



# Research Development Using REDCap Software

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**Objectives:** High-quality clinical research is dependent on adequate design, methodology, and data collection. The utilization of electronic data capture (EDC) systems is recommended to optimize research data through proper management. This paper's objective is to present the procedures of REDCap (Research Electronic Data Capture), which supports research development, and to promote the utilization of this software among the scientific community. **Methods:** REDCap's web application version 10.4.1 released on 2021 (Vanderbilt University) is an EDC system suitable for clinical research development. This paper describes how to join the REDCap consortium and presents how to develop survey instruments and use them to collect and analyze data. **Results:** Since REDCap is a web application that stimulates knowledge-sharing among the scientific community, its development is not finished and it is constantly receiving updates to improve the system. REDCap's tools provide access control, audit trails, and data security to the research team. **Conclusions:** REDCap is a web application that can facilitate clinical research development, mainly in health fields, and reduce the costs of conducting research. Its tools allow researchers to make the best use of EDC components, such as data storage.

**Keywords:** Health Information Systems, Public Health Surveillance, Data Collection, Mobile Applications, Health Services Research

## I. Introduction

High-quality clinical research is dependent on adequate design, methodology, and data collection [1]. A common part of clinical research and health surveillance is the dissemination of the information produced throughout the

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process [2,3]. Electronic data capture methods and systems have been used in clinical research to improve data collection, storage, and analysis, and proper management tools are subsequently used for access control, audit trails, and data security [4-6].

The Research Electronic Data Capture (REDCap) platform is a web application that supports several types of clinical research, such as clinical trials, retrospective studies, and cohort studies, among others [7-13]. REDCap is compliant with FISMA (Federal Information Security Management Act), GDPR (General Data Protection Regulation), HIPAA (Health Insurance Portability and Accountability Act), and 21 CFR Part 11 (Part 11 of Title 21 of the Code of Federal Regulations). REDCap's consortium includes 5,200 partners spread across 141 countries (Figure 1), and it has been cited in over 14,500 articles (information updated in June 2021) [7-15].

This tutorial is motivated by the intention to disseminate a valid and detailed document for users ranging from begin-

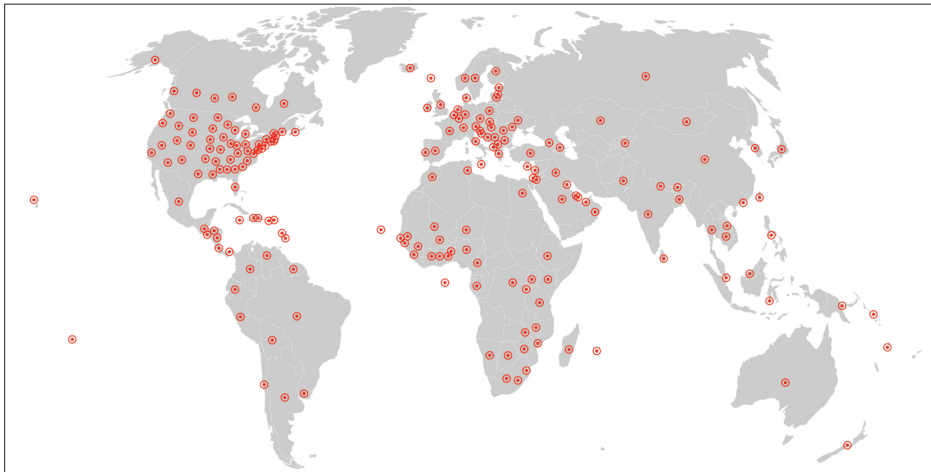


Figure 1. REDCap Consortium distribution across the globe.

