

# BMJ Open NIH funding of COVID-19 research in 2020: a cross-sectional study

Logesvar Balaguru,<sup>1</sup> Chen Dun ,<sup>1</sup> Andrea Meyer,<sup>2</sup> Sanuri Hennayake,<sup>1</sup> Christi Walsh,<sup>1</sup> Christopher Kung,<sup>1</sup> Brittany Cary,<sup>3</sup> Frank Migliarese,<sup>1</sup> Tinglong Dai,<sup>4</sup> Ge Bai,<sup>4,5</sup> Kathleen Sutcliffe,<sup>4,5,6,7</sup> Martin Makary<sup>1,4</sup>

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<sup>1</sup>Department of Surgery, Johns Hopkins Medicine School of Medicine, Baltimore, Maryland, USA

<sup>2</sup>The Pennsylvania State University College of Medicine, Hershey, Pennsylvania, USA

<sup>3</sup>MedStar Washington Hospital Center, Washington, District of Columbia, USA

<sup>4</sup>Johns Hopkins University Carey Business School, Baltimore, Maryland, USA

<sup>5</sup>Health Policy and Management, Johns Hopkins University Bloomberg School of Public Health, Baltimore, Maryland, USA

<sup>6</sup>Department of Anesthesia and Critical Care Medicine, Johns Hopkins University, Baltimore, Maryland, USA

<sup>7</sup>School of Nursing, Johns Hopkins University, Baltimore, Maryland, USA

## Correspondence to

Ms Chen Dun; [cdun1@jhmi.edu](mailto:cdun1@jhmi.edu)

## ABSTRACT

**Objective** This study aims to characterise and evaluate the National Institutes of Health's (NIH's) grant allocation speed and pattern of COVID-19 research.

**Design** Cross-sectional study.

**Setting** COVID-19 NIH RePORTER Dataset was used to identify COVID-19 relevant grants.

**Participants** 1108 grants allocated to COVID-19 research.

**Main outcomes and measures** The primary outcome was to determine the number of grants and funding amount the NIH allocated for COVID-19 by research type and clinical/scientific area. The secondary outcome was to calculate the time from the funding opportunity announcement to the award notice date.

**Results** The NIH awarded a total of 56 169 grants in 2020, of which 2.0% (n=1108) was allocated for COVID-19 research. The NIH had a US\$45.3 billion budget that year, of which 4.9% (US\$2.2 billion) was allocated to COVID-19 research. The most common clinical/scientific areas were social determinants of health (n=278, 8.5% of COVID-19 funding), immunology (n=211, 25.8%) and pharmaceutical interventions research (n=208, 47.6%). There were 104 grants studying COVID-19 non-pharmaceutical interventions, of which 2 grants studied the efficacy of face masks and 6 studied the efficacy of social distancing. Of the 83 COVID-19 funded grants on transmission, 5 were awarded to study airborne transmission of COVID-19 and 2 grants on transmission of COVID-19 in schools. The average time from the funding opportunity announcement to the award notice date was 151 days (SD: ±57.9).

**Conclusion** In the first year of the pandemic, the NIH diverted a small fraction of its budget to COVID-19 research. Future health emergencies will require research funding to pivot in a timely fashion and funding levels to be proportional to the anticipated burden of disease in the population.

## INTRODUCTION

The National Institutes of Health (NIH) is the world's largest funder of biomedical research, employing over 20 000 people with a US\$45.3 billion budget in 2020, 41.7 billion appropriated by Congress with an additional 3.6 billion in COVID-19 supplementary funding.<sup>1–3</sup> Prior research suggested that the NIH research funding has not been proportionately aligned with disease burden in the

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Our study is the first study to characterise and evaluate the National Institutes of Health's (NIH's) under funding of COVID-19 clinical research in the year the pandemic hit the USA.
- ⇒ We conducted a cross-sectional study using the NIH Research Portfolio Online Reporting Tools Expenditures and Results (RePORTER) datasets of all COVID-19 grants, including grants funded by COVID-19 supplemental appropriations.
- ⇒ We calculated the number of grants and funding the NIH allocated towards COVID-19 in 2020 to different research types and clinical/scientific areas, and the time from funding opportunity announcement to award notice date.
- ⇒ We only reviewed abstracts and did not review the entire funded proposals. There were other barriers to clinical research that were not captured here, including slow institutional review boards and long journal peer-review times.

