwise be constructed honestly without those reference values. Use a broken axis rarely.
    c. Use nonlinear scales where it makes sense to do so, but label axes or values on the original scale. For example, odds ratios, prevalence ratios, hazard ratios, and some chemical or pathogen concentrations can often be presented on a logarithmic scale.

6. A graphic should almost never contain components on multiple scales.
    a. If a graphic is presented with multiple scales, then the relationship between those scales should be carefully planned to avoid extorting data or relationships between data elements.
    b. If a graphic is presented with multiple scales, then ensure that superposed elements are not obscured.
7. When graphics contain multiple panels, ensure that a reader can relate the scales between components. For example, apply the same horizontal and vertical extents to each component, unless doing so obscures visual elements.
8. Assure that graphics render well in grayscale. Avoid hash patterns.
9. Promote use of superposition between scatterplots and smooths (e.g., segmented curves) or between different smooths (e.g., loess and segmented curves).

6 Results in context and beyond: What do the data signify?

This section addresses interpretation of results within the context of public health. In the previous section, we focused on analysis and formal results, primarily in terms of mathematical assumptions and interpretations. In this section, we examine how authors place their data, methods, and results into the context of public health, including discussion and recommendations.

6.1 Interpret effects and their significance

Calculated values, including values derived from models, should be interpreted in their public health context. First, what is the clinical or public health significance of a measured or derived magnitude of an effect? What does the effect size or contrast mean in public health practice? Second, while taking into account the variability or uncertainty that comes with data, how compatible is the effect size with a reference hypothesis about the world? Because the effect measure is estimated from data, the analyst can only say that the data are more or less compatible with the hypothesis of interest, not whether the hypothesis itself is true or false.

Principles: Measured effects of interest should foremost be described in terms of their public health (or clinical) significance and the variability or uncertainty that comes from using observed data. There's an inherent tension between stating findings and justifying interpretations on one hand and avoiding underinterpretation and overinterpretation on the other.

1. Interpretation of an effect must match the method(s) used to measure or derive the effect.
2. Always describe sources of uncertainty, including random variation and nonrandom influences on observation and measurement.
3. Statistical significance, if presented at all, should be used only to assess the compatibility of results with a background hypothesis, mindful of additional assumptions, potential biases, and variability.

Observations:

1. Report mm6903a1 (Peterson et al. 2020) relies exclusively on statistically significant differences above a population threshold to identify industry segments with higher than average proportions of suicides among civilian, noninstitutionalized working persons aged 16–64 years. The report states but does not further interpret the magnitude of the highest values.
2. Report mm6906a3 (Divers et al. 2020) limited the interpretation of results, which rely heavily on statistical significance. The following sentence in the discussion overinterprets changes that are not statistically significantly different from 0: "Since 2012, the rate of increase in type 2 diabetes has not changed, and has also remained constant for type 1 diabetes, except among Asians and Pacific Islanders." It is not clear whether this statement pertains to changes from 2012 to 2015 or contrasts between changes during 2002–2010 and 2011–2015. In either case, failing to reject a slope of 0 does not generally imply that the slope is 0.
3. Reports mm7006e2 (Joo et al. 2021) and mm7010e3 (Guy et al. 2021) present associations between mask-mandate policies and aggregated incidence values. Although the regression model that is used in both reports is attested in the literature, the analytic method does not admit a straightforward interpretation from which public health implications can be inferred.
4. Report mm7010e4 (Kompaniyets et al. 2021) fits logistic models with fractional polynomial terms to pick up nonlinear associations between body mass index and the risk of 4 possible outcomes. The report interprets the estimated probability of each outcome (conditional on specific BMI values) as risk, and it uses marginal-effect methods to estimate predictive margins, which

are interpreted as risk ratios. The methods and interpretation appear to be sound, with 3 considerations: (1) The finding of nonlinear associations through fractional polynomials is notable. The authors perform limited comparison to other functional forms for BMI, thus overinterpreting the specificity of the functional form. (2) In particular, they overinterpret the estimates for BMI values with the least risk and present those estimates without a sense of their variability (unlike the paper on which the methods are based (Wong et al. 2011)). (3) The use of predictive margins is uncommon in the MMWR, especially risk ratios (rather than odds ratios) derived from logistic regression; readers would therefore benefit from more guidance or references on the method and interpretation.

5. Report mm7043e2 (Xu et al. 2021) analyzes mortality risk associated with Covid-19 vaccines by comparing 6.4 million vaccine recipients to 4.6 million unvaccinated persons. The results indicate lower mortality among all vaccinated age groups ≥18 years, where all 95% pointwise confidence interval upper limits for adjusted relative risks are 0.82 or less. Among 12-17–year-old mRNA vaccine recipients, however, the relative risks are 0.85 and 0.73, and the upper limits of 95% CIs are 1.90 and 1.64. Therefore, when the report asserts that "there is no increased risk for mortality" and that "[t]his finding reinforces the safety profile", these claims should be limited to adults. The results in adolescents are subject to too much variability to support the strong claims.
6. Report mm7121e1 (Bull-Otterson et al. 2022) analyzes data in which persons under analysis have follow-up that varies in duration between 30 and 365 days. Thus the method yields cumulative incidence and does not admit a straightforward interpretation in terms of "absolute risk difference", although the report frames it in that way. With additional assumptions, the analysis could estimate the risk difference, but this report does not state or apply such assumptions.

Recommendations:

1. Reports should, by default, interpret the public health significance of the main reported values. Exceptions should be justified, with an explicit note that the public health significance remains to be determined.
2. *P*-values and CIs should be interpreted in the context of public health significance. It is insufficient to leave all inferential procedures to be interpreted on their own.
3. Avoid misleading implications by qualifying whether a statement comprises a comparison of observed magnitude or a formal inferential procedure.
4. "Avoid nontechnical uses of technical terms in statistics, such as 'random', 'normal', 'significant', and 'expected'." (Bailar and Mosteller 1988) The word "significant" and its variants and negations should always be qualified, at least on the first occurrence within a given context, as denoting statistical, clinical, public health, or other significance.

6.2 Describe potential impact to the extent possible

By design, *MMWR* full reports are often explicitly connected to assessing public health impact or recommending specific interventions through policy, education, vaccination, and other actions. Yet the nature of observational or incidental data especially complicates analyses for both descriptive and causal inference without additional, explicit assumptions. Causal concepts can be supported by, but almost never flow directly from, statistical analysis.

Principles: Reports should approach causal claims carefully and explicitly, with particular attention to assumptions and subject-matter context that go beyond statistics. It is especially important to relate clearly the inferential support from the report's analyses to all implicit or explicit claims or recommendations regarding public health actions and impact, and to avoid both understating what would need to be known and overstating the value of evidence presented.

A multinational, systematic assessment of causal and associational language in observational health research (Haber et al. 2022) screened 1,170 articles from 18 high-profile journals. In their discussion, the authors wrote the following (p 2094-2095):

> The practice of avoiding causal language linking exposures and outcomes appears to add little if any clarity. … Misalignment between the research question being asked and action implications is on its own a source of confusion, which could be avoided if the causal nature of the research question were made explicit. … Authors, reviewers, and editors should focus on being clear about what questions are being asked, what decisions are being informed, and the degree to which we are and are not able to achieve those goals.

Observations: We evaluate 4 (slightly overlapping) groups of reports on the ways that they handle explicit or implicit causal concepts: vaccine effectiveness, changes over time, expressions of causal intent, and linking reports to public health recommendations. Reports commonly describe the current state of a public health phenomenon or its state over time for one of a few purposes: to determine whether, when, and how to apply existing guidance; to set a baseline for further monitoring, especially with emerging conditions like Covid-19; or to monitor phenomena relative to existing knowledge. In some cases, reports help to set, affirm, or revise guidance.

1. **Vaccine effectiveness**: Among the reports reviewed here, 7 assess vaccine effectiveness, or the difference in untoward health outcomes between those who have received the prescribed vaccine regimen and those who have not, usually interpreted in the context of phase 3 randomized controlled trials. Report mm6806a2 (Doyle et al. 2019) covers influenza vaccines, and the remaining 6 reports cover Covid-19 vaccines: mm7011e3 (Britton et al. 2021), mm7013e3 (Thompson et al. 2021), mm7018e1 (Tenforde et al. 2021), mm7032e3 (Moline et al. 2021), mm7037e1 (Scobie et al. 2021), and mm705152a2 (Lutrick et al. 2021). These vaccine studies use 5 different study designs: Reports mm7013e3 and mm705152a2 apply hazard regression methods in prospective cohorts. Report mm7011e3 applies hazard regression in a retrospective cohort. Reports mm6806a2 and mm7018e1 apply logistic regression in a case-control or "test-negative" design. Report mm7032e3 applies Poisson regression in a hybrid cohort. And report mm7037e1 uses empirical estimation methods in ecological analysis of linked data sources. These reports show consistent care in addressing possible uncontrolled confounding, limited sample sizes (where applicable), consistency with signals from phase 3 trials, and acknowledgment of the relative strength of evidence conferred by each observational study design.
2. **Changes over time**: Here we focus on 8 reports that explicitly characterize results from before and after a reference event.
    a. The 5 reports that apply a version of piecewise linear spline regression can be distinguished by whether the location of a change point was preselected (e.g., to capture a change in policy or practice at a specified time) or data-driven (e.g., to help describe temporal changes) and whether the modeled relationship at changepoints was continuous or discontinuous. The 3 reports that assessed policy changes also used preselected change points: reports mm6802a1 (García et al. 2019) (continuous), mm6947e2 (Van Dyke et al. 2020) (discontinuous "segmented regression"), and mm7110e1 (Donovan et al. 2022) (discontinuous "comparative interrupted time series"). The other 2 reports, mm6906a3 (Divers et al. 2020) and mm6927a4 (Waltzman et al. 2020), used the joinpoint method to find data-driven change points, producing descriptive models that could be straightforwardly interpreted.
    Report mm6927a4 (Waltzman et al. 2020): "… it is difficult to tell whether decreases in injuries result from interventions, decline in participation, or a combination of both. … it cannot be determined whether the observed changes in the number of ED visits resulted from an actual change in incidence, care-seeking behaviors, or other reasons."

Report mm6947e2 (Van Dyke et al. 2020): "After implementation of mask mandates …, the increasing trend in COVID-19 incidence reversed. … [Mandated] counties … appear to have mitigated the transmission of COVID-19, whereas [nonmandated] counties continued to experience increases in cases. … The decreased COVID-19 incidence among mask-mandated counties in Kansas occurred during a time when the only other state mandates issued were focused on mitigation strategies for schools as they reopened in mid-August. … the ecologic design of this study and limited information on [behaviors and enforcement] limit the ability to determine the extent to which the countywide mask mandates accounted for the observed declines in COVID-19 incidence in mandated counties. … countywide mask mandates appear to have contributed to the mitigation of COVID-19 spread in Kansas counties that had them in place."
Report mm7110e1 (Donovan et al. 2022): "… this was an ecologic study … the pre- and postimplementation of mask policy analysis in a subset of 26 school districts could not separately investigate the impact of full and partial mask policies because of small sample sizes. … This investigation indicates that school mask policies were associated with lower COVID-19 incidence in areas with moderate to substantial community transmission."

b. Among the other 3 before-and-after reports that focused on empirical or model-based contrasts, report mm7010e3 (Guy et al. 2021) presents percentages, and reports mm7037e1 (Scobie et al. 2021) and mm7039e3 (Budzyn et al. 2021) present incidence rates. Report mm7010e3 (Guy et al. 2021) applies a weighted least squares model to calculate differences, with pointwise confidence intervals, before and after specified county-level policy changes. Report mm7037e1 (Scobie et al. 2021) presents age-standardized incidence values and patterns before and after predominance of the delta variant, stratified by vaccination status. Report mm7039e3 (Budzyn et al. 2021) contrasts empirical incidence values before and after a change in policy.
Report mm7010e3 (Guy et al. 2021): "In this study, mask mandates were associated with reductions in COVID-19 case and death growth rates within 20 days, whereas allowing on-premises dining at restaurants was associated with increases in COVID-19 case and death growth rates after 40 days."
Report mm7039e3 (Budzyn et al. 2021): "this was an ecologic study, and causation cannot be inferred …. The results of this analysis indicate that increases in pediatric COVID-19 case rates during the start of the 2021–22 school year were smaller in U.S. counties with school mask requirements than in those without school mask requirements."

3. **Causal intent**: Several reports directly address an intention to corroborate causation or to explicitly disavow a causal interpretation. Others address causal ideas indirectly through discussion of effect modification, evidence, or propensities. These reports typically distinguish results that are consistent with causal inferences from evidence of causation.

   a. *Causation*: Report mm7018e1 (Tenforde et al. 2021): "Postmarketing observational studies are important … to strengthen evidence from clinical trials of vaccine efficacy. … the case-control design infers protection based on associations between disease outcome and previous vaccination but cannot establish *causation*."
   Report mm7039e3 (Budzyn et al. 2021): "… this was an ecologic study, and *causation* cannot be inferred."
   Report mm7024e1 (Yard et al. 2021): "… this analysis was not designed to determine whether a *causal* link existed between these trends and the COVID-19 pandemic."

   b. *Effect modification*: Report mm7047e1 (DeSisto et al. 2021) states, "*Effect modification* by period was assessed using adjusted models with interaction terms." This statement

amounts to a causal claim; whereas "interaction" is a statistical concept, "effect modification" is a causal interpretation of the modeled interactions. The report otherwise takes care to describe associations rather than causal links. The interaction of interest contrasts adjusted relative risks (rate ratios from a loglinear model): 1.47 during the pre-delta period and 4.04 during the delta period, with a *P*-value < 0.001 for the contrast; the report does not, however, quantify or interpret this contrast (about 2.75).

c. *Corroborate*, *reinforce*: Report mm705152a2 (Lutrick et al. 2021): "The VE estimates described in this report for the Pfizer-BioNTech vaccine in real-world conditions during the period of Delta variant predominance *corroborate* and expand upon the VE estimates from other recent studies in adolescents and *reinforce* previous findings that current vaccination efforts are resulting in substantial preventive benefits among adolescents aged 12–17 years."

4. **Linking to recommendations**: In their discussion sections, reports typically place results in the context of previous understanding, practice, and policy. Among the reports reviewed here, 27 reports use words like *highlight*, *reinforce*, and *underscore* (to say nothing of similar words used in these and other reports, like *demonstrate* or *show*). These linking terms connect each report's subject to related recommendations. It is often unclear, however, whether these linking words are meant to convey that a report provides evidence for the cited guidance or only that the guidance relates to the subject of the report. We highlight 3 examples:

   a. Report mm6943e3 (Kambhampati et al. 2020): "These results are consistent with previously reported data suggesting that underlying conditions, including obesity, diabetes, and cardiovascular disease, are risk factors for COVID-19–associated hospitalization and ICU admission. … The findings in this report *highlight* the need for prevention and management of obesity … to reduce risk [among health care personnel] for poor COVID-19–related outcomes. … It is unknown whether HCP were exposed to SARS-CoV-2 in the workplace or community, *highlighting* the need for community prevention efforts as well as infection prevention and control measures in health care settings."

   b. Report mm7010e4 (Kompaniyets et al. 2021): "These findings *highlight* the clinical and public health implications of higher BMIs, including the need for intensive COVID-19 illness management as obesity severity increases … and policies to ensure community access to nutrition and physical activities that promote and support a healthy BMI. … These results *highlight* the need to promote and support a healthy BMI, which might be especially important for populations disproportionately affected by obesity, particularly … populations who have a higher prevalence of obesity and are more likely to have worse outcomes from COVID-19 compared with other populations. The findings in this report *highlight* a dose-response [*sic*] relationship between higher BMI and severe COVID-19–associated illness and *underscore* the need for progressively intensive illness management as obesity severity increases."

   c. Report mm705152a3 (Wanga et al. 2021): "Among pediatric patients with COVID-19–related hospitalizations, … few vaccine-eligible patients hospitalized for COVID-19 were vaccinated, *highlighting* the importance of vaccination for those aged ≥5 years and other prevention strategies to protect children and adolescents from COVID-19, particularly those with underlying medical conditions. … Approximately two thirds of patients hospitalized for COVID-19 aged 12–17 years had obesity. Compared with patients without obesity, those with obesity required higher levels and longer duration of care. These findings … *highlight* the importance of obesity and other medical conditions as risk factors for severe COVID-19 in children and adolescents. … this study demonstrates that unvaccinated children hospitalized for COVID-19 could experience severe disease and *reinforces* the importance of vaccination of all eligible children … These data *highlight* the importance of COVID-19 vaccination for those aged ≥5 years and other prevention

strategies to protect children and adolescents from COVID-19, particularly those with obesity and other underlying health conditions."

Recommendations:

Take care with implicit and explicit causal claims, including recommendations for public health interventions or other public health action.

1. State and address assumptions that are intended to support causal claims, especially from nonexperimental data. These assumptions, such as assumptions regarding confounders and mediators, often require careful justification because they cannot be directly tested.
2. Time-structured analyses, such as joinpoint, interrupted time series, and other time series methods, are especially prone to potentially specious causal claims. Pay special attention to efforts to capture, describe, and draw inferences from changes over time.
3. Be especially mindful of words that do or do not imply causal relationships:
    a. *Association* and *trend* assert quantifiable relationships without causal interpretation.
    b. The following words or phrases typically convey a causal interpretation: protect, harm, effective, increase/decrease risk, impact.
    c. Take care with *interaction* (a statistical concept) and the related but distinct *effect modification* (a causal concept).
4. When linking to related but distinct information, be clear about whether or not the report substantively supports or refutes the outside information. Otherwise, it can appear that the link implies substantive support, whether that is warranted or not.

6.3 Place interpretation in context, including limitations

MMWR full reports typically include a paragraph that enumerates limitations, in part to establish transparency, and in part to help the reader avoid overinterpreting results and potential implications.

Principles: Enumerated limitations should allow a reader to contextualize the interpretations of findings, including a sense of how the interpretations could differ if the setting or assumptions varied from those in the report.

Observations: The overwhelming majority (about 95%) of weekly reports contain a sentence worded as follows: "The findings in this report are subject to at least [number] limitations." Over the period under review in this report, 731 weekly reports (not just full reports) enumerated at least 1 limitation, with 104 (14%) listing 6-9 limitations. Among the 56 full reports under review, 55 report at least 1 limitation (all except report mm6841e3 (Siegel et al. 2019), a guidance document), and 11 (20%) list 6-9 limitations.

We summarize limitations from selected reports to demonstrate the range and variety.

1. Report mm7024e1 (Yard et al. 2021) lists 9 limitations related to representativeness, variation across sites and time, underreporting and incompleteness, and "this analysis was not designed to determine whether a causal link existed between these trends and the COVID-19 pandemic."
2. Reports mm7004e3 (Falk et al. 2021), mm7011e3 (Britton et al. 2021), mm7047e1 (DeSisto et al. 2021), and mm7104e1 (León et al. 2022) list 7 limitations each.
3. Report mm7001a4 (Leidner et al. 2021) is 1 of 6 reports listing 6 limitations, including misclassification, scope, and generalizability across geography, student populations, and time.

Recommendations:

1. Ideally, a limitation would be accompanied by the expected implication of that limitation for interpreting the results under discussion. This is especially true for limitations related to bias, unmeasured confounders, and causal claims. The examples above often, but not always, include such possible implications.
2. Ensure that limitations pertain to the reported data, methods, results, and interpretation and do not attempt to imply conclusions that are otherwise not supported by the particular study design or sample selection procedures.
3. Rather than enumerating each distinct limitation statement, consider grouping limitation statements conceptually, such as those pertaining to potential bias or that might limit generalizability.
4. If the number or weight of limitations is substantial, narrow the scope of the report's claims.

7 Additional practices: How else might data presentation improve?

This section recommends ways to enrich the resources available to readers outside of published reports, such as additional technical details, supporting data, and analytic code, while further enhancing focus in the report itself.