**My Projects** Organize Collapse All Filter projects by title

Project Title	Records	Fields	Instruments	Type	Status
XXXXXXXXXXXXXXXXXXXXXXXXXX	1	52	1 survey		
XXXXXXXXXXXXXXXXXXXXXXXXXX	1	7	1 form		✓
XXXXXXXXXXXXXXXXXXXXXXXXXX	1	12	6 surveys		
XXXXXXXXXXXXXXXXXXXXXXXXXX	0	6	2 surveys		
XXXXXXXXXXXXXXXXXXXXXXXXXX	1	49	2 surveys		✓
<b>Death Surveillance</b>	1	16	1 survey		

**+ Create a new REDCap Project**

You may begin the creation of a new REDCap project on your own by completing the form below and clicking the Create Project button at the bottom.

**Project title:**   
Title to be displayed on project webpage

**Purpose of this project:**   
How will it be used?

**Project notes (optional):**

**Start project from scratch or begin with a template?**

- Create an empty project (blank slate)
- Upload a REDCap project XML file (CDISC ODM format) [?]
- Use a template (choose one below)

**★ Choose a project template** (comes pre-filled with fields, forms/surveys, and other settings)

select template	Template title (sorted by title)	Template description
<input type="radio"/>	Basic Demography	Contains a single data collection instrument to capture basic demographic information.
<input type="radio"/>	Classic Database	Contains six data entry forms, including forms for demography and baseline data, three monthly data forms, and concludes with a completion data form.
<input type="radio"/>	Field Embedding Example Project	Contains a single data collection instrument to demonstrate the Field Embedding feature.
<input type="radio"/>	Formulario desvio de qualidade em imunobiológicos	
<input type="radio"/>	Human Cancer Tissue Biobank	Contains five data entry forms for collecting and tracking information for cancer tissue

Figure 2. REDCap user's new project configuration.

ners to highly-experienced scientists in clinical research. This article's objective is to present the major procedures involved in using REDCap to conduct research, as well as to promote utilization of the software among the scientific community.

## II. Methods

### 1. Joining the REDCap Consortium and Installation

The REDCap software version described in this article is 10.4.1 released on 2021 (Vanderbilt University). REDCap software and consortium support are available at no charge to non-profit organizations that join the consortium.

To obtain access to the REDCap software, the researcher must first contact the REDCap consortium to receive support and an adequate orientation through the following link: <https://www.project-REDCap.org/partners/join/>. To join, it is only necessary to agree to the standard license terms. If the researcher’s institution already utilizes REDCap, the researcher must contact the institution’s REDCap administrator to request the creation of a new user to log in to the system.

A REDCap requirement is to have a MySQL client for performing the installation and updates. MySQL needs to be

installed on a machine with a compatible operating system, such as Oracle Linux 8, Red Hat Enterprise 8, Debian 8, Ubuntu 21.04, or Microsoft Windows Server. A cloud solution for REDCap installation is an Amazon EC2 (Elastic Computing Cloud) instance with a compatible operating system. Cloud storage can be done through other Amazon Web Services (AWS) provided to avoid overloading the EC2 instance.

Institutions with limited infrastructure have the option of contacting the REDCap organization to have its administration carried out by a specific company at the cost of a

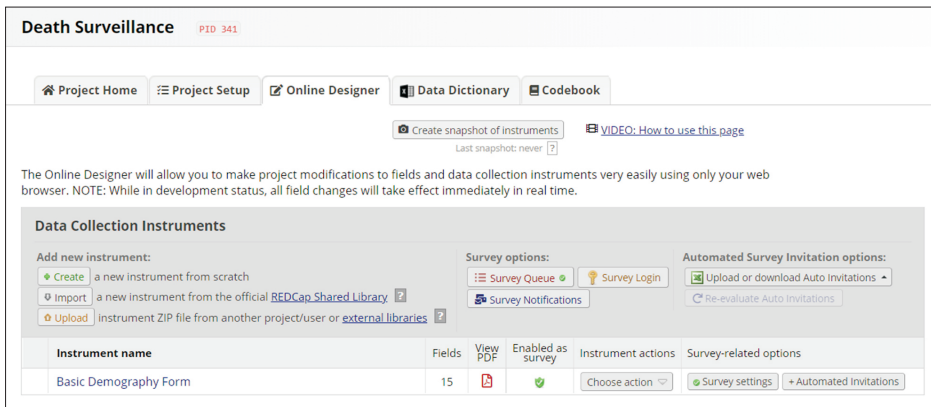


Figure 3. Online designer menu.