population.<sup>4–7</sup> Throughout the 1990s, NIH funding patterns were under major scrutiny from Congress and the scientific community due to concerns that funding allocations by the NIH failed to adequately reflect the burden of disease on society.<sup>6</sup> In 1998, the Institute of Medicine (IOM) released a groundbreaking report guiding the NIH to improve and develop disease-specific funding processes.<sup>8</sup> A landmark study published in the *New England Journal of Medicine* as well as a follow-up study by Gillum *et al* in 2011 revealed that the NIH disease-specific funding levels were not correlated with several measures of disease burden.<sup>5 6</sup>

The COVID-19 pandemic tested the NIH's ability to fund critical research to answer research questions that significantly affect public health and require urgent scientific clarity. We analysed the relative weight and composition of the NIH research funding of COVID-19 research in 2020 to evaluate the responsiveness of the agency to the pandemic.

## METHODS

### Study design and settings

We conducted a cross-sectional study using the NIH Research Portfolio Online Reporting Tools Expenditures and Results (RePORTER) datasets of all COVID-19 grants, including grants funded by COVID-19 supplemental appropriations.<sup>9 10</sup> We also reviewed the NIH Fiscal Year 2020 budget and NIH Fiscal Year 2020 supplemental appropriations to identify spending on NIH COVID-19 research.<sup>11</sup>

We reviewed all grants funded for COVID-19 research between 1 January 2020 and 31 December 2020. For each grant, we collected the date of funding opportunity announcements (NIH's advertisements of available grant support), award notice date and the amount awarded as listed in the NIH RePORTER dataset.<sup>12</sup> The date of the Funding Opportunity Announcement was obtained from the NIH COVID-19 grant opportunities.<sup>13</sup>

We categorised each grant into one of six research types: basic science, clinical science, translational science, public health, infrastructure and education and other (online supplemental appendix 1). Each NIH-funded grant was screened to identify one or multiple clinical/scientific areas of focus within the abstracts (online supplemental appendix 2). In order to create comprehensive definitions, we adapted definitions for research areas and subcategories of primary research subjects from NIH Research, Condition and Disease Categorization (RCDC) thesaurus and supplemented them using definitions from the Association of American Medical Colleges, National Cancer Institute, Economic Social Research Council, the Department of Health and Human Services and Methods in Educational Research.<sup>14–20</sup>

Each grant was independently reviewed and categorised by at least two independent reviewers (LB, SH, CD, CK, AM, BC). For grants that were categorised differently, a study group discussed the aims of the grant and made a final decision.

### Patient and public involvement

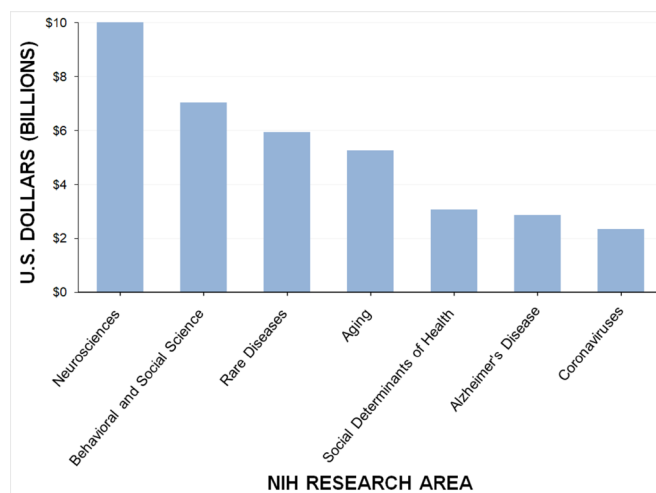
No patients were involved in this study.