7.1 Intensive exposition of methods

Principle: Sophisticated, unfamiliar, or unconventional methods should be presented in balance with other detail while supporting focus on the public health issue and impact.

Observations: Some reports have extensive exposition on methods, either in the body of the report or in footnotes. Other reports might benefit from additional details, including reports mm6802a1 (García et al. 2019), mm6935a2 (Moreland et al. 2020), mm7001a4 (Leidner et al. 2021), mm7006e2 (Joo et al. 2021), mm7010e3 (Guy et al. 2021), mm7010e4 (Kompaniyets et al. 2021), mm7032e3 (Moline et al. 2021), and mm7110e1 (Donovan et al. 2022).

Recommendations:

1. *MMWR* should allow for technical supplements, just as supplemental tables and figures are supported. In addition, *MMWR* should develop guidance on how to ensure that reports that warrant technical supplementation maintain proper focus and scope within the body of the report. Alternatively, *MMWR* could develop guidance for authors to place methods in a technical report posted to a public resource besides CDC Stacks, such as prepublication archives.

7.2 Incorporate less familiar methods

Principle: Public health practice can and should gather information and learn through the full variety of available data types and analytic methods, whether familiar or unfamiliar. Examples of ascendent sources include electronic health records and wastewater. Methods with potential to enrich public health findings within the *MMWR* include, for example, economic methods and prevention effectiveness as well as machine learning, especially as applied to textual and image-based data. In all cases, data uses in *MMWR* should be rigorous and focus on public health relevance.

Observations:

1. Several reports analyze data from electronic health record services or vendors, including athenahealth in report mm6802a1 (García et al. 2019) and Cerner in report mm7212e1 (Chun et al. 2023), as well as systems fed by electronic health records or laboratory records as part of networks or programs (such as PCORnet and the National Syndromic Surveillance Program), state systems, and hospital systems.
2. Report mm6935a2 (Moreland et al. 2020) analyzed anonymized location data from mobile devices.
3. None of the reports reviewed here include economic analysis, but a few published reports do, including mm6646a3 (Marx et al. 2017), mm7015a1 (Luo et al. 2021), mm7048a1 (Peterson, Miller, et al. 2021), and mm7048a2 (Peterson, Luo, et al. 2021).
4. None of the reports reviewed here include machine learning as applied to text or image data, but a few published reports mention machine learning, as in report mm7044e1 (Bozio et al.

2021), or cite references pertaining to machine learning, as in report mm7049a3 (Miller et al. 2021).

Recommendations: Stimulate and cultivate a richer set of methods, perhaps through focused solicitation with guest editors, keeping tight focus on public health relevance and credibility.

7.3 Open data and analytic code

Principles: The Executive Branch has encouraged making data publicly available since 2013 and has signaled that federally supported publications will also be expected to make associated data and analytic code available in tandem with peer-reviewed publications. In addition, academia, government, and even the commercial sector have been advancing access to analytic code through public repositories, and many peer-reviewed journals require a statement regarding availability. (OSTP 2022; White House Office of Science and Technology Policy 2022)

Observation: While many reports cite publicly available data sources used within those respective reports, there is no current practice for sharing or describing availability of data or analytic code.

Recommendations:

1. Require a brief statement on availability of data and analytic code, including whether items are unavailable, available with restriction, or available without restriction.
2. Develop boilerplate text to describe common modes of availability.
3. Allow and encourage publicly available data, or data available through a specific, stable request process; data might be limited to machine-readable elements sufficient to reconstruct published and supplemental tables and figures.
4. Allow and encourage publicly available analytic code, or code available through a specific, stable request process, usually posted on a repository like GitHub.

MMWR reports selected for or cited in this review

8 *MMWR* reports selected for or cited in this review

8.1 MMWR reports selected for this review

The 56 full reports selected for this review are listed here in chronological order of publication, with links to their HTML and PDF versions on the *MMWR* website (labeled "PDF1"), a local copy of the PDF version (labeled "PDF2"), the citation as formatted in this review (i.e., "Author (year)"), as well as the publication date, volume, issue, pages, and title. (A trimmed, collated version has been compiled and posted for convenience.)

1. Report mm6802a1 (HTML | PDF1 | PDF2) García et al. (2019)
   2019-01-18;68(2):25-30. Opioid prescribing rates in nonmetropolitan and metropolitan counties among primary care providers using an electronic health record system — United States, 2014–2017.
   Cited in sections 4.1, 5.1, 5.2, 5.6, 6.2, 7.1, 7.2, 9.2, 9.3.
2. Report mm6806a2 (HTML | PDF1 | PDF2) Doyle et al. (2019)
   2019-02-15;68(6):135-139. Interim estimates of 2018–19 seasonal influenza vaccine effectiveness — United States, February 2019.
   Cited in section 6.2.
3. Report mm6817a3 (HTML | PDF1 | PDF2) Kariisa et al. (2019)
   2019-05-03;68(17):388-395. Drug overdose deaths involving cocaine and psychostimulants with abuse potential — United States, 2003–2017.
   Cited in sections 5.2, 5.3, 5.5, 5.6, 9.3.
4. Report mm6827a2 (HTML | PDF1 | PDF2) Su et al. (2019)
   2019-07-12;68(27):604-607. Workplace secondhand tobacco smoke exposure among U.S. non-smoking workers, 2015.
   Cited in sections 3.1, 5.3, 5.5, 9.2, 9.3.
5. Report mm6834a3 (HTML | PDF1 | PDF2) Beauregard et al. (2019)
   2019-08-30;68(34):745-748. Racial disparities in breastfeeding initiation and duration among U.S. infants born in 2015.
   Not cited in this review.
6. Report mm6841e3 (HTML | PDF1 | PDF2) Siegel et al. (2019)
   2019-10-18;68(41):919-927. Update: Interim guidance for health care providers evaluating and caring for patients with suspected e-cigarette, or vaping, product use associated lung injury — United States, October 2019.
   Cited in sections 3.1, 6.3, 9.2, 9.3.
7. Report mm6844a1 (HTML | PDF1 | PDF2) O'Neil et al. (2019)
   2019-11-08;68(44):993-998. Lung cancer incidence in nonmetropolitan and metropolitan counties — United States, 2007–2016.
   Cited in sections 5.5, 5.6, 9.2, 9.3.
8. Report mm6848a1 (HTML | PDF1 | PDF2) Patel et al. (2019)
   2019-12-06;68(48):1105-1111. Progress toward regional measles elimination — worldwide,

2000–2018.
Cited in sections 9.2, 9.3.

9. Report mm6903a1 (HTML | PDF1 | PDF2) Peterson et al. (2020)
2020-01-24;69(3):57-62. Suicide rates by industry and occupation — National Violent Death Reporting System, 32 states, 2016.
Cited in sections 5.6, 6.1.

10. Report mm6906a3 (HTML | PDF1 | PDF2) Divers et al. (2020)
2020-02-14;69(6):161-165. Trends in incidence of type 1 and type 2 diabetes among youths — selected counties and Indian reservations, United States, 2002–2015.
Cited in sections 5.6, 6.1, 6.2, 9.2, 9.3.

11. Report mm6911a5 (HTML | PDF1 | PDF2) Schieber et al. (2020)
2020-03-20;69(11):298-302. Variation in Adult outpatient opioid prescription dispensing by age and sex — United States, 2008–2018.
Cited in sections 4.1, 5.2, 5.4, 5.5, 5.6, 9.2, 9.3.

12. Report mm6916e1 (HTML | PDF1 | PDF2) Chang et al. (2020)
2020-04-24;69(16):496-498. Cleaning and disinfectant chemical exposures and temporal associations with COVID-19 — National Poison Data System, United States, January 1, 2020–March 31, 2020.
Cited in sections 9.2, 9.3.

13. Report mm6920e2 (HTML | PDF1 | PDF2) James et al. (2020)
2020-05-22;69(20):632-635. High COVID-19 attack rate among attendees at events at a church — Arkansas, March 2020.
Cited in sections 5.1, 9.3.

14. Report mm6923e4 (HTML | PDF1 | PDF2) Payne et al. (2020)
2020-06-12;69(23):714-721. SARS-CoV-2 infections and serologic responses from a sample of U.S. Navy service members — USS Theodore Roosevelt, April 2020.
Cited in sections 9.2, 9.3.

15. Report mm6924e1 (HTML | PDF1 | PDF2) Czeisler, Tynan, et al. (2020)
2020-06-19;69(24):751-758. Public attitudes, behaviors, and beliefs related to COVID-19, stay-at-home orders, nonessential business closures, and public health guidance — United States, New York City, and Los Angeles, May 5–12, 2020.
Cited in sections 3.1, 4.1, 5.1, 5.5, 5.6.

16. Report mm6925a1 (HTML | PDF1 | PDF2) Ellington et al. (2020)
2020-06-26;69(25):769-775. Characteristics of women of reproductive age with laboratory-confirmed SARS-CoV-2 infection by pregnancy status — United States, January 22–June 7, 2020.
Not cited in this review.

17. Report mm6927a4 (HTML | PDF1 | PDF2) Waltzman et al. (2020)
2020-07-10;69(27):870-874. Trends in emergency department visits for contact sports–related traumatic brain injuries among children — United States, 2001–2018.
Cited in sections 6.2, 9.2, 9.3.

18. Report mm6928e3 (HTML | PDF1 | PDF2) Fisher, Barile, et al. (2020)
2020-07-17;69(28):933-937. Factors associated with cloth face covering use among adults during

the COVID-19 pandemic — United States, April and May 2020.
Not cited in this review.

19. Report mm6930e1 (HTML | PDF1 | PDF2) Tenforde et al. (2020)
2020-07-31;69(30):993-998. Symptom duration and risk factors for delayed return to usual health among outpatients with COVID-19 in a multistate health care systems network — United States, March–June 2020.
Cited in sections 5.6, 9.2, 9.3.

20. Report mm6932a1 (HTML | PDF1 | PDF2) Czeisler, Lane, et al. (2020)
2020-08-14;69(32):1049-1057. Mental health, substance use, and suicidal ideation during the COVID-19 pandemic — United States, June 24–30, 2020.
Cited in sections 4.1, 5.6.

21. Report mm6932e5 (HTML | PDF1 | PDF2) Hatfield et al. (2020)
2020-08-14;69(32):1095-1099. Facility-wide testing for SARS-CoV-2 in nursing homes — seven U.S. jurisdictions, March–June 2020.
Cited in section 9.3.

22. Report mm6935a2 (HTML | PDF1 | PDF2) Moreland et al. (2020)
2020-09-04;69(35):1198-1203. Timing of state and territorial COVID-19 stay-at-home orders and changes in population movement — United States, March 1–May 31, 2020.
Cited in sections 7.1, 7.2, 9.2, 9.3.

23. Report mm6935e2 (HTML | PDF1 | PDF2) Self et al. (2020)
2020-09-04;69(35):1221-1226. Seroprevalence of SARS-CoV-2 among frontline health care personnel in a multistate hospital network — 13 academic medical centers, April–June 2020.
Cited in sections 9.2, 9.3.

24. Report mm6936a5 (HTML | PDF1 | PDF2) Fisher, Tenforde, et al. (2020)
2020-09-11;69(36):1258-1264. Community and close contact exposures associated with COVID-19 among symptomatic adults ≥18 years in 11 outpatient health care facilities — United States, July 2020.
Cited in sections 5.1, 9.2, 9.3.

25. Report mm6939e2 (HTML | PDF1 | PDF2) Leeb et al. (2020)
2020-10-02;69(39):1410-1415. COVID-19 trends among school-aged children — United States, March 1–September 19, 2020.
Cited in sections 3.1, 9.2, 9.3.

26. Report mm6943e3 (HTML | PDF1 | PDF2) Kambhampati et al. (2020)
2020-10-30;69(43):1576-1583. COVID-19–associated hospitalizations among health care personnel — COVID-NET, 13 states, March 1–May 31, 2020.
Cited in sections 6.2, 9.2, 9.3.

27. Report mm6944e3 (HTML | PDF1 | PDF2) Zambrano et al. (2020)
2020-11-06;69(44):1641-1647. Update: Characteristics of symptomatic women of reproductive age with laboratory-confirmed SARS-CoV-2 infection by pregnancy status — United States, January 22–October 3, 2020.
Not cited in this review.

28. Report mm6947e2 (HTML | PDF1 | PDF2) Van Dyke et al. (2020)
2020-11-27;69(47):1777-1781. Trends in county-level COVID-19 incidence in counties with and without a mask mandate — Kansas, June 1–August 23, 2020.
Cited in sections 6.2, 9.2, 9.3.

29. Report mm6949a2 (HTML | PDF1 | PDF2) Gilbert et al. (2020)
2020-12-11;69(49):1848-1852. Racial and ethnic differences in parental attitudes and concerns about school reopening during the COVID-19 pandemic — United States, July 2020.
Cited in section 4.1.

30. Report mm695152a3 (HTML PDF1 | PDF2) Pray et al. (2021)
2021-01-01;69(5152):1942-1947. Performance of an antigen-based test for asymptomatic and symptomatic SARS-CoV-2 testing at two university campuses — Wisconsin, September–October 2020.
Cited in section 9.3.

31. Report mm7001a4 (HTML | PDF1 | PDF2) Leidner et al. (2021)
2021-01-08;70(1):14-19. Opening of large institutions of higher education and county-level COVID-19 incidence — United States, July 6–September 17, 2020.
Cited in sections 6.3, 7.1, 9.2, 9.3.

32. Report mm7004e3 (HTML | PDF1 | PDF2) Falk et al. (2021)
2021-01-29;70(4):136-140. COVID-19 cases and transmission in 17 K–12 schools — Wood County, Wisconsin, August 31–November 29, 2020.
Cited in sections 6.3, 9.2, 9.3.

33. Report mm7006e2 (HTML | PDF1 | PDF2) Joo et al. (2021)
2021-02-12;70(6):212-216. Decline in COVID-19 hospitalization growth rates associated with statewide mask mandates — 10 states, March–October 2020.
Cited in sections 3.2, 6.1, 7.1, 9.2, 9.3.

34. Report mm7010e3 (HTML | PDF1 | PDF2) Guy et al. (2021)
2021-03-12;70(10):350-354. Association of state-issued mask mandates and allowing on-premises restaurant dining with county-level COVID-19 case and death growth rates — United States, March 1–December 31, 2020.
Cited in sections 3.2, 6.1, 6.2, 7.1, 9.2, 9.3.

35. Report mm7010e4 (HTML | PDF1 | PDF2) Kompaniyets et al. (2021)
2021-03-12;70(10):355-361. Body mass index and risk for COVID-19–related hospitalization, intensive care unit admission, invasive mechanical ventilation, and death — United States, March–December 2020.
Cited in sections 6.1, 6.2, 7.1, 9.2, 9.3.

36. Report mm7011e3 (HTML | PDF1 | PDF2) Britton et al. (2021)
2021-03-19;70(11):396-401. Effectiveness of the Pfizer-BioNTech COVID-19 vaccine among residents of two skilled nursing facilities experiencing COVID-19 outbreaks — Connecticut, December 2020–February 2021.
Cited in sections 6.2, 6.3, 9.2, 9.3.

37. Report mm7013e3 (HTML | PDF1 | PDF2) Thompson et al. (2021)
2021-04-02;70(13):495-500. Interim estimates of vaccine effectiveness of BNT162b2 and

mRNA-1273 COVID-19 vaccines in preventing SARS-CoV-2 infection among health care personnel, first responders, and other essential and frontline workers — eight U.S. locations, December 2020–March.
Cited in section 6.2.

38. Report mm7018e1 (HTML | PDF1 | PDF2) Tenforde et al. (2021)
2021-05-07;70(18):674-679. Effectiveness of Pfizer-BioNTech and Moderna vaccines against COVID-19 among hospitalized adults aged ≥65 years — United States, January–March 2021.
Cited in sections 5.7, 6.2, 9.2, 9.3.

39. Report mm7021e1 (HTML | PDF1 | PDF2) Gettings et al. (2021)
2021-05-28;70(21):779-784. Mask use and ventilation improvements to reduce COVID-19 incidence in elementary schools — Georgia, November 16–December 11, 2020.
Cited in sections 5.1, 9.3.

40. Report mm7023e2 (HTML | PDF1 | PDF2) Christie et al. (2021)
2021-06-11;70(23):858-864. Decreases in COVID-19 cases, emergency department visits, hospital admissions, and deaths among older adults following the introduction of COVID-19 vaccine — United States, September 6, 2020–May 1, 2021.
Cited in sections 5.2, 5.3, 5.6, 9.2, 9.3.

41. Report mm7024e1 (HTML | PDF1 | PDF2) Yard et al. (2021)
2021-06-18;70(24):888-894. Emergency department visits for suspected suicide attempts among persons aged 12–25 years before and during the COVID-19 pandemic — United States, January 2019–May 2021.
Cited in sections 6.2, 6.3, 9.3.

42. Report mm7031e1 (HTML | PDF1 | PDF2) Hause et al. (2021)
2021-08-06;70(31):1053-1058. COVID-19 vaccine safety in adolescents aged 12–17 years — United States, December 14, 2020–July 16, 2021.
Not cited in this review.

43. Report mm7032e3 (HTML | PDF1 | PDF2) Moline et al. (2021)
2021-08-13;70(32):1088-1093. Effectiveness of COVID-19 vaccines in preventing hospitalization among adults aged ≥65 years — COVID-NET, 13 states, February–April 2021.
Cited in sections 6.2, 7.1, 9.2, 9.3.

44. Report mm7034e5 (HTML | PDF1 | PDF2) Griffin et al. (2021)
2021-08-27;70(34):1170-1176. SARS-CoV-2 infections and hospitalizations among persons aged ≥16 years, by vaccination status — Los Angeles County, California, May 1–July 25, 2021.
Cited in sections 5.4, 5.5, 9.3.

45. Report mm7037e1 (HTML | PDF1 | PDF2) Scobie et al. (2021)
2021-09-17;70(37):1284-1290. Monitoring incidence of COVID-19 cases, hospitalizations, and deaths, by vaccination status — 13 U.S. jurisdictions, April 4–July 17, 2021.
Cited in sections 5.2, 5.3, 5.4, 6.2, 9.2, 9.3.

46. Report mm7039e3 (HTML | PDF1 | PDF2) Budzyn et al. (2021)
2021-10-01;70(39):1377-1378. Pediatric COVID-19 cases in counties with and without school mask requirements — United States, July 1–September 4, 2021.
Cited in sections 3.1, 5.3, 6.2, 9.2, 9.3.

47. Report mm7041a2 (HTML | PDF1 | PDF2) Bohm et al. (2021)
2021-10-15;70(41):1441-1446. Binge drinking among adults, by select characteristics and state — United States, 2018.
Cited in sections 5.3, 5.4, 5.5, 5.6, 9.3.

48. Report mm7043e2 (HTML | PDF1 | PDF2) Xu et al. (2021)
2021-10-29;70(43):1520-1524. COVID-19 Vaccination and non–COVID-19 mortality risk — seven integrated health care organizations, United States, December 14, 2020–July 31, 2021.
Cited in sections 5.2, 5.4, 6.1.

49. Report mm7047e1 (HTML | PDF1 | PDF2) DeSisto et al. (2021)
2021-11-26;70(47):1640-1645. Risk for stillbirth among women with and without COVID-19 at delivery hospitalization — United States, March 2020–September 2021.
Cited in sections 5.3, 6.2, 6.3, 9.2, 9.3.

50. Report mm705152a2 (HTML PDF1 | PDF2) Lutrick et al. (2021)
2021-12-31;70(5152):1761-1765. Interim estimate of vaccine effectiveness of BNT162b2 (Pfizer-BioNTech) vaccine in preventing SARS-CoV-2 infection among adolescents aged 12–17 years — Arizona, July–December 2021.
Cited in sections 5.5, 6.2.