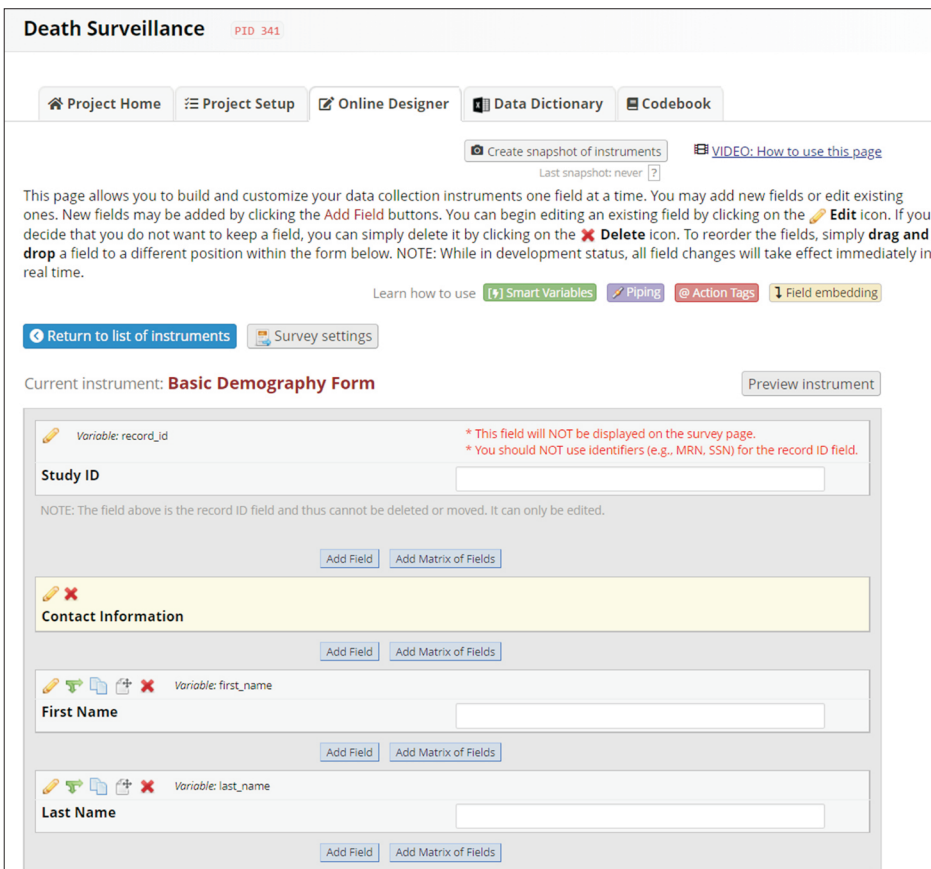


Figure 4. Development of an instrument for data collection.

monthly fee. Although a third-party company may administer the REDCap system, REDCap is not available for use by individuals without an institutional affiliation.

The opening page requires the researcher's login and password. After logging in, the user can start new projects.

**Death Surveillance** PID 341

Project Home | Project Setup | Online Designer | **Data Dictionary** | Codebook

The Codebook is a human-readable, read-only version of the project's Data Dictionary and serves as a quick reference for viewing the attributes of any given field in the project without having to download and interpret the Data Dictionary. Note: Checkbox fields have their coded values displayed both in the format defined by users in the Online Designer/Data Dictionary as well as in the extended format seen in data imports and exports (i.e., field\_\_code).

