A Shiny application to summarise study adherence to reporting checklists

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1 Overview

Health and medical research must be transparently reported to ensure findings are interpreted correctly and are reproducible by other researchers [1, 2]. Improved reporting is an actionable step towards improving the quality of published research.

The Enhancing the Quality and Transparency of Health Research (EQUATOR) Network is an international initiative that was established to promote good reporting practices [3]. A major component of the EQUATOR Network has been the development of reporting checklists, which offer expert guidance on reporting key details about study conduct, assumptions and outcomes for commonly used study designs.

Despite reporting checklists being freely available from the EQUATOR website, adherence to checklist guidance in published studies is low [4, 5]. A major contributor to continuing poor adherence has been a lack of awareness about available checklists among researchers [6]. The appraisal of already published studies against reporting checklists as part of systematic and scoping reviews is a helpful way to evaluate current trends in reporting and to increase awareness around transparent reporting practices [7]. When charting data across several studies, visualisation provides an effective means of communication, to identify inconsistencies in reporting and therefore highlight areas for improvement within the targeted area of research [8–11].

We have developed a freely available Shiny application for visualising reporting quality against EQUATOR reporting checklists. Shiny is a package available in R for building interactive web-based applications and dashboards using R code [12, 13]. The application uses data provided by the user to display assessments of individual studies against appropriate checklist criteria. Summary figures and tables for selected studies and checklist items can be generated and exported for use in publications.

In the following sections, we outline the main steps involved when using the application. The application is available at https://aushsi.shinyapps.io/visual_checklist/. Code is available on GitHub at https://github.com/nicolemwhite/visual_checklist.

2 Getting started

The application requires data to be entered using a standardised template. For a given checklist, minimum data comprises checklist item information and individual study responses to checklist items. Templates for different checklists can be downloaded from the Home menu (Figure 1).

Reporting checklists available for download are listed in Table 1. To complement the TRIPOD checklist, a template for the Prediction Model Risk Of Bias Assessment Tool (PROBAST) [14] is

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also available for download. A Custom option allows users to create their own checklist based on standardised fields.

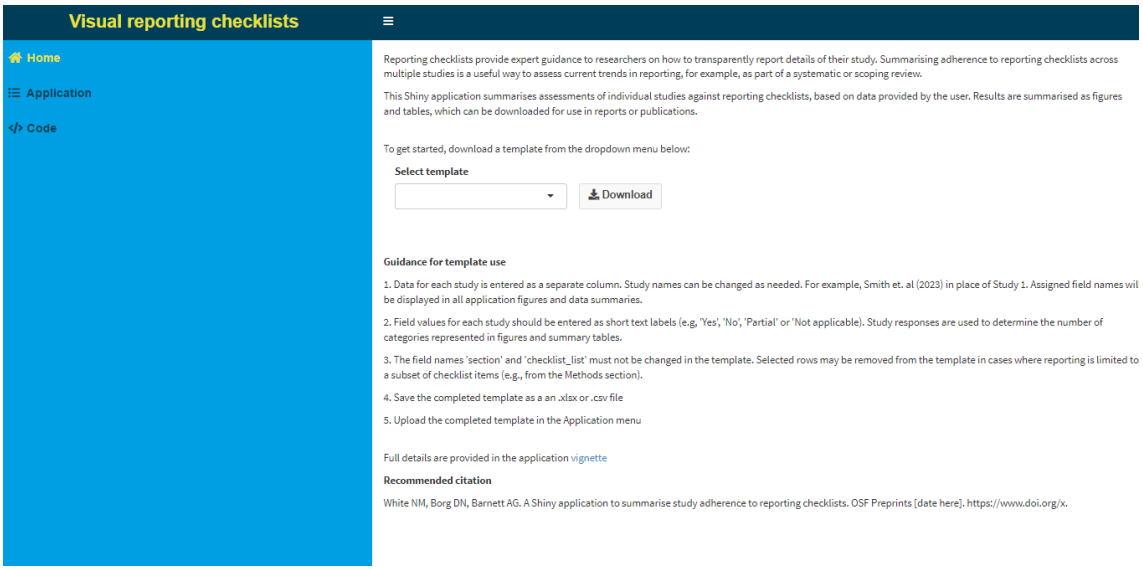

Figure 1: Application home page for accessing checklist templates and general instructions for data entry

Core variables in each template are the section of the checklist (`section`) and checklist item descriptions within each section (`item_number`). Reporting guidance for each checklist item is also provided in a separate column (`item_full_text`), however, this column is not used by the application. Data for each study is entered into its own column, denoted by the variable names `Study 1`, `Study 2`, and so on.