### Data source

RePORTER is an electronic tool developed by the NIH that works in conjunction with the NIH's RePORT website. This tool allows users to generate lists of funded NIH studies based on specific search criteria, such as funding source and research area.<sup>11</sup> To obtain a list of all the grants that funded COVID-19 research in 2020, we used the NIH's pregenerated COVID-19 RePORTER dataset.<sup>9 11</sup> The information describing 2020 NIH funding by research was found on the RCDC RePORTER database.<sup>21</sup>

### Outcomes

The primary outcome for this analysis was to calculate the number of grants and funding the NIH allocated towards COVID-19 in 2020 to the six research types and each



**Figure 1** National Institutes of Health funding by research area (2020).

clinical/scientific area. The secondary outcome was to calculate the time from funding opportunity announcement to award.

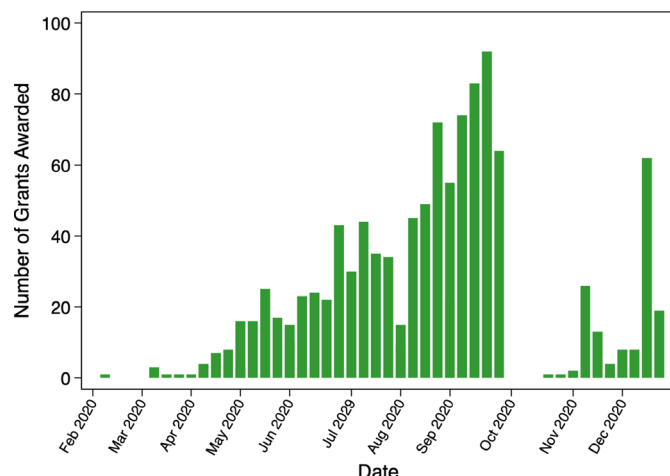
### Statistical analysis

We calculated the funding amount for research areas by compiling each grant's total funding amount allocated by the NIH. The funding amount for the clinical/scientific area was calculated based on each grant's categorization. We plotted the weekly number of COVID-19 grants awarded during 2020. Data cleaning and statistical analyses were conducted using Stata (V.16.0).

## RESULTS

In 2020, COVID-19 research accounted for 4.9% (US\$2.2 billion) of the annual NIH budget of US\$45.3 billion.<sup>3 22</sup> Of the US\$2.2 billion that the NIH spent on COVID-19 research, 91.0% was allocated from congressional special appropriations, while the remaining 9.0% of COVID-19 funding originated from the regular NIH annual budget that year. We found that several disease and condition-specific research areas were funded at levels much greater than COVID-19 (figure 1). Rare Diseases research received 2.5-fold more funding than coronavirus research and ageing research received 2.2-fold more research funding than coronavirus research.<sup>21</sup>

There were 1419 NIH COVID-19 grants from the year 2020 in the NIH RePORTER dataset. Of these, we identified 1108 COVID-19 grants with relevance to COVID-19 research, 24 were duplicates appearing in different places and 287 were categorised COVID-19 research; however, COVID-19 was not mentioned in the grant abstract or was not the focus of the grant. Of the 1108 COVID-19 grants identified, 266 grants were able to be matched to their funding opportunity announcement. The remainder had their funding opportunity announcements linked to ongoing projects and were unable to be matched with a current COVID-19 funding opportunity announcement.



**Figure 2** Number of COVID-19 grants approved by National Institutes of Health in 2020.

The average COVID-19 grant was issued funding 151 days (SD:±57.9) after its funding opportunity announcement, with a median of 137 days (IQR: 109–196) and range from 43 to 295 days. In a randomly selected pre-COVID sample of 20 grants in 2018 and 2019, the average time from the funding opportunity announcement to the awarded date was 606 days. There were 535 (48.3%) grants funded through regular 2020 appropriations and 573 (51.7%) funded through supplemental COVID-19) funding.

In the first 3 months of the global pandemic, a total of six grants were awarded for COVID-19 research. In the first half of 2020, a total of 240 grants were awarded funding (figure 2). Accordingly, in the first 3 months of 2020, the NIH spent a total of 0.04% of its annual budget on COVID-19 research. In the first half of 2020, the NIH spent 1.1% of its annual budget on COVID-19 research. The months with the most COVID-19 research grants awarded were August and October.