[Print page](#) **Data Dictionary Codebook**

[Collapse all instruments](#)

#	Variable / Field Name	Field Label <small>Field Note</small>	Field Attributes (Field Type, Validation, Choices, Calculations, etc.)						
Instrument: <b>Basic Demography Form</b> (demographics) <span style="color: green;">Enabled as survey</span> <span style="float: right;"><a href="#">Collapse</a></span>									
1	record_id	Study ID	text						
2	first_name	Section Header: <i>Contact Information</i> First Name	text, Identifier						
3	last_name	Last Name	text, Identifier						
4	address	Street, City, State, ZIP	notes, Identifier						
5	telephone	Phone number <small>Include Area Code</small>	text (phone), Identifier						
6	email	E-mail	text (email), Identifier						
7	dob	Date of birth	text (date_ymd), Identifier						
8	age	Age (years)	calc Calculation: rounddown(datediff([dob],today,'y'))						
9	ethnicity	Ethnicity	radio <table border="1" style="width: 100%;"> <tr><td>0</td><td>Hispanic or Latino</td></tr> <tr><td>1</td><td>NOT Hispanic or Latino</td></tr> <tr><td>2</td><td>Unknown / Not Reported</td></tr> </table> Custom alignment: LH	0	Hispanic or Latino	1	NOT Hispanic or Latino	2	Unknown / Not Reported
0	Hispanic or Latino								
1	NOT Hispanic or Latino								
2	Unknown / Not Reported								

Figure 5. Instrument codebook and data dictionary.

**Death Surveillance** PID 341

**Survey Distribution Tools**

Public Survey Link | Participant List | Survey Invitation Log

Using a public survey link is the simplest and fastest way to collect responses for your survey. You may obtain the survey link below to email it to your participants. Responses will be collected anonymously (unless the survey contains questions asking for identifying data from the participant). **NOTE:** Since this method uses a single survey link for all participants, it allows for the possibility of participants taking the survey multiple times, which may be necessary in some cases.

To obtain the survey link, copy the URL below and paste it into the body of an email message in your own email client. Your email recipient(s) can then click the link to begin taking your survey.

**Public Survey URL:** https://redcap.saude.gov.br/surveys/?s=NP7C9WHXR8

Protect the public survey using the Google reCAPTCHA feature [?](#)

**Link Actions**

[Open public survey](#)

[Open public survey + Log out](#)

[Send me URL via email](#)

[Survey Access Code or QR Code](#)

**Link Customizations**

[Get Short Survey Link](#)

[Create Custom Survey Link](#)

[Get Embed Code](#)

Figure 6. Instrument distribution tools.

## 2. Project Creation

When the researcher first accesses REDCap, the initial page will present no projects to check. To initiate a project, the researcher must select “New Project” (Figure 2).

A new page will appear, on which the researcher must initialize the project configuration. A project title and project objective must be defined; examples of objectives would include “research” and “practice/just for fun.” It is possible to insert notes about the project and to choose whether this new project will follow an existing template. REDCap has 15 pre-defined template options available with variables related to each theme (Figure 2). It is important to explore these templates before starting an official project to maximize their usefulness for the development of the study. However, it is advisable that if the project’s questionnaires are already prepared, the research team should not use templates.

## 3. Instrument Creation and Data Dictionary

Once a project is ready to run, it is time to develop the data collection instrument. The “Online Designer” icon leads to the designer’s menu (Figure 3). Then, one can select the “Create/a new instrument from scratch” option or edit an

instrument that is already available if an initial template was selected in the previous steps. The user selects the instrument to be edited.

Next, it is possible to add questions through the “Add field” option (Figure 4). A new project page will open to allow field configuration. In this step, the user can choose question types such as “simple text,” “calculated field,” and “multiple choice,” among others. Other configuration options, such as marking whether a field is required and whether it identifies participants, are required to finalize the question configuration.