51. Report mm705152a3 (HTML PDF1 | PDF2) Wanga et al. (2021)
2021-12-31;70(5152):1766-1772. Characteristics and clinical outcomes of children and adolescents aged 18 years hospitalized with COVID-19 — six hospitals, United States, July–August 2021.
Cited in sections 3.2, 5.1, 6.2.

52. Report mm7104e1 (HTML | PDF1 | PDF2) León et al. (2022)
2022-01-28;71(4):125-131. COVID-19 Cases and hospitalizations by COVID-19 vaccination status and previous COVID-19 diagnosis — California and New York, May–November 2021.
Cited in sections 5.2, 5.6, 6.3, 9.3.

53. Report mm7110e1 (HTML | PDF1 | PDF2) Donovan et al. (2022)
2022-03-11;71(10):384-389. SARS-CoV-2 incidence in K–12 school districts with mask-required versus mask-optional policies — Arkansas, August–October 2021.
Cited in sections 6.2, 7.1, 9.2, 9.3.

54. Report mm7114e1 (HTML | PDF1 | PDF2) Block et al. (2022)
2022-04-08;71(14):517-523. Cardiac complications after SARS-CoV-2 infection and mRNA COVID-19 vaccination — PCORnet, United States, January 2021–January 2022.
Cited in section 4.1.

55. Report mm7121a2 (HTML | PDF1 | PDF2) Sapkota et al. (2022)
2022-05-27;71(21):703-708. Seizure- or epilepsy-related emergency department visits before and during the COVID-19 pandemic — United States, 2019–2021.
Cited in sections 5.2, 5.5, 9.3.

56. Report mm7121e1 (HTML | PDF1 | PDF2) Bull-Otterson et al. (2022)
2022-05-27;71(21):713-717. Post–COVID conditions among adult COVID-19 survivors aged 18–64 and ≥65 years — United States, March 2020–November 2021.
Cited in sections 3.2, 4.1, 5.1, 5.3, 5.5, 6.1, 9.2, 9.3.

8.2 MMWR reports cited in this review but not among the 56 selected

In addition to the 56 full reports selected for this review, the following reports are also cited:

- Report mm6646a3 (HTML | PDF1) Marx et al. (2017)
  Cited in section 7.2.
- Report mm7015a1 (HTML | PDF1) Luo et al. (2021)
  Cited in section 7.2.
- Report mm7044e1 (HTML | PDF1) Bozio et al. (2021)
  Cited in section 7.2.
- Report mm7048a1 (HTML | PDF1) Peterson, Miller, et al. (2021)
  Cited in section 7.2.
- Report mm7048a2 (HTML | PDF1) Peterson, Luo, et al. (2021)
  Cited in section 7.2.
- Report mm7049a3 (HTML | PDF1) Miller et al. (2021)
  Cited in section 7.2.
- Report mm7102e2 (HTML | PDF1) Barrett et al. (2022)
  Cited in section 3.2.
- Report mm7131a3 (HTML | PDF1) Kompaniyets et al. (2022)
  Cited in section 3.2.
- Report mm7212e1 (HTML | PDF1) Chun et al. (2023)
  Cited in section 7.2.

9 Figures in the *MMWR*

9.1 Introduction

This appendix to the report *Data in the MMWR* contains all 63 figures from the 56 full reports under review, together with figure descriptors and commentary. Each figure appears in its own subsection, with information on the report in which it was published, a reduced-scale image, the figure caption and alt text (from online HTML files), and comments on the design characteristics of the figure.

1. **Report citation**: publication identifier, figure number within report, and the publication date, volume, number, and page(s) on which the figure appears
2. **Figure *X* of *Y***: the within-report designation, linked directly to the online figure
3. **File name**: name of figure file in online HTML version
4. **Reduced figure**: GIF image at 50% of the original width
5. **Caption**: the descriptive figure label as it appears in the published report
6. **Alt text**: alternative text that accompanies the figure in the online HTML version
7. **Panels**: the number of individually framed fields in the figure
8. **Elements**: whether the figure contains dots, line graphs, maps, or other components, and the general characteristics that those components are intended to depict
9. **Horizontal**: the quantitative or categorical scale, axis, and extent of each panel along the horizontal direction (left to right), plus any vertical reference lines
10. **Vertical**: the quantitative or categorical scale, axis, and extent of each panel along the vertical direction (top to bottom), plus any horizontal reference lines
11. **Remarks**: commentary on alternative design choices that could have been made

9.2 Observations

This section summarizes salient characteristics of figures in the reviewed reports. Appendix 1 contains detailed commentary on all 63 figures in the 41 reports that contain figures.

1. The following figures use dual-scale axes, meaning that the scale on one side differs from the scale on the other.

   Report mm6935e2 (Self et al. 2020), figure 1 of 1; mm6939e2 (Leeb et al. 2020), figure 2 of 2; mm7004e3 (Falk et al. 2021), figure 2 of 3; mm7023e2 (Christie et al. 2021), figure 1 of 2; mm7023e2 (Christie et al. 2021), figure 2 of 2; mm7032e3 (Moline et al. 2021), figure 1 of 2.

2. The following figures use broken axes, meaning that an axis has a visible gap meant to replace an even larger gap, as a way of reducing the total extent if the axis were unbroken. In most cases, the breaks allow the range of percentages to include 100, although not all figures with percentage scales include 100, and some other graphic types include breaks.

   Report mm6827a2 (Su et al. 2019), figure 1 of 1; mm6936a5 (Fisher, Tenforde, et al. 2020), figure 1 of 1; mm6939e2 (Leeb et al. 2020), figure 2 of 2; mm6943e3 (Kambhampati et al. 2020), figure 2 of 2; mm7032e3 (Moline et al. 2021), figure 1 of 2; mm7037e1 (Scobie et al. 2021), figure 1 of 2; mm6802a1 (García et al. 2019), figure 1 of 1; mm6911a5 (Schieber et al. 2020), figure 1 of 2; mm6935e2 (Self et al. 2020), figure 1 of 1; mm7004e3 (Falk et al. 2021), figure 2 of 3

3. The following figures are bar charts (without intervals).

   Report mm7039e3 (Budzyn et al. 2021), figure 1 of 1; mm6930e1 (Tenforde et al. 2020), figure 1 of 1

4. The following figures are bar charts with intervals, also known as dynamite charts.

   Report mm6827a2 (Su et al. 2019), figure 1 of 1; mm6943e3 (Kambhampati et al. 2020), figure 2 of 2; mm6841e3 (Siegel et al. 2019), figure 1 of 1

5. The following figures exemplify issues of scale, including the extent of the axis relative to the extent of depicted data, the overall use of space, and the use of transformations like the logarithm.

   Report mm6827a2 (Su et al. 2019), figure 1 of 1; mm6841e3 (Siegel et al. 2019), figure 1 of 1; mm6844a1 (O'Neil et al. 2019), figure 1 of 2; mm6911a5 (Schieber et al. 2020), figure 2 of 2; mm6916e1 (Chang et al. 2020), figure 1 of 1; mm6923e4 (Payne et al. 2020), figure 2 of 3; mm7010e3 (Guy et al. 2021), figure 1 of 1; mm7032e3 (Moline et al. 2021), figure 2 of 2; mm7037e1 (Scobie et al. 2021), figure 1 of 2; mm7004e3 (Falk et al. 2021), figure 3 of 3; mm7047e1 (DeSisto et al. 2021), figure 1 of 1; mm6936a5 (Fisher, Tenforde, et al. 2020), figure 1 of 1; mm7121e1 (Bull-Otterson et al. 2022), figure 1 of 1; mm6911a5 (Schieber et al. 2020), figure 1 of 1

6. The following figures exemplify the use of visual reference features that do not directly depict data elements, including frames around graphic panels and fields as well as grids and other guides.

   Report mm6841e3 (Siegel et al. 2019), figure 1 of 1; mm6844a1 (O'Neil et al. 2019), figure 1 of 2; mm6935a2 (Moreland et al. 2020), figure 2 of 2; mm7001a4 (Leidner et al. 2021), figure 1 of 1; mm7006e2 (Joo et al. 2021), figure 1 of 1; mm7010e3 (Guy et al. 2021), figure 1 of 1; mm7010e4 (Kompaniyets et al. 2021), figure 2 of 2; mm7023e2 (Christie et al. 2021), figure 2 of 2; mm7037e1 (Scobie et al. 2021), figure 2 of 2; mm7047e1 (DeSisto et al. 2021), figure 1 of 1; mm6911a5 (Schieber et al. 2020), figure 1 of 2; mm6916e1 (Chang et al. 2020), figure 1 of 1; mm7011e3 (Britton et al. 2021), figure 1 of 1; mm7037e1 (Scobie et al. 2021), figure 1 of 2

7. The following figures use, or could use, scatterplot smooths.

   Report mm6802a1 (García et al. 2019), figure 1 of 1; mm6906a3 (Divers et al. 2020), figure 1 of 1; mm6927a4 (Waltzman et al. 2020), figures 1, 2, and 3; mm6947e2 (Van Dyke et al. 2020), figure 1 of 1; mm6844a1 (O'Neil et al. 2019), figure 1 of 2; mm7110e1 (Donovan et al. 2022), figure 2 of 2

8. The following figures depict several intervals, either around dots or around points on a line graph. In most cases, a single interval around a dot need not have end caps (see, e.g., mm7018e1 (Tenforde et al. 2021)). Where the intervals appear at a sequence of locations on a line graph, the set of intervals could be replaced by shading a polynomial that covers the extent from the lower limits of the intervals (connected dot to dot) to the upper limits. Then the line graph appears in the interior of the pointwise confidence region. Overlap between shaded polygons can appear as a blended shade.

   Report mm6848a1 (Patel et al. 2019), figure 2 of 2; mm7010e3 (Guy et al. 2021), figure 1 of 1; mm7010e4 (Kompaniyets et al. 2021), figure 2 of 2; mm7011e3 (Britton et al. 2021), figure 2 of

2; mm7018e1 (Tenforde et al. 2021), figure 1 of 1; mm6923e4 (Payne et al. 2020), figure 2 of 3; mm7006e2 (Joo et al. 2021), figure 1 of 1; mm7032e3 (Moline et al. 2021), figure 2 of 2; mm7047e1 (DeSisto et al. 2021), figure 1 of 1; mm7121e1 (Bull-Otterson et al. 2022), figure 1 of 1

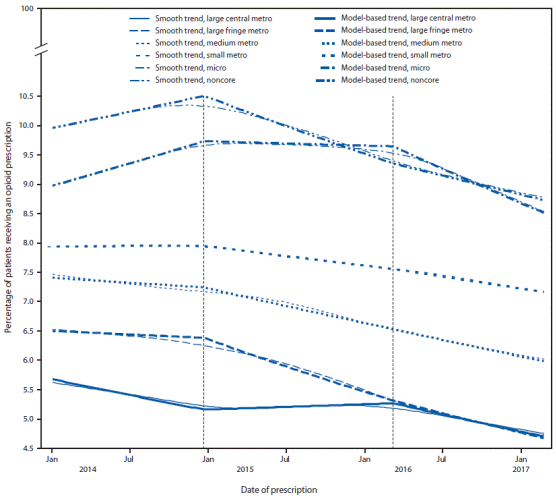
9. As seen with tables, figures rarely mention estimation or inferential procedures by name.
    a. The footnote for figure 2 in report mm6911a5 (Schieber et al. 2020) describes the result of a Pearson's chi-squared test, but its relevance to the figure is not clear.
    b. Report mm7010e4 (Kompaniyets et al. 2021) states that CIs come from logistic regression models.
    c. The following reports include figures with CIs that do not come from regression models and for which the CI construction method is not stated: mm6827a2 (Su et al. 2019) (percentages), mm6841e3 (Siegel et al. 2019) (percentages and means), mm6848a1 (Patel et al. 2019) (counts), mm6923e4 (Payne et al. 2020) (odds ratios), mm6943e3 (Kambhampati et al. 2020) (weighted percentages), mm7006e2 (Joo et al. 2021) (differences in percentages), and mm7010e3 (Guy et al. 2021) (differences in percentages).
    d. The following reports include figures with CIs that come from regression models, but the footnote does not indicate what kind: mm6936a5 (Fisher, Tenforde, et al. 2020) (presumably logistic regression, but not stated), mm7018e1 (Tenforde et al. 2021) (figure note does not specify adjustment method), mm7047e1 (DeSisto et al. 2021) (figure note does not specify adjustment method).
    e. Report mm6844a1 (O'Neil et al. 2019) includes APCs but does not state the source or method for the APCs.
    f. Report mm7011e3 (Britton et al. 2021), figure 2, depicts Kaplan-Meier curves with pointwise CIs, but the figure footnote does not indicate the method for the curves or the CIs.
    g. Report mm7032e3 (Moline et al. 2021) states that point estimates and CIs were estimated using the screening method.

9.3 Analysis of individual figures

Report mm6802a1 (García et al. 2019)

Figure 1 of 1

File name: mm6802a1-F.gif



Caption: FIGURE. Model-based trends in percentage of patient-weeks with at least one opioid prescription, by urban-rural category — Athenahealth, United States, January 2014–March 2017

Alt text: The figure is a line chart showing the model-based trends in percentage of patient-weeks with at least one opioid prescription, by urban-rural category, in the United States, during January 2014–March 2017, and based on data from Athenahealth.

Panels: 1

Elements: 6 pairs of lines (6 line types, 2 line weights) depict percentages over time; each pair superposes a piecewise linear spline on a locally weighted regression curve

Horizontal: January 2014 to March 2017; no excess space; vertical guides at 2015-01-04 and 2016-03-20

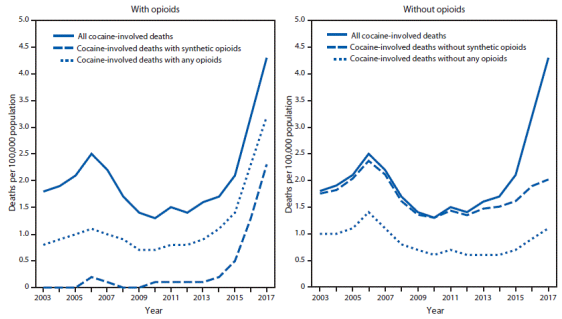
Vertical: 4.5% to 10.5%, break, 100%; no excess except break, which accommodates legend

Remarks: Unnecessary vertical break between 10.5 and 100; house convention might have called for break between 0 and 4.5, but extent ends at 4.5.

Report mm6817a3 (Kariisa et al. 2019)

Figure 1 of 2

File name: mm6817a3-F1.gif



Caption: FIGURE 1. Age-adjusted rates of drug overdose deaths involving cocaine with and without synthetic opioids other than methadone (synthetic opioids) and any opioids — United States, 2003–2017

Alt text: The figure consists of two line graphs, one showing the rate of overdose deaths involving cocaine with opioids per 100,000 population, and the other showing the rate of overdose deaths involving cocaine without opioids, per 100,000 population, in the United States during 2003–2017.

Panels: 2

Elements: 3 lines (3 line types) in each panel depict deaths per unit population over time

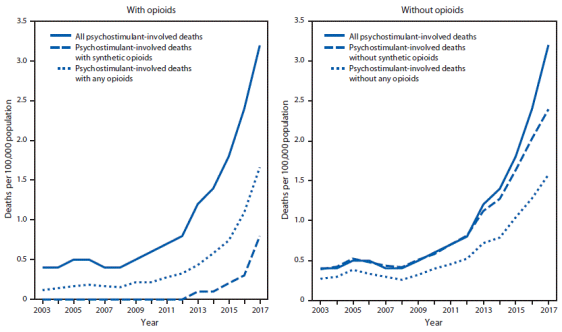
Horizontal: 15 years (2003-2017); no excess

Vertical: 0-5.0 deaths per 1e5; only excess between 4.5-5.0, used for legend; 0 should be 0.0

Remarks: Nice graphic

Figure 2 of 2

File name: mm6817a3-F2.gif



Caption: FIGURE 2. Age-adjusted rates of drug overdose deaths involving psychostimulants with abuse potential (psychostimulants) with and without synthetic opioids other than methadone (synthetic opioids) and any opioids — United States, 2003–2017

Alt text: The figure consists of two line graphs, one showing the rate of drug overdose deaths involving psychostimulants with abuse potential with synthetic opioids other than methadone, and the other

showing the rate of overdose deaths involving psychostimulants with abuse potential without synthetic opioids other than methadone, per 100,000 population, in the United States during 2003–2017.

Panels: 2

Elements: 3 lines (3 line types) in each panel depict death count per unit population over time

Horizontal: 15 years (2003-2017); no excess

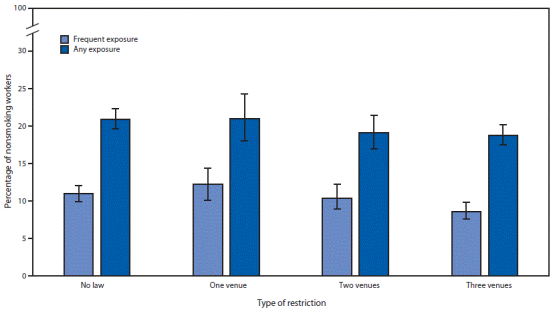
Vertical: 0-3.5 deaths per 1e5, no excess, even with legend; 0 should be 0.0

Remarks: Nice graphic

Report mm6827a2 (Su et al. 2019)

Figure 1 of 1

File name: mm6827a2-F.gif



Caption: FIGURE. Percentage of nonsmoking workers reporting any and frequent workplace exposure to secondhand smoke, by type of restriction of smoke-free indoor air legislation in state of residence — United States, 2015

Alt text: The figure is a bar chart showing the percentage of U.S. nonsmoking workers reporting any and frequent workplace exposure to secondhand smoke in 2015, by type of restriction of smoke-free indoor air legislation in their state of residence.

Panels: 1

Elements: 4 pairs of dynamite (bars with capped intervals) depict percentages, pairs in 2 shades

Horizontal: 4 categories: 0, 1, 2, or 3 restrictions

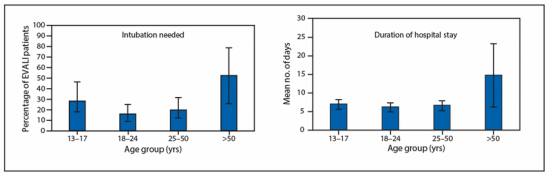
Vertical: 0%-30%, break, 100%; excess above 25% (about 2/7 of extent)

Remarks: Would work better as dots with intervals, vertical extent about 8%-25%

Report mm6841e3 (Siegel et al. 2019)

Figure 1 of 1

File name: mm6841e3-F.gif



Caption: FIGURE. Percentage of persons needing intubation (N = 338) and hospitalization (N = 242) among patients with e-cigarette, or vaping, product use associated lung injury (EVALI), by age of patient — United States, February 1–October 3, 2019

Alt text: The figure consists of two bar charts showing the percentage of U.S. persons needing intubation (N = 338) and hospitalization (N = 242) among patients with lung injury associated with e-cigarette, or vaping, product use, by age of patient, based on reports from 29 states during February 1–October 3, 2019.

Panels: 2

Elements: 4 dynamite per panel (all same color) depict (1) percentage and (2) mean days

Horizontal: 4 interval categories, same in each panel

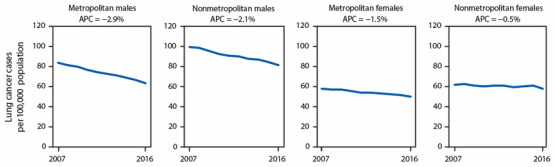
Vertical: (1) 0%-100%; (2) 0-30, with excess ~25-30 (about 1/6 of extent)

Remarks: Panels differ in height (an aesthetic issue, not needed for perception); second panel should not be dynamite, so both would work better as dots with intervals

Report mm6844a1 (O'Neil et al. 2019)

Figure 1 of 2

File name: mm6844a1-F1.gif



Caption: FIGURE 1. Trends in lung cancer incidence rates in nonmetropolitan and metropolitan counties, by sex — United States, 2007–2016

Alt text: The figure is a series of four line charts showing trends in lung cancer incidence rates in nonmetropolitan and metropolitan counties, by sex, in the United States during 2007–2016.