Regarding the type of COVID-19 research funded, basic science research comprised the greatest number of grants funded by the NIH with a total of 313 grants, compromising 6.9% of total COVID-19 research funding. There were 231 grants awarded for public health research and 231 grants awarded for clinical research, accounting for 5.7% and 26.8% of NIH COVID-19 funding, respectively. The NIH allocated the largest dollar amount to

infrastructure and education research with 55.5% of all COVID-19 funds going to these purposes with 216 grants, accounting for 2.7% of the NIH's annual budget (table 1).

There was an average of 1.9 (SD:±1.0) clinical/scientific areas per grant awarded by the NIH. The most common clinical/scientific areas of research were social determinants of health (n=278 grants, 8.5% of COVID-19 funding), immunology (n=211 grants, 25.8% of COVID-19 funding) and pharmaceutical interventions (n=208 grants, 47.6% of COVID-19 funding) (table 2). Of the 208 grants dedicated to pharmaceutical intervention research, 85 grants focused on novel therapeutics development (6.4% of COVID-19 funding), 79 grants focused on existing therapeutics (28.2% of COVID-19 funding) and 69 grants on vaccine development (32.2% of COVID-19 funding). Of the 211 immunology grants, 41 grants studied immunity gained after infection of COVID-19 and 15 grants studied immune response from vaccination. Of 64 neurological grants, 13 grants focused on changes of tastes or smell.

There were 132 grants awarded for COVID-19 testing, compromising 8.5% of all COVID-19 funding. There were 83 grants on COVID-19 transmission, representing 3.5% of COVID-19 funding. Of these, 5 studied airborne transmission, and two grants studied COVID-19 transmission in schools.

A total of 104 grants focused on non-pharmaceutical interventions, with six grants on the efficacy of social distancing and two grants on the efficacy of face masks. Additionally, 92 grants studied the effects of COVID-19 infection in paediatric populations, 10 of which examined inflammatory syndrome in children. Geriatric health and COVID-19 was awarded 68 grants and maternal health and COVID-19 was awarded 41 grants. There were no grants dedicated to studying the efficacy of face masks in children.

## DISCUSSION

Despite the escalating public health threat and poorly understood mechanism of transmission of the novel coronavirus in 2020, the NIH only spent 5.3% of their total budget that year on COVID-19 research, extending the prior literature that the NIH funding priorities

**Table 1** National Institutes of Health (NIH) grants for COVID-19 research by research type (2020)

|                              | Number of COVID-19 grants (%) | Dollars spent, US\$ | Percent of all COVID-19 funding (%) | Percent of total NIH annual budget (%) |
|------------------------------|-------------------------------|---------------------|-------------------------------------|----------------------------------------|
| Basic science                | 313 (28.25%)                  | 151 252 564         | 6.85                                | 0.33                                   |
| Translational                | 81 (7.31%)                    | 85 436 684          | 3.87                                | 0.19                                   |
| Clinical                     | 231 (20.85%)                  | 591 533 574         | 26.77                               | 1.31                                   |
| Infrastructure and education | 216 (19.49%)                  | 1 235 403 053       | 55.92                               | 2.73                                   |
| Public health                | 231 (20.85%)                  | 124 813 879         | 5.65                                | 0.28                                   |
| Other                        | 36 (3.25%)                    | 20 946 874          | 0.95                                | 0.05                                   |
| Total                        | 1108                          | 2 209 386 628       | 100.00                              | 4.88                                   |