Once an instrument’s fields have been created, it is possible to reorganize them using drag-and-drop functionality. After the instrument is finalized, it is possible to check the “Codebook” (data dictionary) available in the tabs at the top of the page (Figure 5).

After checking whether the instrument is complete and accurate, the researcher must go to the “Project Setup” tab and click on the “Enable” icons in the “Main project setting” fields. The “I’m done!” icon must also be activated in the “Design your data collection instruments and enable your surveys” field. After the previous steps are concluded, a new

The screenshot displays the 'Basic Demography Form' in REDCap. At the top, it shows the project title 'Death Surveillance' with a PID of 341. Below the title, there are action buttons: 'Modify Instrument', 'Download PDF of instrument(s)', and a video link 'VIDEO: Basic data entry'. On the right side, there are buttons for 'Save & Exit Form', 'Save & ...', and 'Cancel'. The form itself is titled 'Basic Demography Form' and includes a section for 'Adding new Study ID 2'. The 'Study ID' is set to 2. The 'Contact Information' section contains the following fields: 'First Name' (John), 'Last Name' (Maya), 'Street, City, State, ZIP' (Sc 9999), 'Phone number' ((415) 999-9999), 'E-mail' (JMxxxx@xxxx.com), 'Date of birth' (2000-01-01), 'Age (years)' (21), 'Ethnicity' (radio buttons for Hispanic or Latino, NOT Hispanic or Latino, Unknown / Not Reported), 'Race' (American Indian/Alaska Native), 'Sex' (radio buttons for Female, Male), 'Height (cm)' (177), 'Weight (kilograms)' (77), and 'BMI' (24.6). Each field has a 'View equation' link next to it.

Figure 7. Manual data insertion.

named field will be available in the side menu.

#### 4. Dissemination and Questionnaire Completion

In the “Survey Distribution Tools” menu, the researcher can configure the distribution tools to disseminate the data collection instrument. The researcher must click on the “Enable” icon below the “Enabled as survey” column on the options for the generated instrument. A new window will be opened, where it will be possible to configure the survey

title along with other tools such as “Survey Instructions” for the respondent. After the researcher presses “Save Changes,” the software will return to the previous page where the icon “Survey Queue” must be selected to activate the instrument, and then dissemination to participants will be enabled. Once the previous step is completed, the researcher must select “Survey Distribution Tools” again. A new window will be opened where the researcher can copy the “Public Survey URL” or disseminate it through e-mail (Figure 6).

**Death Surveillance** PID 341

**Data Exports, Reports, and Stats** VIDEO: How to use Data Exports, Reports, and Stats

+ Create New Report My Reports & Exports Other Export Options

This module allows you to easily view reports of your data, inspect plots and descriptive statistics of your data, as well as export your data to Microsoft Excel, SAS, Stata, R, or SPSS for analysis (if you have such privileges). If you wish to export your \*entire\* data set or view it as a report, then Report A is the best and quickest way. However, if you want to view or export data from only specific instruments (or events) on the fly, then Report B is the best choice. You may also create your own custom reports below (if you have such privileges) in which you can filter the report to specific fields, records, or events using a vast array of filtering tools to make sure you get the exact data you want. Once you have created a report, you may view it as a webpage, export it out of REDCap in a specified format (Excel, SAS, Stata, SPSS, R), or view the plots and descriptive statistics for that report.

My Reports & Exports		View/Export Options	Management Options
A	All data (all records and fields)	View Report Export Data Stats & Charts	
B	Selected instruments (all records)	Make custom selections	

+ Create New Report

Number of results returned: 1  
Total number of records queried: 1  
Report execution time: 0 seconds

Stats & Charts Export Data Print Page

**All data (all records and fields)**

Study ID record_id	Survey Identifier redcap_survey_identifier	Survey Timestamp identity_timestamp	First Name first_name	Last Name last_name	Street, City, State, ZIP address	Phone number telephone	E-mail email	Date of birth dob	Age (years) age	Ethnicity ethnicity	Race race	Sex sex	Height (cm) height	Weight (kilograms) weight	BMI bmi
1			John	Maya	St 9999	(415) 999-9999	JMxxxxx@xxxxx.com	2000-01-01	21	American Indian/Alaska Native (0)		Male (1)	177	77	24.6

Figure 8. Data reports and exports menu.