Panels: 4

Elements: 1 line in each panel (all solid, same color) depicts case count per unit population over time

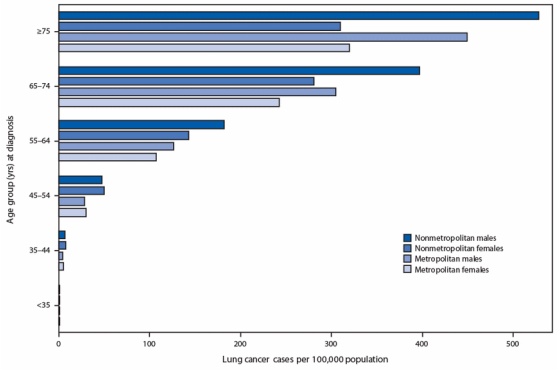
Horizontal: 2007-2016, same in each panel

Vertical: 0-120, matches across panels; excess ~0-40 and ~100-120 (about 50% of extent)

Remarks: Could have rendered as 2 panels (or maybe 1) with better vertical extent; might be better if observed lines were superposed on fitted lines whose slopes give the reported APCs

Figure 2 of 2

File name: mm6844a1-F2.gif



Caption: FIGURE 2. Rate of lung cancer in nonmetropolitan and metropolitan counties, by sex and age at diagnosis — United States, 2016

Alt text: The figure is a bar chart showing incidence rates of lung cancer in nonmetropolitan and metropolitan counties, by sex and age at diagnosis, in the United States during 2016.

Panels: 1

Elements: Bars (horizontal), 6 groups (age intervals) of 4 (metro/gender categories, rendered in 4 different shades) depict case count per unit population

Horizontal: 0-~520, no excess (rare example where data element extends beyond labeled axis ticks)

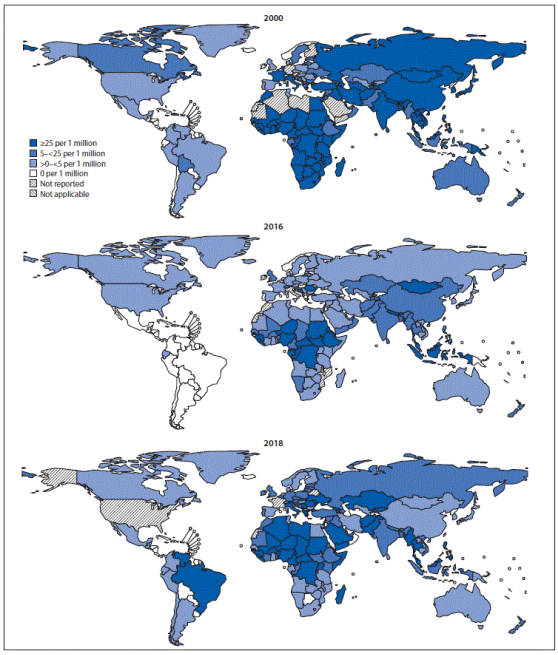
Vertical: 6 age interval categories, space between groups of 4

Remarks: Works as a bar chart; would also work well as a dot plot with same horizontal extent, given range of bar lengths

Report mm6848a1 (Patel et al. 2019)

Figure 1 of 2

File name: mm6848a1-F1.gif



Caption: FIGURE 1. Reported measles incidence per 1 million persons — worldwide, 2000, 2016, and 2018

Alt text: The figure consists of three world maps showing reported measles incidence per 1 million population, by country, in the years 2000, 2016, and 2018.

Panels: 1 panel

Elements: 3 world map choropleths, all same projection and coloration (same cutpoints)

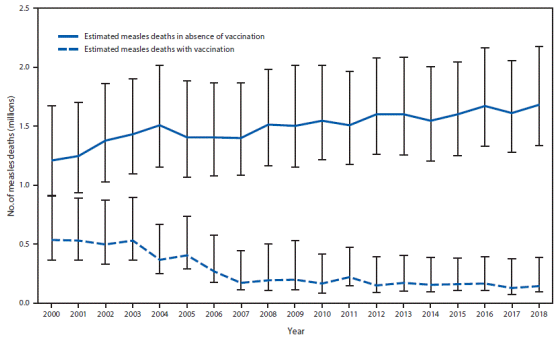
Horizontal: Latitude

Vertical: Longitude

Remarks: No comments

Figure 2 of 2

File name: mm6848a1-F2.gif



Caption: FIGURE 2. Estimated annual number of measles deaths, by vaccination status — worldwide, 2000–2018

Alt text: The figure is a bar chart comparing the estimated number of deaths with and without measles vaccination for the years 2000–2018.

Panels: 1

Elements: 2 lines (2 line types), each with 19 pointwise capped intervals, depict counts and corresponding confidence intervals over time

Horizontal: 2000-2018, no excess

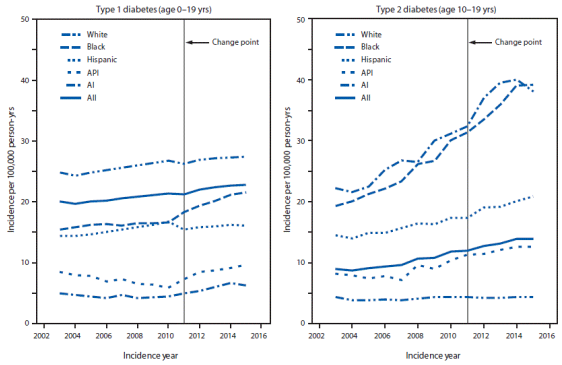
Vertical: 0-2.5 millions, little excess

Remarks: Might work better with shading instead of serial intervals

Report mm6906a3 (Divers et al. 2020)

Figure 1 of 1

File name: mm6906a3-F.gif



Caption: FIGURE. Model-adjusted incidence of type 1 and type 2 diabetes among youths, overall and by race/ethnicity — SEARCH for Diabetes in Youth Study (SEARCH), United States, 2002–2015

Alt text: The figure contains two line graphs showing the model-adjusted incidence of type 1 and type 2 diabetes among youths in the United States, overall and by race/ethnicity during 2002–2015, based on data from the SEARCH for Diabetes in Youth Study.

Panels: 2

Elements: 6 lines (6 line types) in each panel depict incidence per person-year over time

Horizontal: 2002-2016; could have been 2003-2015?; vertical reference lines at 2011

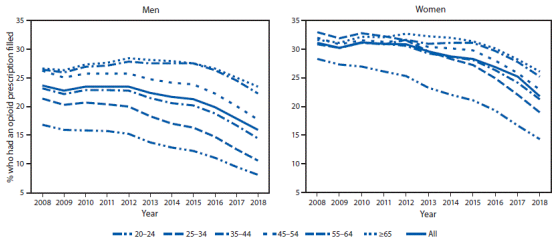
Vertical: 0-50 (x 100,000), with excess ~0-4 and ~42-50 (about 24% excess); panel scales match

Remarks: Since the analysis included piecewise linear spline models—with the location of the change point depicted with a vertical reference line—the panels could have been enhanced by superposing the current line graphs over the fitted splines. Reduce vertical and horizontal extent and deemphasize frames, axes, and vertical reference lines

Report mm6911a5 (Schieber et al. 2020)

Figure 1 of 2

File name: mm6911a5-F1.gif



Caption: FIGURE 1. Comparison of trends in the annual percentage of adults aged ≥20 years who had an opioid prescription filled, by age group and sex — United States, 2008–2018

Alt text: The figure is a line chart that compares trends in the annual percentage of adults aged ≥20 years who had a prescription filled, by age group and sex, in the United States during 2008–2018.

Panels: 2 panels, common legend below panels

Elements: 7 lines in each panel (7 line types) depict percentage over time

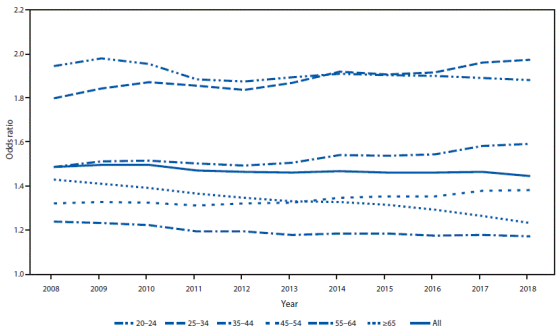
Horizontal: 2008-2018, no excess

Vertical: 5%-35%, no excess (and no 0% or 100%), panel scales match

Remarks: Nice graphics, including matching vertical extents tailored to data elements

Figure 2 of 2

File name: mm6911a5-F2.gif



Caption: FIGURE 2. Trends in odds of women having an opioid prescription filled compared with men, by age group among adults aged ≥20 years — United States, 2008–2018

Alt text: The figure is a line chart showing trends in the odds of women having an opioid prescription filled compared with men, by age group among adults aged ≥20 years, in the United States during 2008–2018.

Panels: 1

Elements: 7 lines (7 styles) depict odds ratios over time

Horizontal: 2008-2018, little excess

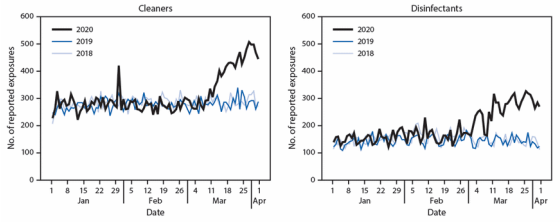
Vertical: 1.0-2.2, with excess ~1.0-1.2 and ~2.0-2.2 (about 1/3 of extent)

Remarks: Lines correspond to same categories as in figure 1. Even though vertical scale is odds ratio, depicting on log scale would probably not help, but limiting range to ~1.2-2.0 might.

Report mm6916e1 (Chang et al. 2020)

Figure 1 of 1

File name: mm6916e1-F.gif



Caption: FIGURE. Number of daily exposures to cleaners and disinfectants reported to U.S. poison centers — United States, January–March 2018, 2019, and 2020

Alt text: The figure consists of two side-by-side line graphs, comparing the number of daily exposures to cleaners and disinfectants reported to U.S. poison centers during January–March of 2018, 2019, and 2020.

Panels: 2

Elements: 3 lines in each panel (3 colors, 2 weights) depict count over time

Horizontal: Weeks from January 1 to April 1, no excess

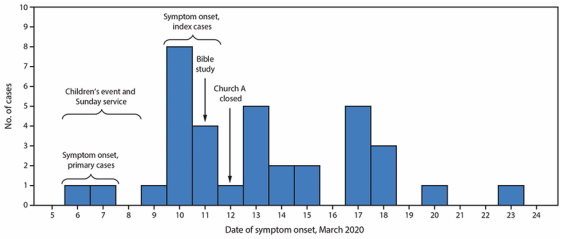
Vertical: 0-600, with excess ~0-100 and ~500-600 (about 1/3 of extent); panel scales match

Remarks: Main purpose is to emphasize 2020, with 2018 and 2019 only for reference. With that, the graphic could work as a single panel, with 2020 lines superposed on a high-bandwidth smooth of 2018 and 2019, for a total of 2 main line graphs superposed on 2 reference curves.

Report mm6920e2 (James et al. 2020)

Figure 1 of 1

File name: mm6920e2-F.gif



Caption: FIGURE. Date of symptom onset among persons with laboratory-confirmed cases of COVID-19 (N = 35) who attended March 6–11 church A events — Arkansas, March 6–23, 2020

Alt text: The figure is a histogram, an epidemiologic curve showing the date of symptom onset during March 6–23, 2020, among 35 persons with laboratory-confirmed cases of COVID-19 who attended March 6–11 events at church A in Arkansas.

Panels: 1

Elements: Bars indicate case counts per day

Horizontal: 20 days, March 5-24, no excess (assuming days 5 and 24 help establish baseline)

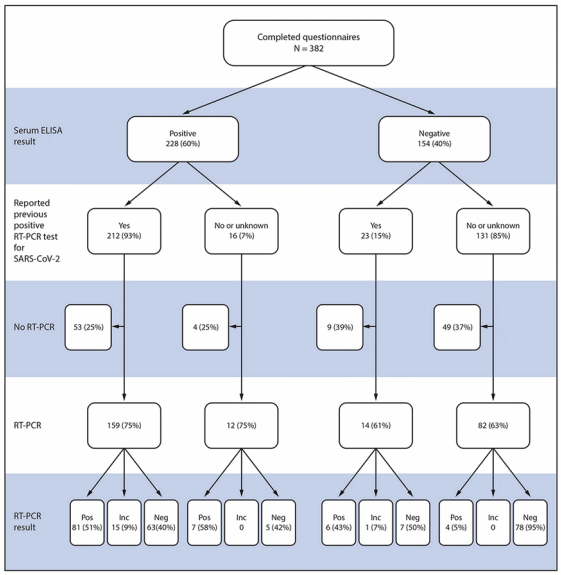
Vertical: 0-10, could be 0-8 if annotations are managed

Remarks: Best example of graphic type for which bars are suitable

Report mm6923e4 (Payne et al. 2020)

Figure 1 of 3

File name: mm6923e4-F1.gif



Caption: FIGURE 1. Laboratory results among a convenience sample of U.S. service members who provided serum specimens (N = 382) and nasopharyngeal swabs (N = 267) for SARS-CoV-2 testing — USS Theodore Roosevelt, April 2020

Alt text: The figure is a flowchart showing laboratory results among a convenience sample of U.S. service members aboard the USS Theodore Roosevelt who provided serum samples (N = 382) and nasopharyngeal swabs (N = 267) for SARS-CoV-2 testing during April 2020.

Panels: 1

Elements: Flow diagram

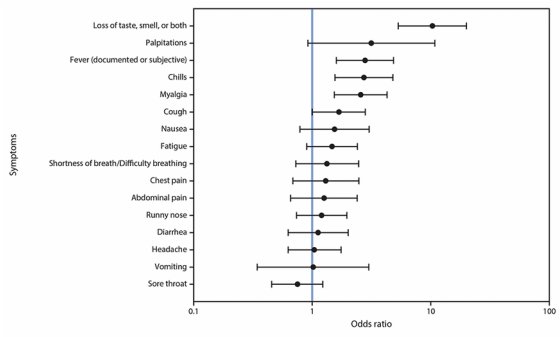
Horizontal: Nodes

Vertical: Sequential steps or results

Remarks: No remarks.

Figure 2 of 3

File name: mm6923e4-F2.gif



Caption: FIGURE 2. Odds ratios and 95% confidence intervals of previous or current SARS-CoV-2 infection, by individual symptoms among service members reporting at least one symptom (n = 284) — USS Theodore Roosevelt, April 2020

Alt text: The figure is a logarithmic plot showing odds ratios and 95% confidence intervals of previous or current SARS-CoV-2 infection, by individual symptoms, among service members aboard the USS Theodore Roosevelt reporting at least one symptom (n = 284) during April 2020.

Panels: 1

Elements: Dots with capped intervals depict odds ratios and CIs for categorical symptoms, in descending order of OR

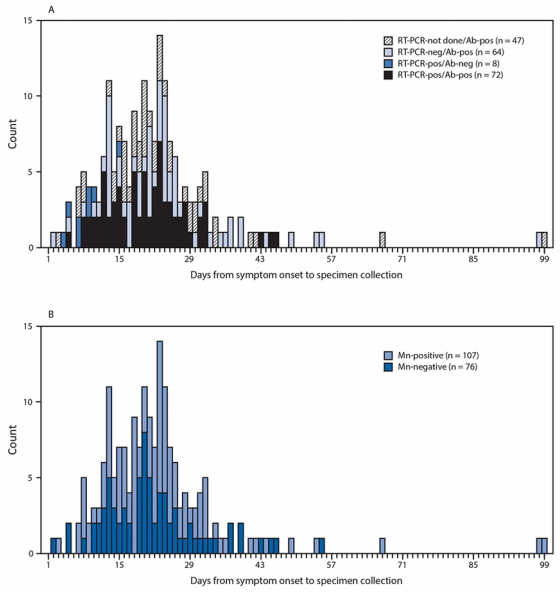
Horizontal: 0.1 to 100 on log scale, labeled on linear scale; vertical reference line at 1; excess on left and right (~40%, or 45 mm/112 mm as printed)

Vertical: 16 symptom categories

Remarks: Nice graphic, especially if horizontal extent were reduced and frame and reference line deemphasized

Figure 3 of 3

File name: mm6923e4-F3.gif



Caption: FIGURE 3. Days from symptom onset to specimen collection (A) among a convenience sample of participants who had positive real-time reverse transcription–polymerase chain reaction (RT-PCR) or positive enzyme-linked immunosorbent assay (ELISA) test results for SARS-CoV-2 (n = 191) and (B) microneutralization results among those with positive ELISA test results (n = 183) — USS Theodore Roosevelt, April 2020

Alt text: The figure is a bar chart in two panels, which show the days from symptom onset to specimen collection among a convenience sample of participants aboard the USS Theodore Roosevelt who had positive real-time reverse transcription–polymerase chain reaction or positive enzyme-linked immunosorbent assay test results for SARS-CoV-2 (n = 191) and microneutralization results among those with positive ELISA test results (n = 183) during April 2020.

Panels: 2

Elements: Stacked bars depict counts by day, with 2-4 bar colors and shades

Horizontal: 1-99 days, no excess; panel scales match

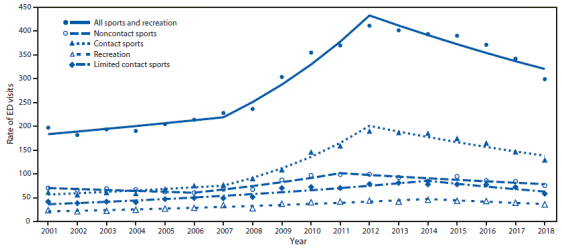
Vertical: 0-15 cases; panel scales match

Remarks: Nice graphic, especially with alternative to hashing

Report mm6927a4 (Waltzman et al. 2020)

Figure 1 of 3

File name: mm6927a4-F1.gif



Caption: FIGURE 1. Trends in rates of ED visits for nonfatal sports and recreation–related TBIs among persons aged ≤17 years, by type of activity and contact level — National Electronic Injury Surveillance System–All Injury Program, United States, 2001–2018

Alt text: The figure is a line graph showing trends in rates of emergency department visits for nonfatal sports and recreation–related traumatic brain injuries among U.S. persons aged ≤17 years, by type of activity and contact level.

Panels: 1

Elements: 5 sets of dots and 5 lines (piecewise linear splines, 5 types) depict counts per unit population over time

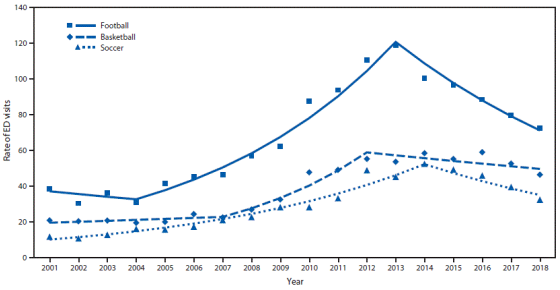
Horizontal: 2001-2018, no excess

Vertical: 0-450 per 100,000 population, no excess

Remarks: Nice graphic

Figure 2 of 3

File name: mm6927a4-F2.gif



Caption: FIGURE 2. Trends in rates of ED visits for the three most common contact sports associated with nonfatal sports and recreation–related TBI among persons aged 5–17 years — National Electronic Injury Surveillance System–All Injury Program, United States, 2001–2018

Alt text: The figure is a line graph showing trends in rates of emergency department visits for the three most common contact sports associated with nonfatal sports and recreation–related traumatic brain injuries among U.S. persons aged 5–17 years.