**Table 2** National Institutes of Health (NIH) grants for COVID-19 by clinical/scientific area (2020)\*

|                                  | Number of grants | Dollars spent, US\$ | Percent of COVID-19 funding, % | Percent of NIH annual funding, % |
|----------------------------------|------------------|---------------------|--------------------------------|----------------------------------|
| Social determinants of health    | 278              | 188 229 016         | 8.52                           | 0.42                             |
| Immunology                       | 211              | 570 461 693         | 25.82                          | 1.26                             |
| Pharmaceutical interventions     | 208              | 1 051 790 057       | 47.61                          | 2.32                             |
| Impacts on other disease         | 133              | 40 865 572          | 1.85                           | 0.09                             |
| Diagnosis and testing            | 132              | 186 846 477         | 8.46                           | 0.41                             |
| Risk factor analysis             | 111              | 55 501 547          | 2.51                           | 0.12                             |
| Non-pharmaceutical interventions | 104              | 115 971 759         | 5.25                           | 0.26                             |
| Paediatric health                | 92               | 63 635 942          | 2.88                           | 0.14                             |
| Transmission                     | 83               | 77 675 659          | 3.52                           | 0.17                             |
| Other research                   | 83               | 515 823 132         | 23.35                          | 1.14                             |
| Virology                         | 79               | 33 601 202          | 1.52                           | 0.07                             |
| Geriatric health                 | 68               | 467 815 039         | 21.17                          | 1.03                             |
| Neurology                        | 64               | 21 705 014          | 0.98                           | 0.05                             |
| Pulmonology                      | 61               | 37 068 124          | 1.68                           | 0.08                             |
| Maternal health                  | 41               | 19 633 841          | 0.89                           | 0.04                             |
| Gastroenterology                 | 31               | 12 081 004          | 0.55                           | 0.03                             |
| Cardiology                       | 18               | 32 997 172          | 1.49                           | 0.07                             |
| Nephrology                       | 14               | 8 386 775           | 0.38                           | 0.02                             |

\*Each grant can have multiple areas.

misaligned with disease burden in the population.<sup>6 8</sup> The NIH's slow start in funding COVID-19 research was also noted in a February 2021 study in *Health Affairs* by Sampat and Shadlen.<sup>7</sup> They described the current low investment in COVID-19 research as 'small compared with the potential value of these interventions for ameliorating or preventing the disease and securing a return to normalcy'. A stronger research effort could have helped reduce transmission of the infection before a vaccine became available.

Infrastructure and education accounted for 55.9% of NIH COVID-19 funding, yet many of the major clinical questions surrounding COVID-19 transmission were unanswered at that time, such as transmission among children. Significant restrictions have been placed on the nation's 52 million school-aged children, including school closures, 6-foot distancing requirements and outdoor masking while distancing; however, only a few grants were dedicated to studying these questions in this unique population, creating challenges for evidence-based policymaking. It is also concerning that we have identified 287 grants that are categorised as COVID-19 where COVID-19 was not mentioned in the grant abstract or was not the focus of the grant.

The lack of rapid clinical research funding to understand COVID-19 transmission may have contributed to the politicisation of the virus. Some of the most basic questions that were being asked of medical professionals in early 2020, such as how it spreads, when infected individuals are

most contagious, and whether masks protect individuals from spreading or getting the virus, went unanswered. In the absence of evidence-based answers to the common questions the public was asking, political opinions filled that vacuum. Patient and public involvement in research prioritisation of funding could help direct a more urgent, focused and equitable response to health emergency.

The social and political climate of the COVID-19 pandemic has been plagued with misinformation hindering important mitigation efforts. Significant funding was made to Biomedical Advanced Research and Development Authority. However, this funding was focused on vaccines and therapeutics rather than clinical research on characteristic COVID-19.<sup>9</sup> A resilient healthcare system in times of crisis should be able to pivot funding towards specific grants answering critical gaps in knowledge. NIH may consider developing procedures to rapidly pivot funding and guidelines for reviewing targeted proposals relevant to addressing a public health emergency.

Our study has several limitations. The type of research and the clinical/scientific areas studied were based on definitions that may not be collectively exhaustive and mutually exclusive. In addition, we only reviewed abstracts and did not review the entire funded proposals, and we did not separate the share of new grants vs continued grants in the analysis. There were other barriers to clinical research that were not captured here, including slow institutional review boards and long journal peer-review



times. A rapid research protocol that protects research subjects with standard ethical principles for research could be developed for the next health emergency.

## CONCLUSION

NIH funding patterns for COVID-19 grants did not align with COVID-19 disease burden and were allocated slowly. The NIH should develop mechanisms to rapidly pivot funding to address scientific unknowns associated with a sudden, large-scale health emergency. Supporting sound clinical research aimed at developing evidence-based recommendations is important for public policy and promotes public trust in the medical profession during a pandemic.