**Exporting "All data (all records and fields)"**

Select your export settings, which includes the export format (Excel/CSV, SAS, SPSS, R, Stata) and if you wish to perform de-identification on the data set.

**Choose export format**

- CSV / Microsoft Excel (raw data)
- CSV / Microsoft Excel (labels)
- SPSS Statistical Software
- SAS Statistical Software
- R Statistical Software
- Stata Statistical Software
- CDISC ODM (XML)

**De-identification options (optional)**

The options below allow you to limit the amount of sensitive information that you are exporting out of the project. Check all that apply.

**Known Identifiers:**

- Remove all tagged Identifier fields (tagged in Data Dictionary)
- Hash the Record ID field (converts record name to an unrecognizable value)

**Free-form text:**

- Remove unvalidated Text fields (i.e. Text fields other than dates, numbers, etc.)
- Remove Notes/Essay box fields

**Date and datetime fields:**

- Remove all date and datetime fields
- OR
- Shift all dates by value between 0 and 364 days (shifted amount determined by algorithm for each record) [What is date shifting?](#)
- Also shift all survey completion timestamps by value between 0 and 364 days (shifted amount determined by algorithm for each record)

[Deselect all options](#)

**Additional export options**

- Export survey identifier field and survey timestamp field(s)?

**Advanced data formatting options**

**Set CSV delimiter character**  
Set the delimiter used to separate values in the CSV data file (only valid for CSV Raw Data and CSV Labels export formats):  
; (comma) - default

**Force all numbers into a specified decimal format?**  
You may choose to force all data values containing a decimal to have a specified decimal character (comma or period/full stop). This will be applied to all calculations and number-validated text values in the export file.  
Use fields' native decimal format (default)

NOTE: Your data formatting selections above will be remembered in the future and will be pre-selected upon your next export.

Export Data Cancel

Figure 9. Data export configuration page.

**Death Surveillance** PID 341

[Project Home](#)
[Project Setup](#)
[User Rights](#)
[Data Access Groups](#)

This page may be used for granting users access to this project and for managing the user privileges of those users. You may also create roles to which you may assign users (optional). User roles are useful when you will have several users with the same privileges because they allow you to easily add many users to a role in a much faster manner than setting their user privileges individually. Roles are also a nice way to categorize users within a project. In the box below you may add/assign users or create new roles, and the table at the bottom allows you to make modifications to any existing user or role in the project, as well as view a glimpse of their user privileges.

**Add new users:** Give them custom user rights or assign them to a role.

— OR —

**Create new roles:** Add new user roles to which users may be assigned.

(e.g., Project Manager, Data Entry Person)

Role name <small>(click role name to edit role)</small>	Username or users assigned to a role <small>(click username to edit or assign to role)</small>	Expiration <small>(click expiration to edit)</small>	Project Design and Setup	User Rights	Data Access Groups	Data Export Tool	Reports & Report Builder
—	<b>Admin.admin (Manager)</b>	never	✓	✓	✓	Full Data Set	✓

**Adding new user** New.User

You may set the rights for the user below by checking the boxes next to the application tools to which you wish to grant them access. You may also grant them or deny them access to individual data collection instruments, if so desired. To save your selections, click the "Add user" button at the bottom of the page.