Panels: 1

Elements: 3 sets of dots and 3 lines (piecewise linear splines, 3 types) depict counts per unit population over time

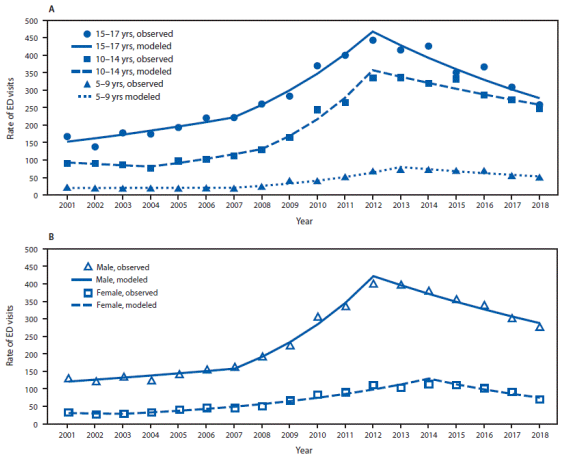
Horizontal: 2001-2018, no excess

Vertical: 0-140 per 100,000 population, little excess

Remarks: Nice graphic

Figure 3 of 3

File name: mm6927a4-F3.gif



Caption: FIGURE 3. Trends in rates of ED visits for nonfatal sports and recreation–related TBI among persons aged 5–17 years, by age group (A) and sex (B) — National Electronic Injury Surveillance System–All Injury Program, United States, 2001–2018

Alt text: The figure is a two-part line graph showing trends in rates of emergency department visits for nonfatal sports and recreation–related TBI among U.S. persons aged 5–17 years, by age group and sex.

Panels: 2

Elements: 3-and-2 sets of dots and 3-and-2 lines (piecewise linear splines, 3-and-2 types) depict counts per unit population over time

Horizontal: 2001-2018, no excess

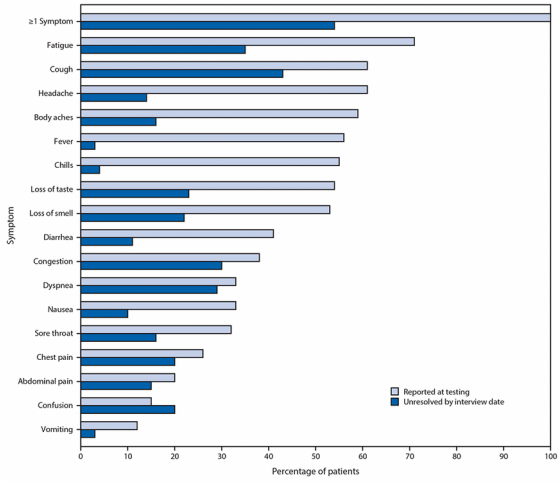
Vertical: 0-500 per 100,000 population, little excess

Remarks: Nice graphic

Report mm6930e1 (Tenforde et al. 2020)

Figure 1 of 1

File name: mm6930e1-F.gif



Caption: FIGURE. Self-reported symptoms at the time of positive SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) testing results and unresolved symptoms 14–21 days later among outpatients (N = 274) — 14 academic health care systems, United States, March–June 2020

Alt text: The figure is a bar chart showing self-reported symptoms at the time of positive SARS-CoV-2 reverse transcription–polymerase chain reaction testing results and unresolved symptoms 14–21 days later among outpatients (N = 274), using data from 14 academic health care systems in the United States, during March–June 2020.

Panels: 1

Elements: 18 pairs (2 colors in pairs) of bars depict percentages by symptom category, in descending order by percentage reported at testing

Horizontal: 0-100, no excess

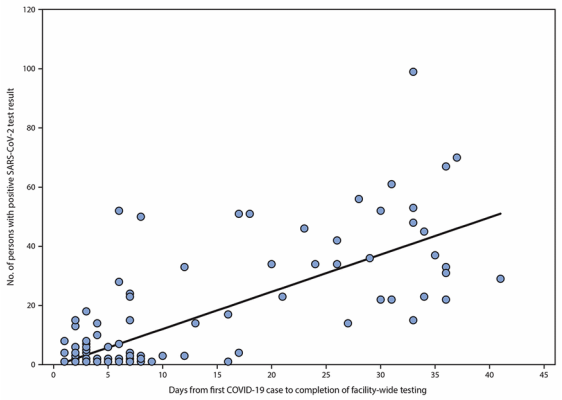
Vertical: 18 symptom categories

Remarks: Candidate for dot plot, especially "dumbbell" plot that joins pairs of dots with line segments; curious about confusion (second-to-last category), where unresolved > reported

Report mm6932e5 (Hatfield et al. 2020)

Figure 1 of 1

File name: mm6932e5-F.gif



Caption: FIGURE. Association between total number of persons with positive SARS-CoV-2 test results after facility-wide testing and number of days from first case identification until completion of facility-wide testing — five state and local health department jurisdictions, United States, March–June 2020

Alt text: The figure is a scatterplot with regression line showing the association between the total number of persons with positive SARS-CoV-2 test results after facility-wide testing and the number of days from first case identification until completion of facility-wide testing in five U.S. jurisdictions during March–June 2020.

Panels: 1

Elements: Scatterplot of days interval by count, superposed on line depicting fitted model

Horizontal: 0-45 days, little excess; if 0 is invalid in model, it should be omitted from axis

Vertical: 0-120, ~16% excess ~100-120

Remarks: Decent graphic

Report mm6935a2 (Moreland et al. 2020)

Figure 1 of 2

File name: mm6935a2-F1.gif

Caption: FIGURE 1. Type and duration of COVID-19 state and territorial stay-at-home orders, by jurisdiction — United States, March 1–May 31, 2020

Alt text: The figure is a line chart showing COVID-19 state and territorial stay-at-home orders in the United States during March 1–May 31, 2020.

Panels: 1

Elements: A dot plot with segments indicating policy status over time for 50 jurisdictions

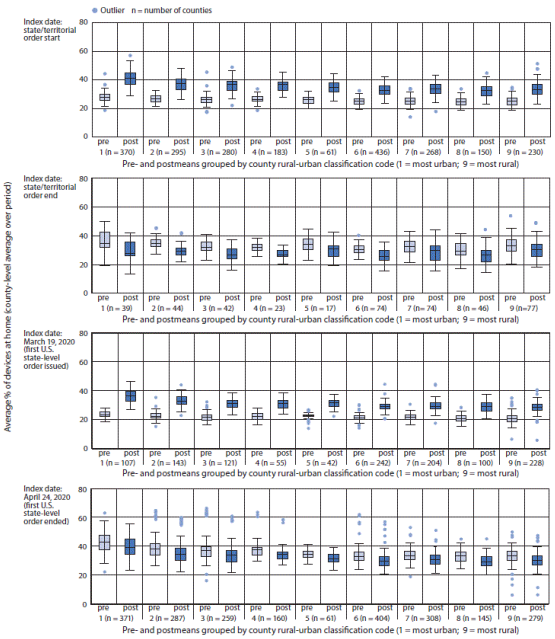
Horizontal: March 7 to ~June 4, with range of interest March 15 to June 1

Vertical: 50 jurisdictions, in order by first date of first policy

Remarks: Bold and creative, but thick lines and wide aspect make it more difficult to track and distinguish individual jurisdictions. Different colors do not distinguish well in grayscale. Might work better with varied plot characters, varied line thickness, and narrower horizontal aspect.

Figure 2 of 2

File name: mm6935a2-F2.gif



Caption: FIGURE 2. Distribution of county-level mean percentage of mobile devices at home pre- and postindex date periods (relative to the start and end of stay-at-home orders), by rural-urban classification — United States, March 1–May 31, 2020

Alt text: The figure is a series of four panels showing the distribution of the county-level mean percentage of mobile devices at home pre- and postindex date periods (start and end of stay-at-home orders), by rural-urban classification in the United States during March 1–May 31, 2020.

Panels: 4

Elements: 9 pairs (pre and post, 2 colors) of box-and-whisker plots in each panel, depict distributions of mean percentages over counties

Horizontal: 9 urban-rural categories, pre and post, same for all panels; vertical reference lines between bow-and-whisker elements

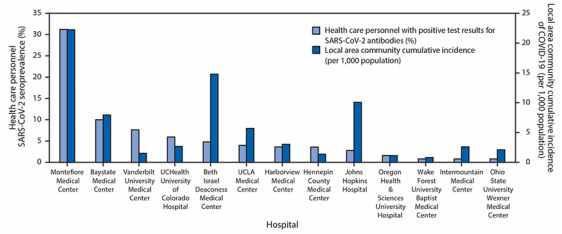
Vertical: 0-80, same for all panels, ~70-80 excess (~12% of extent); 3 horizontal reference lines

Remarks: Data-ink ratio could be improved: remove panel frames, remove vertical reference lines and use horizontal spacing to group pairs closer, reduce vertical extent to ~70, retain only 1 horizontal reference line, omit end caps from fences; collapse to <9 categories

Report mm6935e2 (Self et al. 2020)

Figure 1 of 1

File name: mm6935e2-F.gif



Caption: FIGURE. SARS-CoV-2 seroprevalence among a convenience sample of frontline health care personnel and local area community cumulative incidence of COVID-19 — 13 academic medical centers, United States, April–June 2020

Alt text: The figure is a bar chart showing SARS-CoV-2 seroprevalence among a convenience sample of frontline health care personnel and local area community cumulative incidence of infection at 13 academic medical centers in the United States during April–June 2020.

Panels: 1

Elements: *Looks like* 13 pairs of bars (2 colors) depicting proportions over 13 academic medical centers

Horizontal: 13 academic medical centers

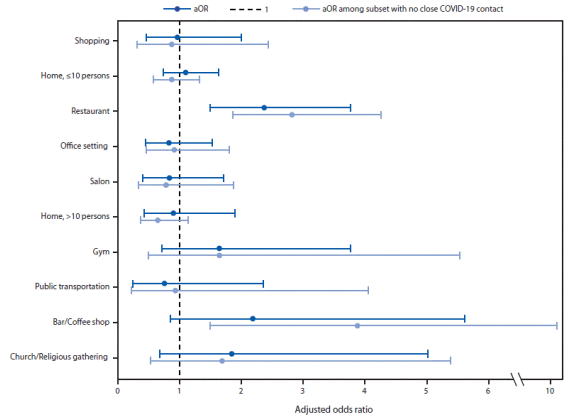
Vertical: Dual scales: left is percentage, 0-35, light blue bars; right is count per 1,000 population, 0-25, dark blue bars; with given scales, no excess extent

Remarks: Since they depict proportions, bars can be justified. Vertical scales appear to be pegged to "pretty" maxima at 35 and 25, but the the relationship between left and right scales is arbitrary. A scatterplot would probably not work, as each point would need to be decoded to a medical center. The best choice might be a parallel coordinate plot.

Report mm6936a5 (Fisher, Tenforde, et al. 2020)

Figure 1 of 1

File name: mm6936a5-F.gif



Caption: FIGURE. Adjusted odds ratio (aOR) and 95% confidence intervals for community exposures associated with confirmed COVID-19 among symptomatic adults aged ≥18 years (N = 314) — United States, July 1–29, 2020

Alt text: The figure is a forest plot showing the adjusted odds ratios and 95% confidence intervals for community exposures associated with confirmed COVID-19 among 314 symptomatic adults aged ≥18 years in the United States during July 1–29, 2020.

Panels: 1

Elements: Pairs of dots (2 colors) with capped intervals, depict odds ratios and CIs for 10 exposure categories, with no apparent significance to ordering of categories.

Horizontal: 0-6, break, 10, on linear scale. The break here is because an interval extends just beyond 10.No apparent excess extent. Vertical reference line at 1.

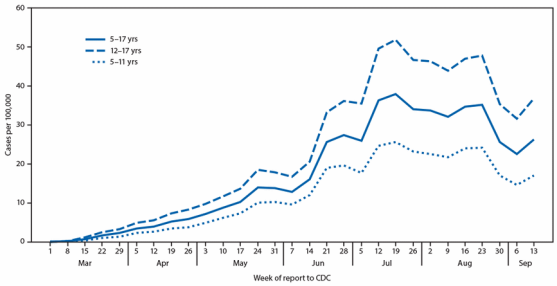
Vertical: Exposure categories, with pairs closer to each other than to other pairs.

Remarks: This graphic is a good candidate for a log scale, which would obviate the need for the break between 6 and 10. It would also work better if pairs had an apparent ordering, such as OR point estimates. The legend should not include the vertical reference line.

Report mm6939e2 (Leeb et al. 2020)

Figure 1 of 2

File name: mm6939e2-F1.gif



Caption: FIGURE 1. COVID-19 incidence among school-aged children aged 5–11 years (N = 101,503) and 12–17 years (N = 175,782), by week — United States, March 1–September 19, 2020

Alt text: The figure is a line chart showing COVID-19 incidence among school-aged children aged 5–11 years (N = 101,503) and 12–17 years (N = 175,782), by week, in the United States, during March 1–September 19, 2020.

Panels: 1

Elements: 3 line graphs (3 line styles) depict case counts per unit population over time

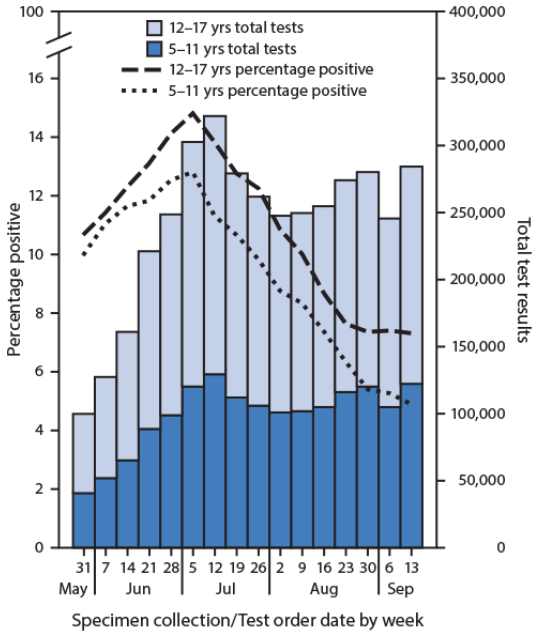
Horizontal: Weeks from March 1 to September 13; no excess.

Vertical: 0-60 (per 100,000), with some excess ~50-60 (about 15% of extent).

Remarks: Graphic is fine, although the line for 5-17 year-olds is superfluous.

Figure 2 of 2

File name: mm6939e2-F2.gif



Caption: FIGURE 2. Percentage of SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) tests with positive results and test volume, by week for school-aged children aged 5–11 years and 12–17 years — United States, May 31–September 19, 2020

Alt text: The figure is a histogram, an epidemiologic curve showing the percentage of SARS-CoV-2 reverse transcription–polymerase chain reaction tests with positive results and test volume, by week for school-aged children aged 5–11 years and 12–17 years, in the United States, during May 31–September 19, 2020.

Panels: 1

Elements: 2 line graphs (2 line styles) depict percentage over time superposed on stacked bars depict counts over the same time

Horizontal: Week from May 31 to September 13

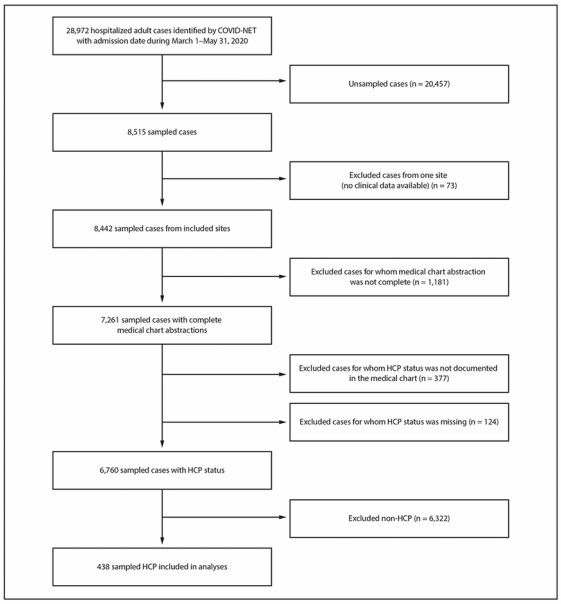
Vertical: Left scale is 0-16, break, 100 (could be 0-15, ~11% excess); right scale is 0-400,000 (could be ~0-325,000)

Remarks: The vertical scales have an arbitrary relationship to each other, and they encode different kinds of information: separate percentages and cumulative (stacked) counts.

Report mm6943e3 (Kambhampati et al. 2020)

Figure 1 of 2

File name: mm6943e3-F1.gif



Caption: FIGURE 1. Selection of cases for analysis of COVID-19–associated hospitalizations among health care personnel (HCP) — COVID-NET, 13 states, March 1–May 31, 2020

Alt text: The figure is a flow chart showing the selection of cases for analysis of COVID-19–associated hospitalizations among health care personnel (HCP), using data from COVID-NET, in 13 states, during March 1–May 31, 2020.

Panels: 1

Elements: Flow diagram

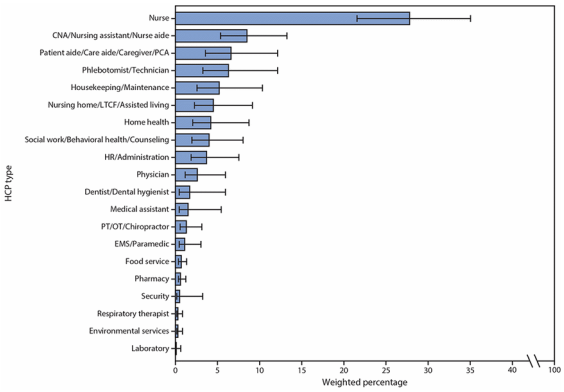
Horizontal:

Vertical:

Remarks:

Figure 2 of 2

File name: mm6943e3-F2.gif



Caption: FIGURE 2. Weighted percentage of personnel types, among reported health care personnel (HCP) with COVID-19–associated hospitalizations (N = 438) — COVID–NET, 13 states, March 1–May 31, 2020

Alt text: The figure is a bar chart showing the weighted percentage of personnel types among reported health care personnel (HCP) with COVID-19–associated hospitalizations (N = 438), using data from COVID–NET, in 13 states, during March 1–May 31, 2020.

Panels: 1

Elements: Dynamite, 20 bars with capped intervals depict percentages and CIs over 20 categories, in order by percentage.

Horizontal: 0-40, break, 100 (could be ~0-36); ~22% excess (26 mm/120 mm as printed)

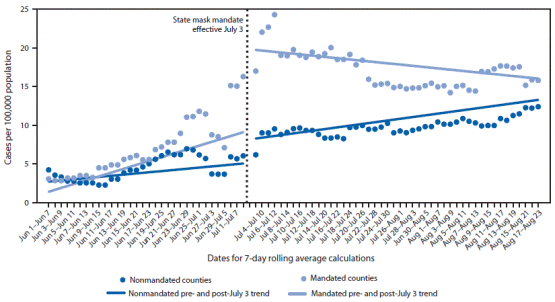
Vertical: 20 categories

Remarks: Although bars are justified for percentages, this graphic would work better as dots with uncapped intervals, with the range ~0-36.

Report mm6947e2 (Van Dyke et al. 2020)

Figure 1 of 1

File name: mm6947e2-F.gif



Caption: FIGURE. Trends in 7-day rolling average of new daily COVID-19 cases per 100,000 population among mask-mandated and non–mask-mandated counties before (June 1–July 2) and after (July 3–August 23) the governor's executive order requiring masks — Kansas, June 1–August 23, 2020

Alt text: The figure is a chart showing trends during June 1–August 23, 2020, in the 7-day rolling average of new daily COVID-19 cases per 100,000 population among mask-mandated and non–mask-mandated counties before (June 1–July 2) and after (July 3–August 23) the Kansas governor's executive order requiring masks.