The variable names `section` and `item_number` must not be changed in the template. Labels for these variables can instead be updated when customising figures and summary tables (see Section 3.2). Selected rows can be deleted from a template if users do not wish to report on specific items.

Labels for individual studies and study responses can be customised by the user. Study labels will appear verbatim in all figures and summary tables. Study labels can therefore be edited based on user preferences (e.g., 'White et al (2023)' in place of 'Study 1'). Individual study responses are used to determine the number of categories represented in figures and summary tables. Examples of study responses include 'Yes'/'No'/'Unsure', and 'Stated'/'Not stated'. The application will remove incidental whitespace in responses before plotting; no further data cleaning is performed. Missing data is automatically labelled 'Missing/Unknown'.

Data for any number of studies can be entered into the template. Whilst we have not imposed a limit on the number of studies, resulting figure dimensions may need to be updated to accommodate large numbers of studies (see Section 3.2).

Reporting checklist	**Website link**
Consolidated Health Economic Evaluation Reporting Standards (CHEERS)[15]	https://www.equator-network.org/reporting-guidelines/cheers/
Consolidated Standards of Reporting Trials (CONSORT)[16]	https://www.equator-network.org/reporting-guidelines/consort/
Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [17]	https://www.equator-network.org/reporting-guidelines/prisma/
PRISMA extension for Scoping Reviews (PRISMA-ScR)[18]	https://www.equator-network.org/reporting-guidelines/prisma-scr/
Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT)[19]	https://www.equator-network.org/reporting-guidelines/spirit-2013-statement-defining-standard-protocol-items-for-clinical-trials/
Standards for Quality Improvement Reporting Excellence (SQUIRE)[20]	https://www.equator-network.org/reporting-guidelines/squire/
Standards for reporting qualitative research (SRQR)[21]	https://www.equator-network.org/reporting-guidelines/srqr/
Standards for Reporting of Diagnostic Accuracy Studies (STARD)[22]	https://www.equator-network.org/reporting-guidelines/stard/
Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [23]	https://www.equator-network.org/reporting-guidelines/strobe/
Template for Intervention Description and Replication (TIDierR) [24]	https://www.equator-network.org/reporting-guidelines/tidier/
Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis (TRIPOD) [25]	https://www.equator-network.org/reporting-guidelines/tripod-statement/
Prediction Model Risk Of Bias Assessment Tool (PROBAST) [14]	https://www.probast.org/downloads/

Table 1: Checklists available for download as pre-filled templates

3 Application

3.1 Upload completed template

Completed templates are uploaded under the Application menu (Figure 2). The completed template must be saved in .csv format. An error message will appear for incompatible file types.

3.2 Figure customisation

Three figure options are available. The options are summarised in Table 2.

Select plot option	Description
Full dataset	Displays all responses by checklist item (x-axis) and study (y-axis)
Summary by study	Displays a frequency bar chart summarising the number of checklist items that fall into each response category (x-axis) by study (y-axis)
Summary by checklist items	Displays a frequency bar chart summarising the number of studies that fall into each response category (x-axis) by checklist item (y-axis)

Table 2: Figure options for summarising checklist reporting

Options to customise figures can be found under the Application menu. The figure colour scheme can be adjusted using the *Choose colour scheme* option, which contains nine fixed palettes and a Custom option (default). Fixed colour palettes include a maximum of eight colours, except for the Greyscale palette which includes up to five colours. Colours are automatically assigned to response categories, based on the number of categories identified. The Custom colour scheme allows users to specify the colour of each judgement (e.g., 'Yes', 'No', 'Unclear') using the full range of hexadecimal values. The assignment of colours to response categories can be varied for all available colour schemes, by clicking on each category in the application sidebar (Figure 2).