**Basic Rights**

Expiration Date  (if applicable)

**Highest level privileges:**

Project Design and Setup  
 User Rights  
 Data Access Groups

**Privileges for data exports (including PDFs and API exports), reports, and stats:**

Data Exports: No Access  
 De-Identified\*  
 Remove all tagged Identifier fields  
 Full Data Set

Add/Edit/Organize Reports  
Also allows user to view ALL reports (but not necessarily all data in the reports)

Stats & Charts

**Other privileges:**

Survey Distribution Tools  
 Calendar  
 Data Import Tool  
 Data Comparison Tool  
 Logging  
 File Repository  
 Data Quality  Create & edit rules  
 Execute rules  
 API  API Export  
 API Import/Update

**Settings pertaining to the REDCap Mobile App:**

REDCap Mobile App  Allow user to collect data offline in the mobile app  
What is the REDCap Mobile App?  
 Allow user to download data for all records to the app?

**Settings pertaining to project records:** [Explain these settings](#)

Create Records

**Data Viewing Rights**

The data viewing rights \*only\* pertain to a user's ability to view or edit data on a web page in REDCap (e.g., data entry forms, reports). If a user has "No Access" to an instrument below, they will not be able to view the data entry form for any record, nor will they be able to view fields from that instrument on a report. Note: This privilege has no effect on data imports or data exports.

	No Access	Read Only	View & Edit	Edit survey responses
Basic Demography Form (survey)	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="checkbox"/>

**New User Notification**

Notify user of their project access via email?

Figure 10. Addition of new users to the project and configuration of access levels.

## 5. Data Addition, Statistics, Exporting, and Reporting

To input collected data manually, the researcher must access “Add/Edit Records” in the menu on the side. In the new window, the researcher must click on “Add new record.” On the following page, the instrument will be available for data insertion. After completing all information, the instrument can be saved (Figure 7). In the “Add/Edit Records” menu, the answered questionnaires can be seen by selecting a record in the “Choose an Existing Study ID” option.

REDCap is available for desktop computers and mobile devices. The REDCap mobile application can be downloaded through a link on the side menu. The mobile app requires the creation of a new login user. Next, the instruments must be copied to the mobile device through the “REDCap Mobile App” option. The instruments can be transferred to the mobile device through a QR code. After data collection, the researcher must upload the data to the server using the mobile app functionality.

After running tests and before data collection, it is necessary to activate all project phases. If all steps have been completed and no other changes are required, it is time to activate “production mode.” Activating “production mode” will block any project reconfiguration to prevent any unplanned modifications of the research. Only the system administrator can revert this process.

To check the data, the researcher must select “Data Exports, Reports, and Stats” in the side menu. From this menu, it is possible to view reports, export data, and check data statistics. The “View Report” icon shows all data that have been entered in a spreadsheet format containing all the questionnaire variables. By selecting the “Stats & Charts” icon, a REDCap automatized visualization of questionnaire answers is shown as a descriptive analysis through tables and graphs (Figure 8). The “Export Data” option allows data extraction in comma-separated values format, as well as in specific statistical software formats for SPSS, SAS, Stata, and R [10] (Figure 9).

## 6. Users' Permissions

Through the “User Rights” option on the side menu, it is possible to configure access levels for projects and instruments. Using this menu, new users can be added (Figure 10). On this page, it is also possible to regulate permission levels, such as providing or denying access to some REDCap functionalities.

## III. Discussion

The REDCap platform is intended to support clinical research [7]. Utilization of REDCap has grown substantially in epidemiology, especially in studies of coronavirus disease 2019 (COVID-19) [16-22]. The major advantages of using the REDCap software are long-term reduction of research costs, the possibility of utilization on both smart devices and desktop computers, and rapid data entry, review, and analysis [6].

REDCap's limitations are related to the need for a computer technician to perform maintenance, data backup, and application programming interface (API) configuration [6,23]. Despite the intuitive interface, the development of projects and instruments may be challenging for new users, making the learning curve slightly longer, and the access levels must be assigned carefully to ensure that no user deletes or changes data accidentally [7].

The utilization of REDCap improves data collection techniques, and REDCap provides a secure data storage system. REDCap has also been established as an appropriate tool for conducting clinical research and has been used widely across the globe by academic and governmental institutions [7-13].

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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