Panels: 1

Elements: 2 sets of dots and 2 discontinuous, piecewise linear splines (2 colors) depict case counts per unit population over time

Horizontal: Weeks from June 1 to August 23, no excess; vertical reference line at July

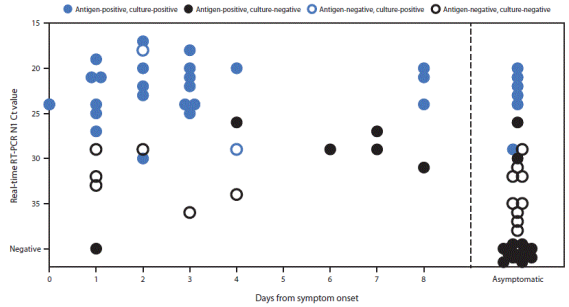
Vertical: 0-25 per 100,000 population, no excess

Remarks: Nice graphic, although the light blue segment on the left does not seem to track with the light blue dots on the left.

Report mm695152a3 (Pray et al. 2021)

Figure 1 of 1

File name: mm695152a3-F.gif



Caption: FIGURE. Viral culture results among participants with positive Sofia SARS Antigen Fluorescent Immunoassay or positive SARS-CoV-2 real-time reverse transcription–polymerase chain reaction (RT-PCR) results (n = 69), by cycle threshold (Ct) value† and the interval between specimen collection and reported symptom onset or asymptomatic status — university A, Wisconsin, September–October 2020

Alt text: The figure is a scatterplot showing viral culture results among participants with positive Sofia SARS Antigen Fluorescent Immunoassay or positive SARS-CoV-2 real-time reverse transcription–polymerase chain reaction results (n = 69), by cycle threshold value and the interval between specimen collection and reported symptom onset or asymptomatic status at university A in Wisconsin during September–October 2020.

Panels: 1

Elements: Dots (4 styles by test type and result) depict cycle threshold values over time indexed to symptom onset; dots with similar Ct values on the same day show horizontal offset (deterministic jittering)

Horizontal: 0-8 days and a section for asymptomatic; rare example with value depicted at edge of axis (day 0, ~26 Ct); dashed vertical line separates asymptomatic from others.

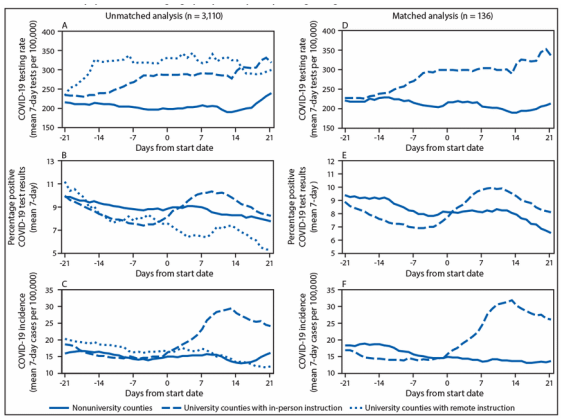
Vertical: 15-~36 (in descending order) and negative; no excess

Remarks: This graphic depicts all unique points rather than summaries. It does 3 unusual things with axes: labels vertical axis in reverse, so that values near the top indicate greater viral activity in vivo; negative (unbounded Ct) is located at the bottom limit of the vertical axis, based on interpretive value than numerical value; and, asymptomatic are located on the right limit of the horizontal axis to facilitate visual comparison with results for symptomatic persons. The only changes would be to remove the frame and vertical dashed line and to ensure that the figure renders well in grayscale, perhaps by varying plot characters more.

Report mm7001a4 (Leidner et al. 2021)

Figure 1 of 1

File name: mm7001a4-F.gif



Caption: FIGURE. Trends in COVID-19 testing rates (A, D), percentage test positivity (B, E), and incidence (C, F) for unmatched U.S. counties and counties matched based on population size and geographic proximity, 7-day moving average — United States, 2020

Alt text: The figure is a series of line charts showing trends in COVID-19 testing rates (A, D), percentage test positivity (B, E), and incidence (C, F) for unmatched U.S. counties and counties matched based on population size and geographic proximity, 7-day moving average, in the United States, during 2020.

Panels: 6

Elements: 3 lines (left 3 panels, 3 styles) or 2 lines (right 3 panels, 2 styles) depict counts per unit population or total tests over time; line styles have same meaning in all 6 panels, in single legend at bottom of figure

Horizontal: -21 to 21 days, no excess

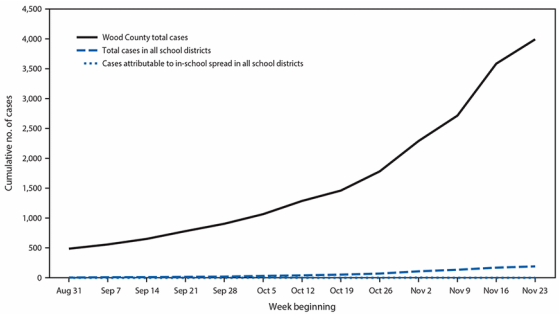
Vertical: 150-400 per 100,000 (panels A, D match); 5-13 (B) and 5-12 (E) percent; 10-35 per 100,000 (panels C, F match) ; panels A, B, D, and E could reduce vertical extent while still matching scales for pairs of panels

Remarks: The overall frame, 6 panel frames, and repeated vertical axis labels add nondata ink.

Report mm7004e3 (Falk et al. 2021)

Figure 1 of 3

File name: mm7004e3-F1.gif



Caption: FIGURE 1. Cumulative number of community and school-associated COVID-19 cases and in-school transmission, by week — Wood County, Wisconsin, August 31–November 29, 2020

Alt text: The figure is a line chart showing the cumulative number of community and school-associated COVID-19 cases and in-school transmission, by week in Wood County, Wisconsin, during August 31–November 29, 2020.

Panels: 1

Elements: 3 lines (3 styles) depict case counts over time

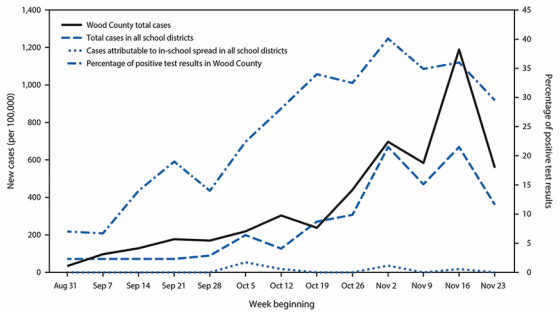
Horizontal: August 31 to November 23, no excess

Vertical: 0-4,500; could be ~00-4,000 (~1/9 excess)

Remarks: The frame, specifically the location of the horizontal axis, obscures the third line graph and a portion of the second line graph.

Figure 2 of 3

File name: mm7004e3-F2.gif



Caption: FIGURE 2. Community and school-associated COVID-19 incidence (cases per 100,000) and percentage of positive test results, by week — Wood County, Wisconsin, August 31– November 29, 2020

Alt text: The figure is a line chart showing community and school-associated COVID-19 incidence (cases per 100,000), by week in Wood County, Wisconsin, during August 31– November 29, 2020.

Panels: 1

Elements: 1 line graph depicts percentage over time superposed on 3 line graphs (3 styles) depicting case counts per unit population over time

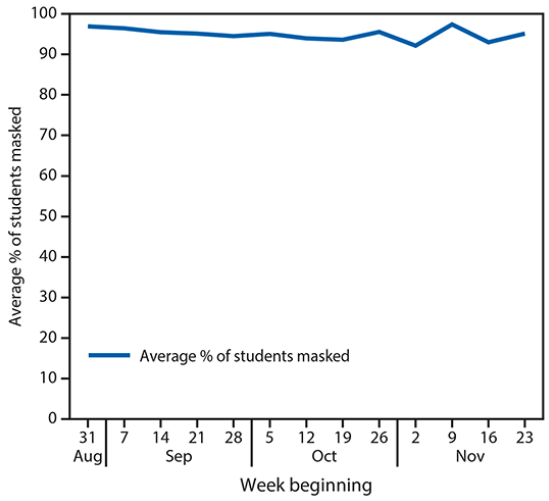
Horizontal: Weeks from August 31 to November 23, no excess

Vertical: Left scale is 0-1,400 per 100,000, limited excess; right scale is 0-45, excess 40-45 (1/9 of extent)

Remarks: While it's good that the right scale is not broken to accommodate 100%, the relationship between the left and right scales is arbitrary. Furthermore, the lowest line graph is obscured by the horizontal axis.

Figure 3 of 3

File name: mm7004e3-F3.gif



Caption: FIGURE 3. Average percentage of students (N = 4,876) in compliance with recommended mask use across all districts — Wood County, Wisconsin, August 31–November 29, 2020

Alt text: The figure is a line chart showing the average percentage of students (N = 4,876) masked across all districts in Wood County, Wisconsin, during August 31–November 29, 2020.

Panels: 1

Elements: 1 line graph depicts average percentage over time

Horizontal: Weeks from August 31 to November 23

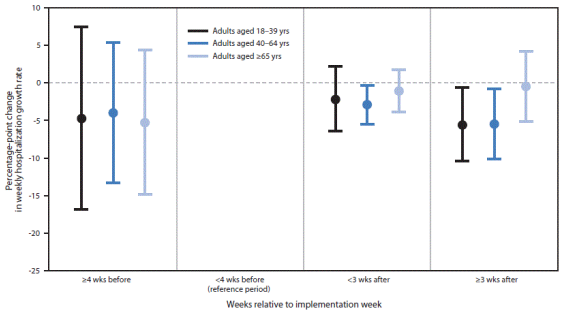
Vertical: 0-100; could be ~90-100 (90% excess)

Remarks: This figure wastes 90% of its vertical extent. it might even do well as table instead of graphic.

Report mm7006e2 (Joo et al. 2021)

Figure 1 of 1

File name: mm7006e2-F.gif



Caption: FIGURE. Estimates of association between implementation of statewide mask mandates and laboratory-confirmed COVID-19–associated hospitalization growth rates, by age group — 10 COVID-19–Associated Hospitalization Surveillance Network sites with statewide mask mandates, March–October 2020

Alt text: The figure is a chart that shows estimates of association between implementation of statewide mask mandates and laboratory-confirmed COVID-19–associated hospitalization growth rates, by age group, at 10 COVID-19–Associated Hospitalization Surveillance Network sites with statewide mask mandates during March–October 2020.

Panels: 1 panel with 4 subregions

Elements: 9 dots in 3 groups (3 colors) with capped intervals depict percentage change with CIs in 9 categories—3 time frames crossed with 3 age groups; change is relative to a fixed time frame.

Horizontal: 4 time frames; since the time frames are effectively quantized categories, of which 1 is the referent, the horizontal extent could depict only 3 of these categories.

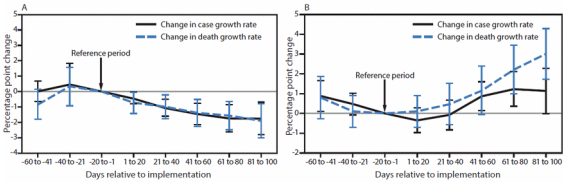
Vertical: -25 to 10 with a horizontal reference line at 0 (no change relative to referent); could be ~-17 to 7 (remove ~22% of extent)

Remarks: In addition to improving use of both the horizontal and vertical extents, this figure could also remove end caps from intervals.

Report mm7010e3 (Guy et al. 2021)

Figure 1 of 1

File name: mm7010e3-F.gif



Caption: FIGURE. Association between changes in COVID-19 case and death growth rates and implementation of state mask mandates (A) and states allowing any on-premises restaurant dining (B) — United States, March 1–December 31, 2020

Alt text: The figure is a pair of line graphs showing the association between changes in COVID-19 case and death growth rates and implementation of mask mandates and allowing on-premises restaurant dining in the United States during March 1–December 31, 2020.

Panels: 2

Elements: In each panel, 2 lines (2 colors and styles) with 7 pointwise capped intervals (2 colors) depict percentage change over successive time intervals relative to a fixed interval

Horizontal: 8 intervals of 20 days each, essentially an ordered category; no excess

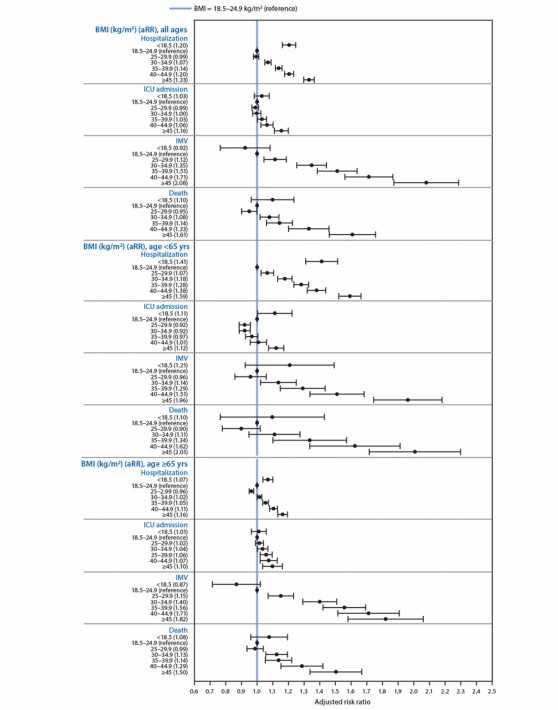
Vertical: -4 to 5 (A) and -2 to 5 (B); panel scales do not match; little excess, even if matched

Remarks: The vertical scales should be matched. The overlapping ink for the intervals makes it difficult to distinguish them, especially in grayscale. These figures might render better if the pointwise intervals were replaced with shading, although it would still be difficult to distinguish them in panel A. If pointwise intervals are maintained, slight horizontal offset (jittering) would improve readability.

Report mm7010e4 (Kompaniyets et al. 2021)

Figure 1 of 2

File name: mm7010e4-F1.gif



Caption: FIGURE 1. Association between body mass index (BMI) and severe COVID-19–associated illness among adults aged ≥18 years, by age group — Premier Healthcare Special COVID-19 Release (PHD-SR), United States, March–December 2020

Alt text: This figure is a chart of adjusted risk ratios indicating the association between body mass index and the risk for hospitalization, intensive care unit admission, invasive mechanical ventilation, and death among adults aged ≥18 years with COVID-19–associated illness, by age group.

Panels: 12 sections

Elements: Each of 12 sections contains 6 dots with capped intervals depict odds ratios and CIs for 6 BMI groups.

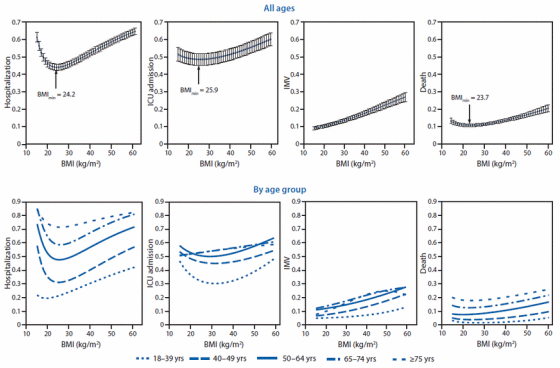
Horizontal: 0.6-2.5 on linear scale with vertical reference line at 1.0; some excess (~15%).

Vertical: Sections in 3 groups (all ages, age < 65 y, age ≥ 65 y) of 4 (hospitalization, ICU admission, IMV, death), with 7 BMI intervals in each section as ordered categories. Axis labels include OR point estimates.

Remarks: Log scale for horizontal extent might (or might not) improve graphic. If all-age group were omitted (or moved to supplement), graphic could be reëxpressed as 4 panels with both age groups in each.

Figure 2 of 2

File name: mm7010e4-F2-125.gif



Caption: FIGURE 2. Estimated risk for severe COVID-19–associated illness among adults aged ≥18 years, by body mass index (BMI) and age group — Premier Healthcare Special COVID-19 Release (PHD-SR), United States, March–December, 2020

Alt text: This figure is a collection of eight charts showing the association between body mass index (BMI) and risk for hospitalization, intensive care unit admission, invasive mechanical ventilation, and death among adults aged ≥18 years with COVID-19–associated illness, by BMI and age group.

Panels: 8

Elements: Top 4 panels each contain 1 line graph (from fractional polynomial model) with a series of pointwise, capped intervals depict 4 kinds of risk and CIs over a range of BMI values. Bottom 4 panels each contain 5 line graphs (from fractional polynomial models, 5 styles by age group) for same 4 kinds of risk over same range of BMI values.

Horizontal: 10-50 kg/m2, no excess; all 8 panels match.

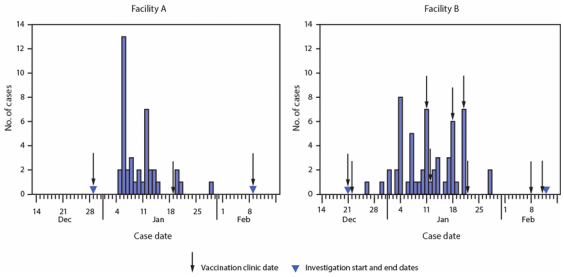
Vertical: Top 4 0-0.7 with no excess, all match; bottom 4 0-0.9 with no excess, all match.

Remarks: Pointwise intervals can be replaced with shading. It might then work to include 5 age-specific fits on same graphic as all-age fit with pointwise confidence shading.

Report mm7011e3 (Britton et al. 2021)

Figure 1 of 2

File name: mm7011e3-F1.gif



Caption: FIGURE 1. New SARS-CoV-2 cases among residents of two skilled nursing facilities, by case date — Connecticut, December 21, 2020–February 12, 2021

Alt text: The figure is a histogram, an epidemiologic curve showing new SARS-CoV-2 cases among residents of two skilled nursing facilities, by case date, in Connecticut, during December 21, 2020–February 12, 2021.

Panels: 2

Elements: In each panel, bars of case counts by date

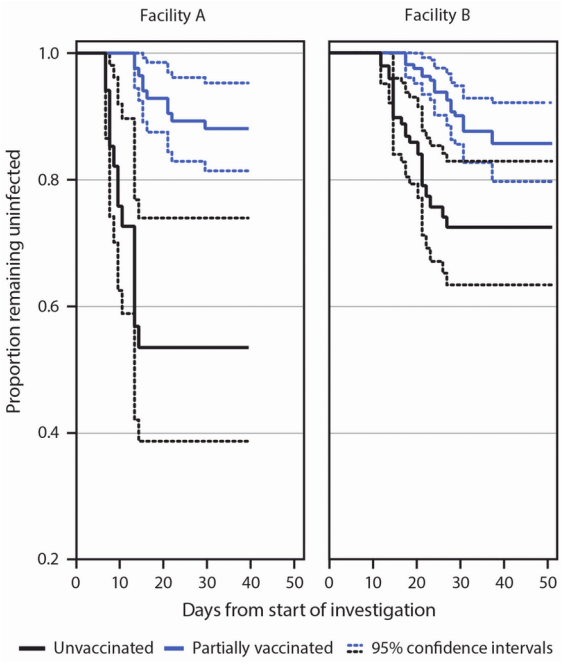
Horizontal: December 14 to February 15, same in each panel; might be reducible

Vertical: 0-14, same in each panel, no excess

Remarks: Justifiable use of bars.

Figure 2 of 2

File name: mm7011e3-F2-large.gif



Caption: FIGURE 2. Proportion of skilled nursing facility residents who remained uninfected with SARS-CoV-2 during the investigation period, by COVID-19 vaccination status and facility — Connecticut, December 21, 2020–February 12, 2021

Alt text: The figure is a line chart showing the proportion of skilled nursing facility residents who remained uninfected with SARS-CoV-2 during the investigation period, by COVID-19 vaccination status and facility, in Connecticut, during December 21, 2020–February 12, 2021.