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**Contributors** LB, CD, CW and MM designed the study. LB, CD, AM, SH, CW, CK, BC, and FM collected the data. LB and CD analysed the data. LB, CD, AM, SH and CW prepared the first draft of the manuscript. LB, CD, AM, SH, CW, CK, BC, FM, TD, GB, KS and MM made critical revisions to the manuscript. CD and LB acted as guarantors for the manuscript. All authors reviewed and approved the final draft and agreed to be accountable for all aspects of the manuscript in ensuring that questions related to the accuracy.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** Not applicable.

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**Data availability statement** Data are available in a public, open access repository. Data are publicly available.

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## ORCID iD

Chen Dun <http://orcid.org/0000-0003-4220-5939>

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### Appendix 1: Definition of Research Types

| Research Type                 | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | RCDC/NIH Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic Science Research</b> | <p>Fundamental laboratory or bench research and provides the foundation of knowledge for applied science and encompasses biochemistry, microbiology, physiology, and pharmacology, and their interplay, and involves laboratory studies with cell cultures, animal studies, or physiological experiments<sup>10</sup></p> <p>Adapted from Concept ID: 681833, 1511287</p>                                                                                                                                                                                                 | <p>Concept Name: Basic Science<br/>Concept ID: 681833<br/>Concept Definition: 0.Research aimed at deriving general knowledge, without a direct application toward solving a specific problem.</p> <p>Concept Name: Basic Research Breast Cancer<br/>Concept ID: 1511287<br/>Concept Definition: 0.Research on the molecular, genetic, biochemical, cellular, structural, immunological, pharmacological mechanisms and factors as they relate to the causation, progression, diagnosis, and treatment of breast cancer.</p>                                                                                                                                            |
| <b>Clinical Research</b>      | <p>Research conducted with human subjects, or on the material of human origin, in which an investigator directly interacts with human subjects, which are studied to understand health and disease; includes the development of new technologies, mechanism of human diseases, therapy, and clinical trials<sup>11</sup></p> <p>Adapted from Concept ID: 8972</p>                                                                                                                                                                                                         | <p>Concept Name: Clinical Research<br/>Concept ID: 8972<br/>Concept Definition: research conducted with human subjects or on material of human origin in which an investigator directly interacts with human subjects; includes development of new technologies, mechanism of human diseases, therapy, clinical trials, epidemiology, behavior and health services research.</p>                                                                                                                                                                                                                                                                                       |
| <b>Translational Research</b> | <p>Translational research requires interdependence between basic and clinical investigators in both the planning and implementation of research and emphasizes the clinical application of basic research findings with patients and populations. This research has both basic science and clinical components which applies discoveries generated during research in the laboratory and in preclinical studies (basic science research), to the development of trials and studies in humans (clinical research)<sup>12</sup></p> <p>Adapted from Concept ID: 1519620</p> | <p>Concept Name: Translational Research<br/>Concept ID: 1519620<br/>Concept Definition: Translational research requires interdependence between basic and clinical investigators in both the planning and implementation of research and emphasizes clinical application of basic research findings with patients and populations. Translational research also applies clinical findings to advance basic research that ultimately may lead to hypothesis-driven clinical trials or prevention and control interventions (from Specialized Programs Of Research Excellence in Prostate Cancer NIH Guide, Volume 23, Number 33, September 16, 1994, RFA: CA-94-031)</p> |