Figure 2: Application window, showing an example summary of study reporting against the CHEERS checklist. Data to replicate this example is available from `https://github.com/nicolemwhite/visual_checklist`

Axis labels can be changed using the *x-axis label* and *y-axis label* text boxes. Study results are arranged by column order specified in the template, however, results can be updated to appear

in alphabetical order. A figure legend can be included or excluded by selecting the appropriate radio button under *Display legend*.

In the main output window, the *Select plot* option allows users to present the full dataset, or to create a figure that summarises judgements by study or checklist item. Users can select the figure export format, the figure resolution (dpi) and the height and width of the figure, in pixels.

3.3 Interactive data summary

Users can create summary tables from data presented in figures to report on specific studies and/or checklist items. The creation of interactive data summaries depends on the figure option selected in the main window.

For the 'Full dataset' figure, users can highlight a specific area of the plot to extract data from. Data for corresponding studies and checklist items within the chosen area are then displayed below the figure in the *Interactive data summary* window. An example is given in the top panel of Figure 3.

For the 'Summary by study' and 'Summary by checklist item' options, users can instead click on a coloured bar within the figure to summarise all studies or checklist items within the same bar. The bottom panel of Figure 3 shows the result of clicking the green bar (Yes) for Study 15.

Data in the interactive summary table can be downloaded at any time using the *Download table* button, located under the summary table. Output is saved as a Word document (.docx).

Figure 3: Examples of interactive summary tables the example dataset generated in Figure 2. The top screenshot displays summary data for the *Full dataset* figure option. Data are displayed for individual assessments based on highlighting the corresponding area in the top left corner of the Figure. The bottom screenshot displays summary data for the *Summary by study* figure option. Here, data are summarised for Study 15 where items as classified as 'Yes'.

4 Code

R code for all three figure types is dynamically generated under the `Code` menu, based on application inputs. The code uses the `vroom` package for importing data; `dplyr` for general data processing, and `ggplot2` for creating figures. The `dplyr` and `ggplot2` packages are available as part of the `tidyverse` collection of R packages [26].

This functionality is aimed at R users who may wish to further modify the appearance of figures outside of the application. Code for each figure type is presented independently, allowing users to cut and paste directly into R. An example of code generated for the CHEERS checklist from Figure 2 is shown in Figure 4.

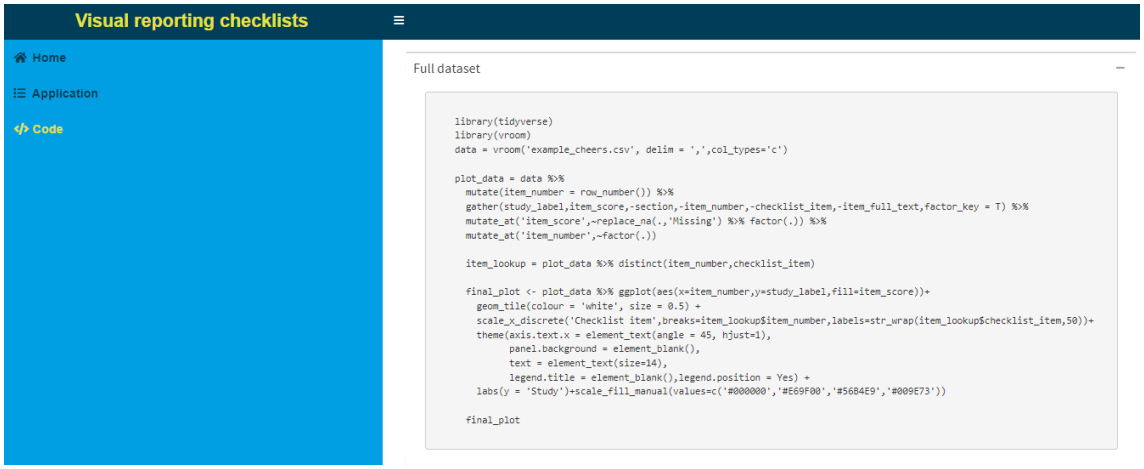

Figure 4: Code generated for the example dataset generated in Figure 2

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