Panels: 2

Elements: In each panel, 2 line graphs of Kaplan-Meier curves and 4 line graphs of pointwise confidence intervals (2 colors) over time from index day

Horizontal: 0-50 days, same for each panel; no excess

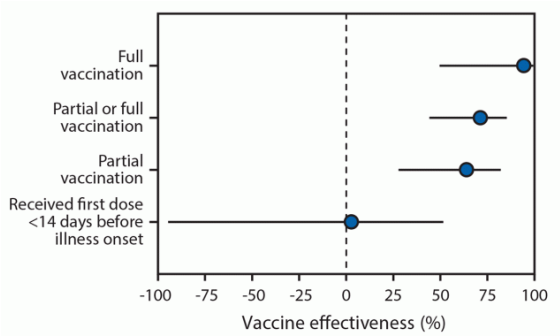
Vertical: 0.2-1.0 with 3 horizonal reference lines; could be reduced to ~0.39-1.0 (~23%)

Remarks: Shading might improve on current presentation; omit horizontal reference lines; increase number of ticks on vertical axis if resolution is of interest.

Report mm7018e1 (Tenforde et al. 2021)

Figure 1 of 1

File name: mm7018e1-F-medium.gif



Caption: FIGURE. Adjusted vaccine effectiveness (with 95% confidence intervals) against COVID-19 among hospitalized adults aged ≥65 years, by vaccination status — 24 medical centers in 14 states, January–March 2021

Alt text: The figure is a forest plot showing the adjusted vaccine effectiveness (with 95% confidence intervals) among adults aged ≥65 years with laboratory-confirmed COVID-19 hospitalization, by vaccination status, in 24 medical centers in 14 states, during January–March 2021.

Panels: 1

Elements: 4 dots with uncapped intervals depict vaccine effectiveness and CIs for 4 categories, in descending order of VE point estimates

Horizontal: -100 to 100, no excess extent

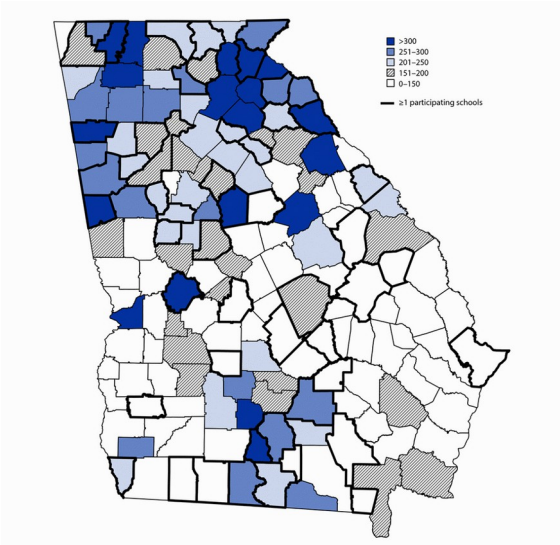
Vertical: 4 categories, vertical reference line at 0, no excess extent

Remarks: Nice graphic; deemphasize frame and vertical reference line. Lack of end caps on intervals is good. Might work equally well as a table.

Report mm7021e1 (Gettings et al. 2021)

Figure 1 of 1

File name: mm7021e1-F-large.gif



Caption: FIGURE. County-level COVID-19 incidence on December 1, 2020, among counties with one or more participating elementary schools and counties without participating schools — Georgia, November 16–December 11, 2020

Alt text: The figure is a map showing the county-level COVID-19 incidence on December 1, 2020, among counties with one or more participating elementary schools and counties without participating schools, in Georgia, during November 16–December 11, 2020.

Panels: 1

Elements: Choropleth map of Georgia counties, 5 color/shade patterns, 2 lined styles for borders

Horizontal: Latitude

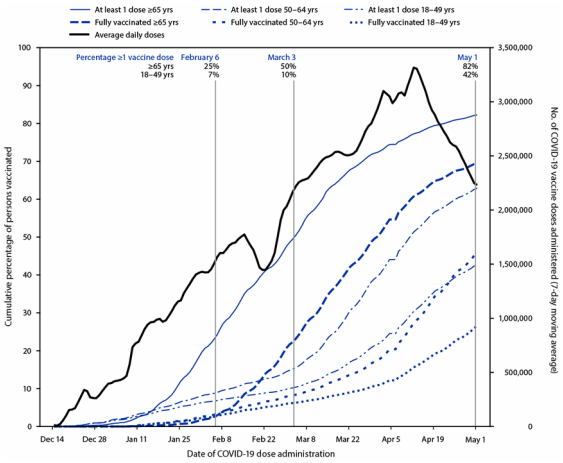
Vertical: Longitude

Remarks:

Report mm7023e2 (Christie et al. 2021)

Figure 1 of 2

File name: mm7023e2-F1.gif



Caption: FIGURE 1. Average daily number of total COVID-19 vaccine doses administered and cumulative percentage of adults aged ≥18 years who received ≥1 dose and who were fully vaccinated, by age group — United States, December 14, 2020–May 1, 2021

Alt text: The figure is a line chart showing the average daily number of total COVID-19 vaccine doses administered and cumulative … [sic]

Panels: 1

Elements: 1 line graph depicts counts of doses administered over time, superposed on 6 lines (6 line styles) depicting cumulative percentage over time; small 2x3 table at top; legend above field

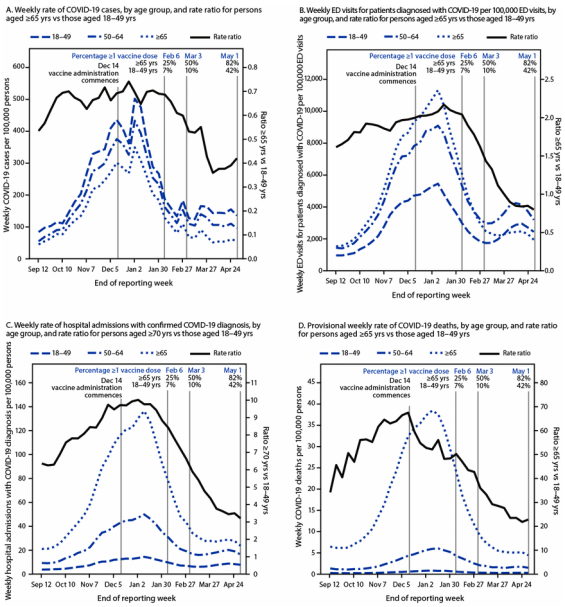
Horizontal: 2-week intervals from December 14 to May 1, with 3 vertical reference lines at February 6, March 3, and May 1; no excess extent

Vertical: Left scale is 0-100%, could trim to ~80%; right scale is 0-3.5 M, no excess extent

Remarks: Relationship between vertical scales is arbitrary.

Figure 2 of 2

File name: mm7023e2-F2.gif



Caption: FIGURE 2. Weekly COVID-19 rates (A), emergency department visits for patients with a diagnosis of COVID-19 (B), hospital admissions with confirmed COVID-19 diagnosis (C), and COVID-19 deaths (D) among adults, by age group, and rate ratio for persons aged ≥65 or ≥70 years versus 18–49 years — United States, September 6, 2020–May 1, 2021

Alt text: The figure is a series of four panels, line charts showing the weekly COVID-19 rates, emergency department visits … [sic]

Panels: 4, 1 each for cases, ED visits, hospital admissions, and deaths

Elements: In each panel 1 line graph depicts rate ratio (≥ 65 or 70 y vs 18-49 y) over time, superposed on 3 lines (3 line styles) depicting 4 different measures over time; small 2x4 table at top of each panel; legend above each panel

Horizontal: 4-week intervals from September 14 to April 24, with 4 vertical reference lines at December 6, February 6, March 3, and May 1; no excess extent

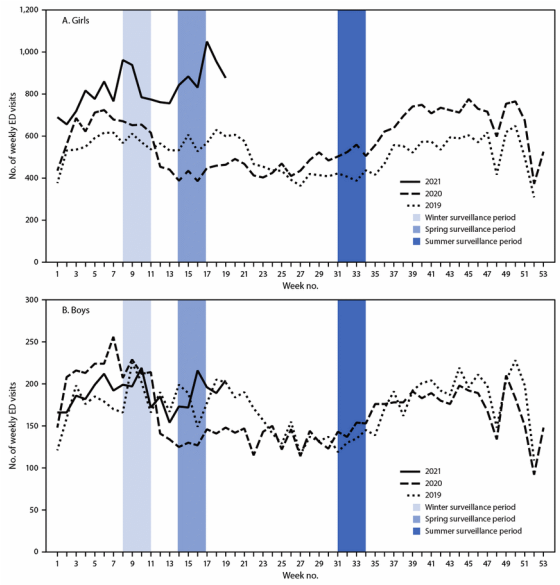
Vertical: Left and right scales are (A) 0-600 per 100,000 and 0.0-0.8; (B) 0-12,000 per 100,000 and 0.0-2.5; (C) 0-160 per 100,000 and 0-11; (D) 0-45 per 100,000 and 0-80. All 8 vertical extents could be trimmed.

Remarks: Relationship between vertical scales is arbitrary in every panel. This figure is loads of gibberish and too much text. It's like a supreme pizza with all the wrong ingredients.

Report mm7024e1 (Yard et al. 2021)

Figure 1 of 2

File name: mm7024e1-F1.gif



Caption: FIGURE 1. Numbers of weekly emergency department visits for suspected suicide attempts among adolescents aged 12–17 years, by sex — National Syndromic Surveillance Program, United States, January 1, 2019–May 15, 2021

Alt text: The figure is a line chart showing numbers of weekly emergency department visits for suspected suicide attempts among adolescents aged 12–17 years, by sex in the United States during January 1, 2019–May 15, 2021, according to the National Syndromic Surveillance Program.

Panels: 2, female and male

Elements: In each panel, 3 line graphs (3 years, 3 line styles) depicting weekly counts over time.

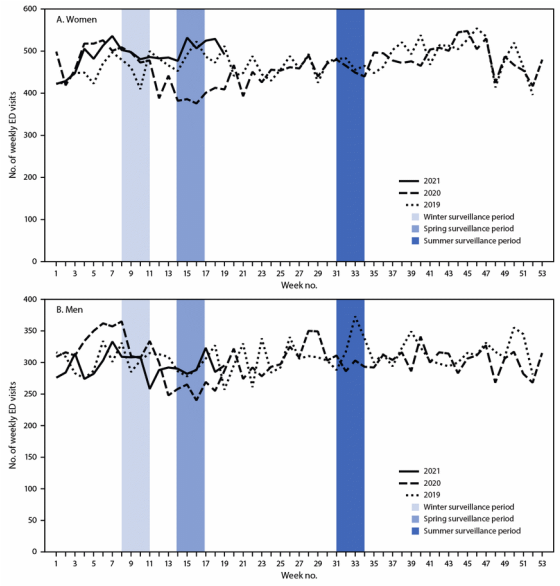
Horizontal: Weeks 1-53, with 3 vertical reference intervals of 3 weeks each ("winter" week 8-11, "spring" 14-17, "summer" 31-34)

Vertical: (A) 0-1,200, could be ~400-1,000 (B) 0-300, could be ~100-250

Remarks: Given the difference between magnitudes in each panel, they could be combined into a single panel with vertical extent ~100-1,000. With direct labeling of some elements, surveillance period shading could be uniform instead of differing colors, where darkest color obscures values.

Figure 2 of 2

File name: mm7024e1-F2.gif



Caption: FIGURE 2. Numbers of weekly emergency department visits for suspected suicide attempts among adults aged 18–25 years, by sex — National Syndromic Surveillance Program, United States, January 1, 2019–May 15, 2021

Alt text: The figure is a line chart showing numbers of weekly emergency department visits for suspected suicide attempts among adults aged 18–25 years, by sex in the United States during January 1, 2019–May 15, 2021, according to the National Syndromic Surveillance Program.

Panels: 2, female and male

Elements: In each panel, 3 line graphs (3 years, 3 line styles) depicting weekly counts over time.

Horizontal: Weeks 1-53, with 3 vertical reference intervals of 3 weeks each ("winter" week 8-11, "spring" 14-17, "summer" 31-34)

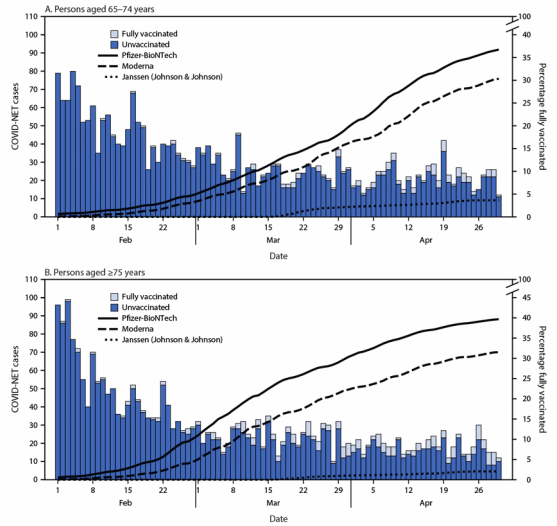
Vertical: (A) 0-600, could be ~400-550 (B) 0-400, could be ~250-375

Remarks: Given the difference between magnitudes in each panel, they could be combined into a single panel with vertical extent ~250-550. With direct labeling of some elements, surveillance period shading could be uniform instead of differing colors, where darkest color obscures values.

Report mm7032e3 (Moline et al. 2021)

Figure 1 of 2

File name: mm7032e3-F1.gif



Caption: FIGURE 1. COVID-NET cases and full vaccination coverage among persons aged 65–74 years (A) and persons aged ≥75 years (B) — 13 states, February 1–April 30, 2021

Alt text: The figure shows cases and full vaccination coverage in 13 states among persons aged 65–74 years and aged ≥75 years with data from the Coronavirus Disease 2019–Associated Hospitalization Surveillance Network during February 1–April 30, 2021.

Panels: 2, ages 65-74 y and ≥75 y

Elements: In each panel, 3 line graphs (3 line styles) depicting percentages over time, superposed on stacked bars (2 categories in 2 colors) depicting case counts over time

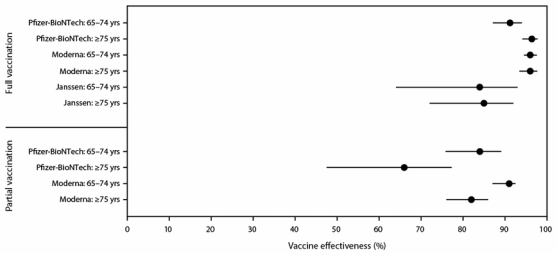
Horizontal: Daily dates from February 1 to April 30; no excess

Vertical: Left scale is 0-110 count, could be 0-100; right scale is 0-45, break, 100, could be 0-40

Remarks: In addition to the abomination of dual vertical scales, this graphic obscures the line graph for J&J against the dark blue bars

Figure 2 of 2

File name: mm7032e3-F2.gif



Caption: FIGURE 2. Estimates of vaccine effectiveness in preventing COVID-19–associated hospitalization among patients aged ≥65 years for the COVID-NET catchment area, by vaccine product and age group using the screening method — COVID-NET, 13 states, February 1–April 30, 2021

Alt text: The figure shows estimated vaccine effectiveness in preventing COVID-19–associated hospitalization for the COVID-NET catchment area, 13 states from the Coronavirus Disease 2019–Associated Hospitalization Surveillance Network during February 1–April 30, 2021.

Panels: 1

Elements: Dots with uncapped intervals depict vaccine effectiveness with CIs for 10 categories that combine vaccine, age, and completeness of vaccination protocols.

Horizontal: 0-100 percent, could be ~48-100, reducing extent by ~48%.

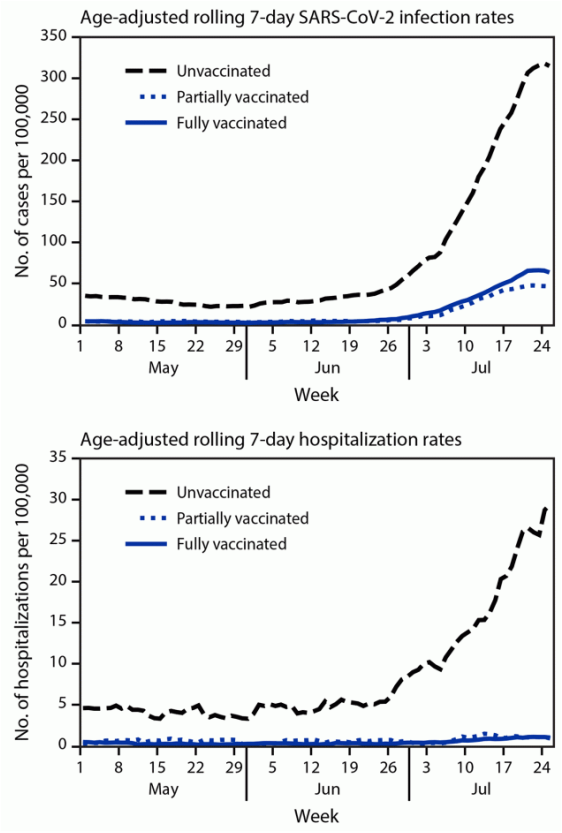
Vertical: 10 categories, in order by full/partial vaccination, Pfizer/Moderna/Janssen, age 65-74 y/≥75 y. Spacing between full and partial groups aids the reader in reading the graphic.

Remarks: This graphic is good, in part because it excludes caps from intervals. It could be improved by limiting the horizontal extent to ~48-100.

Report mm7034e5 (Griffin et al. 2021)

Figure 1 of 2

File name: mm7034e5-F1-medium.gif



Caption: FIGURE 1. Age-adjusted rolling 7-day SARS-CoV-2 infection and hospitalization rates, by vaccination status — Los Angeles County, California, May 1–July 25, 2021

Alt text: This figure includes two line graphs showing the age-adjusted 7-day rolling average of SARS-CoV-2 infection and hospitalization rates in Los Angeles County, California, during May 1–July 25, 2021.

Panels: 2, 1 each for infection and hospitalization

Elements: In each panel, 3 line graphs (3 combinations of color/style) depicting counts per unit population over time

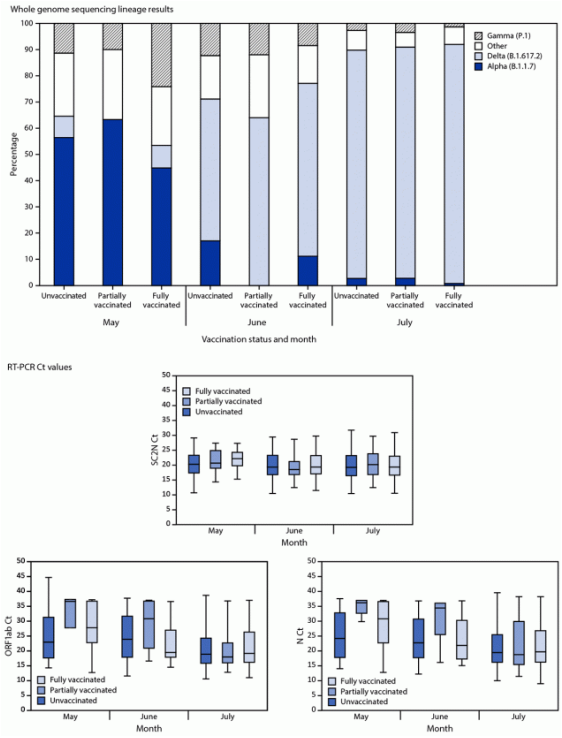
Horizontal: Days, with axis marked each week from May 1 to July 24; no excess

Vertical: Panel 1 is 0- 350 per 100,000, no excess; panel 2 is 0-35 per 100,000, could be 0-30.

Remarks: Generally a good graphic.

Figure 2 of 2

File name: mm7034e5-F2-medium.gif



Caption: FIGURE 2. SARS-CoV-2 whole genome sequencing lineage results and reverse transcription–polymerase chain reaction cycle threshold values for two gene targets, by vaccination status and month — Los Angeles County, California, May 1–July 25, 2021

Alt text: This figure includes one bar chart showing SARS-CoV-2 whole genome sequencing lineage results for five variants, by vaccination status, and three box and whisker plots showing reverse transcription–polymerase chain reaction cycle threshold values for three gene targets, by vaccination status, for specimens from Los Angeles County, California, during May 1–July 25, 2021.

Panels: 4, where panel 1 is a stacked bar chart and 2-4 are box-and-whisker plots with panels for 3 different cycle threshold measures

Elements: Panel 1 is 2 stacked bars with 4 categories each over 9 categories: 3 levels of vaccination crossed with 3 months (May, June, July). Panels 2-4 each depict 9 box-and-whisker plots over the same 9 categories as panel 1.

Horizontal: All 4 panels arrange 9 categories as 3 levels of vaccination crossed with 3 months (May, June, July).

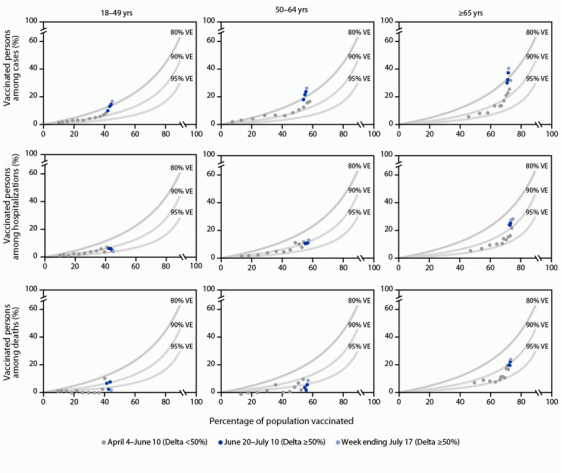
Vertical: Panel 1 scale is 0-100%, no excess. Panels 2-4 scales are 0-50, with data extents ~10-45.

Remarks: This is 2 figures with 1 and 3 panels, respectively. Figure 2A could improve the data-ink ratio by directly labeling the 4 variant categories on, e.g., the leftmost stacked bar. Figure 2B is good, although this is an example in which the vertical extents do not need to match, as the panels represent assays with different levels of detection.

Report mm7037e1 (Scobie et al. 2021)

Figure 1 of 2

File name: mm7037e1-F1-large.gif



Caption: FIGURE 1. Observed versus expected percentage of fully vaccinated persons among COVID-19 cases, hospitalizations, and deaths based on population vaccination coverage and assumed 80%–95% vaccine effectiveness, by week and age group — 13 U.S. jurisdictions, April 4–July 17, 2021

Alt text: The figure is a series of nine scatter plots showing observed versus expected percentage of fully vaccinated persons among COVID-19 cases, hospitalizations, and deaths based on population vaccination coverage and assumed 80%–95% vaccine effectiveness, by week and age group, in 13 U.S. jurisdictions, during April 4–July 17, 2021.

Panels: 9, for 3 endpoints (case, hospitalization, death) crossed with 3 age groups (18-49 y, 50-64 y, ≥65 y)

Elements: In each panel, 14 points depicting percentage by percentage: 11 gray (period 1), 3 dark blue (period 2), and 1 light blue (period 3); each panel has 3 reference curves for 80%, 90%, and 95% expected vaccine effectiveness

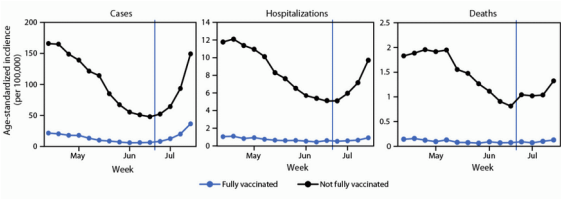
Horizontal: 0-80, break (which is not really a break), 100 percent; extent could be limited to 0-80.

Vertical: 0-60, break, 100 percent; extent could be limited to 0-60.

Remarks: The figure works well, but detail would be clearer if axis extents were restricted and frames were removed or deemphasized.

Figure 2 of 2

File name: mm7037e1-F2-large.gif



Caption: FIGURE 2. Weekly trends in age-standardized incidence of COVID-19 cases, hospitalizations, and deaths, by vaccination status — 13 U.S. jurisdictions, April 4–July 17, 2021

Alt text: The figure is a series of three line graphs showing weekly trends in age-standardized incidence of COVID-19 cases, hospitalizations, and deaths, by vaccination status, in 13 U.S. jurisdictions, during April 4–July 17, 2021.

Panels: 3, for cases, hospitalizations, and deaths

Elements: In each panel, 2 line graphs (by vaccination status) connecting serial dots (2 colors) of counts per unit population over time

Horizontal: Weeks from second week of April to third week of July, same for each panel; vertical reference line after third week in June; no excess; spare axis labeling

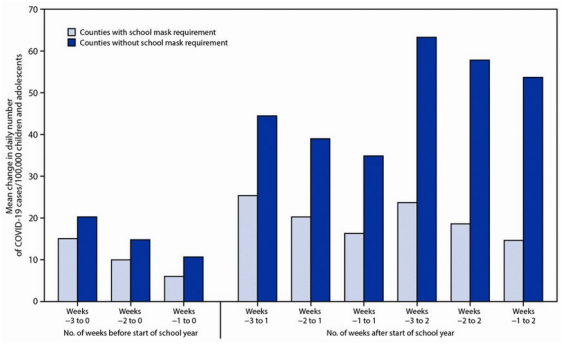
Vertical: 1: 0-200, 2: 0-14; 3: 0-2.5, all per 100,000, little vertical excess

Remarks: Nice graphic; could deemphasize frames. Might work well as 3 panels vertically stacked, since horizontal extent is same but vertical extents differ.

Report mm7039e3 (Budzyn et al. 2021)

Figure 1 of 1

File name: mm7039e3-F-large.gif



Caption: FIGURE. Mean county-level change in daily number of COVID-19 cases per 100,000 children and adolescents aged <18 years in counties (N = 520) with and without school mask requirements before and after the start of the 2021–22 school year — United States, July 1–September 4, 2021

Alt text: [none given]

Panels: 1

Elements: 9 pairs of bars (2 colors), grouped horizontally, indicating mean change through contrasts in pairs of weeks

Horizontal: Week-based intervals as ordered categories, with extra space between differences before and after start of school year.

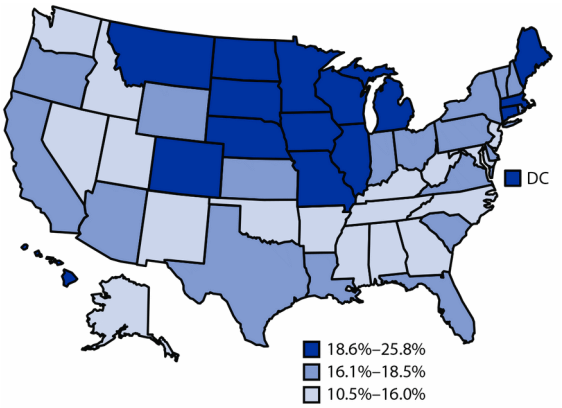
Vertical: 0-70, with little excess

Remarks: Bar charts should not be used for means, nor, in general, for potentially negative values. This graphic would work better as a dumbbell plot over a grid of 9 panels for weeks {-3, -2, and -1} to {0, 1, and 2}.

Report mm7041a2 (Bohm et al. 2021)

Figure 1 of 1

File name: mm7041a2-F.gif



Caption: FIGURE. Prevalence of binge drinking among adults aged ≥18 years — Behavioral Risk Factor Surveillance System, United States, 2018

Alt text: The figure is a map showing the prevalence of binge drinking among adults aged ≥18 years in 2018 in the United States from the Behavioral Risk Factor Surveillance System.

Panels: 1

Elements: Choropleth map of 50 states, 3 colors

Horizontal: Latitude

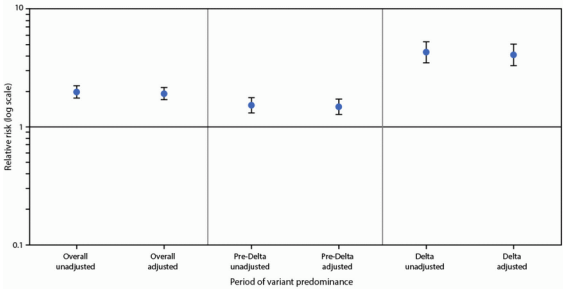
Vertical: Longitude

Remarks:

Report mm7047e1 (DeSisto et al. 2021)

Figure 1 of 1

File name: mm7047e1-F-large.gif



Caption: FIGURE. Relative risk for stillbirth among women with COVID-19 at delivery hospitalization compared with those without COVID-19 at delivery hospitalization — Premier Healthcare Database Special COVID-19 Release, United States, March 2020–September 2021

Alt text: Figure is a chart showing relative risk for stillbirth among women with COVID-19 at delivery hospitalization compared with those without COVID-19 at delivery hospitalization in the United States during March 2020–September 2021 according to the Premier Healthcare Database Special COVID-19 Release.

Panels: 1

Elements: Dots with capped intervals in 3 (overall, pre-delta, delta) pairs (unadjusted and adjusted) depicting relative risk and CIs over 6 categories

Horizontal: 6 categories, spread out

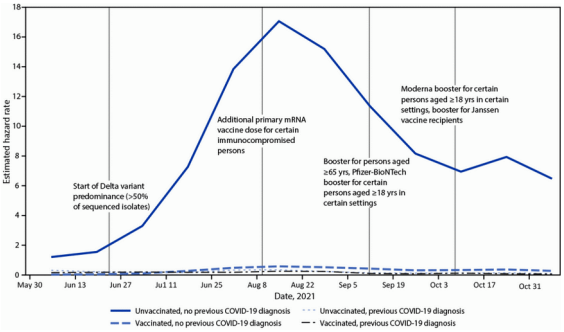
Vertical: 0.1-10 on log scale, data elements 1.27-5.22, ~70% excess extent

Remarks: Horizontal extent could be compressed without loss, and excess vertical space is ~70%. All data values are listed in the table footnote, suggesting that this figure could have been a table or a table and a more space-efficient version of the graphic.

Report mm7104e1 (León et al. 2022)

Figure 1 of 1

File name: mm7104e1_F-large.gif



Caption: FIGURE. Incident laboratory-confirmed COVID-19-associated hospitalizations among immunologic cohorts defined by vaccination and previous diagnosis histories — California, May 30–November 13, 2021

Alt text: The figure is a line chart showing incident laboratory-confirmed COVID-19-associated hospitalizations among immunologic cohorts defined by vaccination and previous diagnosis histories in California during May 30–November 20, 2021.

Panels: 1

Elements: 4 line graphs (4 styles) depicting hazard values over time

Horizontal: Dates from early June to early November, a little excess; 4 vertical reference lines labeled with notable events

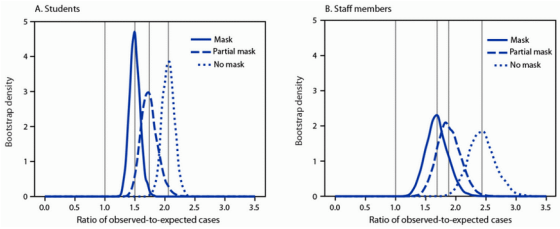
Vertical: 0-18 on linear scale, little excess

Remarks: 3 of the 4 line graphs are obscured by the frame/horizontal axis.

Report mm7110e1 (Donovan et al. 2022)

Figure 1 of 2

File name: mm7110e1-F1-large.gif



Caption: FIGURE 1. Mean estimates of the ratio of observed school district cases to expected school district cases among students (A) and staff members (B), based on surrounding community incidence, by mask requirement status — 233 school districts, Arkansas, August–October 2021

Alt text: The figure is a chart showing mean estimates of the ratio of observed school district cases to expected school district cases among students and staff members, based on surrounding community incidence, by mask requirement status in 233 school districts in Arkansas during August–October 2021.

Panels: 2

Elements: In each panel, 3 density line graphs each

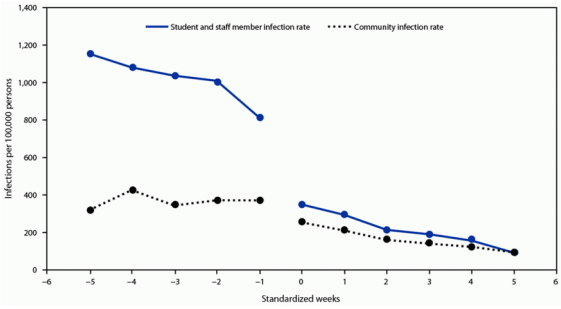
Horizontal: 0.0-3.5, matching across panels, with panel-specific vertical reference lines at 1 and the modes of each of 3 densities; could be reduced to 1.0-3.2 (removing ~40% of extent)

Vertical: 0-5, matches across panels but has little inherent meaning

Remarks: Both panels could be replaced by 1-dimensional representations (such as box-and-whisker plots) or numerical summaries.

Figure 2 of 2

File name: mm7110e1-F2-large.gif



Caption: FIGURE 2. Student and staff member and community SARS-CoV-2 infection rates before and after implementation of school mask requirement — 26 school districts, Arkansas, August–October 2021

Alt text: The figure is a chart showing student and staff member and community COVID infection rates before and after implementation of school mask requirement at 26 school districts in Arkansas during August–October 2021.

Panels: 1

Elements: 2 discontinuous line graphs, with 2 segments connecting 5 and 6 dots each, depicting count per unit population over time from an index event

Horizontal: -6 to +6 weeks, could be reduced to -5 to +5 (~16% excess extent)

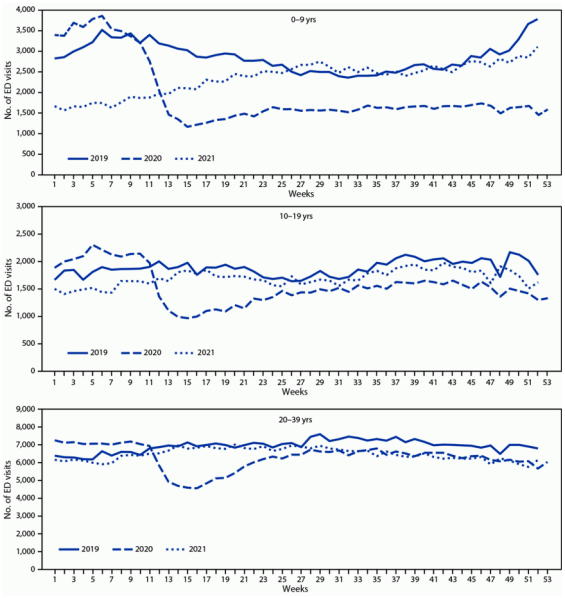
Vertical: 0-1,400 per 100,000, could be reduced to 0-1,200 (~14% excess extent)

Remarks: Graphic might be aided by superposing connected segments on discontinuous, piecewise linear fits.

Report mm7121a2 (Sapkota et al. 2022)

Figure 1 of 2

File name: mm7121a2-F1-large.gif



Caption: FIGURE 1. Weekly seizure- or epilepsy-related emergency department visits among persons aged <40 years, by age group — National Syndromic Surveillance Program, United States, 2019–2021

Alt text: [none given]

Panels: 3, for age groups 0-9 y, 10-19 y, and 20-39 y

Elements: 3 line graphs (3 styles, for years 2019, 2020, 2021) over time

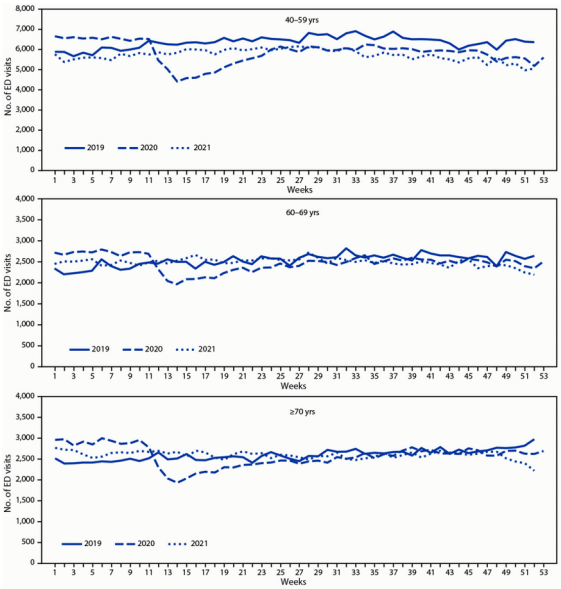
Horizontal: 1-53 weeks, no excess

Vertical: 0-4,000, 0-3,000, and 0-9,000. In every case lower extent can be trimmed. In 2 cases, upper extent can be trimmed.

Remarks:

Figure 2 of 2

File name: mm7121a2-F2-large.gif



Caption: FIGURE 2. Weekly seizure- or epilepsy-related emergency department visits among persons aged ≥40 years, by age group — National Syndromic Surveillance Program, United States, 2019–2021

Alt text: The figure is a line chart showing weekly seizure- or epilepsy-related emergency department visits among persons aged ≥40 years, by age group, using data from the National Syndromic Surveillance Program, in the United States, during 2019–2021.

Panels: 3, for age groups 40-59 y, 60-69 y, and ≥70 y

Elements: 3 line graphs (3 styles, for years 2019, 2020, 2021) over time

Horizontal: 1-53 weeks, no excess

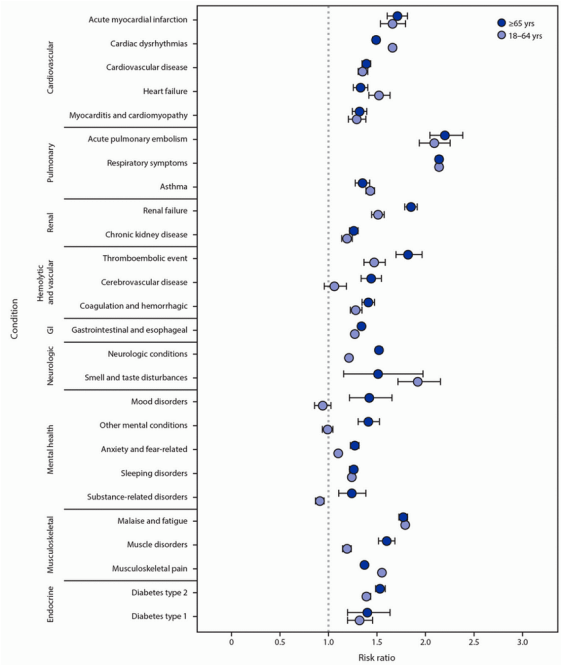
Vertical: 0-8,000, 0-4,000, and 0-3,000. In every case lower extent can be trimmed. In 2 cases, upper extent can be trimmed.

Remarks:

Report mm7121e1 (Bull-Otterson et al. 2022)

Figure 1 of 1

File name: mm7121e1-F-large.gif



Caption: FIGURE. Risk ratios for developing post-COVID conditions among adults aged 18–64 years and ≥65 years — United States, March 2020– November 2021

Alt text: The figure is a forest plot showing the risk ratios for developing post-COVID-19 conditions among adults aged 18–64 years and ≥65 years, by condition in the United States during March 2020–November 2021.

Panels: 1

Elements: 26 pairs (2 age groups, 2 colors) of dots, each dot with a capped interval, depicting risk ratios with CIs in vertical groups of 1-5 pairs per group, in approximate descending order by risk ratio of group

Horizontal: 0 to 3.0 linear scale, which could be reduced to ~0.8-2.6 (removing 40%); log scale might or might not help further

Vertical: 26 condition categories in groups

Remarks: This graphic might be improved by removing interval caps, reducing the dot sizes, applying color to dot/interval combinations, and reducing horizontal extent.

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