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| <p><b>Infrastructure &amp; Education Research</b></p> | <p>Infrastructure: Research infrastructure refers to the facilities, resources, and services that are used by the research and innovation community to conduct research and foster innovation in their fields, such as increasing testing capacity, shipping and receiving services, waste management, and utilities, or Vaccine and Treatment Evaluation Units<sup>13</sup></p> <p>Adapted from Concept ID: 1514880 and 1512763</p> <p>Education: Research related to training and teaching the general public and/or specific populations focused on improving knowledge of COVID-19 and COVID-19 preventative methods. Using systematic investigation, this research also adopts rigorous and well-defined scientific processes and empirical methods to gather and analyze data in order to solve challenges in education.<sup>14</sup></p> <p>Adapted from Concept ID1514602</p> | <p><b>Education:</b><br/>           Concept Name: Public Health Education<br/>           Concept ID: 1514602<br/>           Concept Definition: Health education aimed at the general public</p> <p><b>Infrastructure:</b><br/>           Concept Name: Research Infrastructure<br/>           Concept ID: 1514880<br/>           Concept Definition: 0.Refers to the physical structures needed to conduct research as well as the basic services needed for support, eg shipping and receiving services, waste management, and utilities.<br/>           Synonym Name: Infrastructure</p> <p>Concept Name: Infrastructure Activities<br/>           Concept ID: 1512763<br/>           Concept Definition: 0.NIH Emphasis Area: Infrastructure activities are new or expanded programs in the following: Research Training; Shared Instrumentation and Services; Technology Development; Information Technology and Clinical Research. Again, only new or expanded program initiatives should be reported-e.g., an increase in training related only to the increase in stipends should not be reported as an Infrastructure Initiative.<br/>           Broader Term: Research Infrastructure</p> |
| <p><b>Public Health Research</b></p>                  | <p>Public health research tries to improve the health and well-being of people from a population-level perspective including research that addresses mental health and social determinants of health<sup>15</sup></p> <p>Adapted from Concept ID 34019</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p>Concept Name: Public Health<br/>           Concept ID: 34019<br/>           Concept Definition: Branch of medicine concerned with the prevention and control of disease and disability, and the promotion of physical and mental health of the population on the international, national, state, or municipal level.<br/>           1.branch of medicine concerned with the prevention and control of disease and disability, and the promotion of physical and mental health of the population on the international, national, state, or municipal level. 2.The science and practice of protecting and improving the health of a community, as by preventive medicine, health education, control of communicable diseases,</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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|              |                                                                                                                                                                                          | application of sanitary measures, and monitoring of environmental hazards. (Disability History Museum glossary;<br><a href="http://www.disabilitymuseum.org/glossary.php">http://www.disabilitymuseum.org/glossary.php</a> )<br>Broader Term: Environment and Public Health |
| <b>Other</b> | Research that does not fit into the above research types. This includes research that has tangential impacts on COVID-19 knowledge or response but is not primarily focused on COVID-19. |                                                                                                                                                                                                                                                                             |



**Appendix 2: Definition of Clinical/Scientific Area**

| Category                     | Definition                                                                                                                                                                                                                                                                                  | NIH/RCDC Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| <b>Cardiology</b>            | Research that analyzes the effects of COVID-19 on the heart, blood vessels, or circulation.<br><br>Adapted from Concept ID: 7226                                                                                                                                                            | Concept Name: Cardiovascular system<br>Concept ID: 7226<br>Concept Definition: 0.The HEART and the BLOOD VESSELS by which BLOOD is pumped and circulated through the body. 1.Relating to the heart and the blood vessels or the circulation.<br>2.Cardiovascular; pertaining to the heart or blood vessels.<br>Synonym Name: Cardio-vascular                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Diagnosis and Testing</b> | Research involving the development, improvement, and testing of methods and tools for diagnosing, detecting, and monitoring COVID-19 infection.<br><br>Adapted from Concept ID: 11900                                                                                                       | Concept Name: Diagnosis<br>Concept ID: 11900<br>Concept Definition: The determination of the nature of a disease or condition or the distinguishing of one disease or condition from another. Assessment may be made through physical examination, laboratory tests, or the like, and may be assisted by computerized programs designed to enhance the decision-making process. 1.general term for detecting and classifying diseases. 2.The investigation, analysis and recognizing of the presence and nature of disease, condition, or injury from expressed signs and symptoms; also, the scientific determination of any kind; the concise description of characterization of a species where the characteristics of an organism are diagnosed to determine which taxonomic classification is suitable to them. In oncology also: the development, improvement, and testing of methods for cancer detection and staging. |
| <b>Gastroenterology</b>      | Research that analyzes the effects of COVID-19 infection on the structures and functions of the gastrointestinal tract, including the esophagus, stomach, small intestine, and large intestine (colon, rectum, and anus) and associated digestive organs (liver, gallbladder, and pancreas) | Concept Name: Gastroenterology<br>Concept ID: 17163<br>Concept Definition: 0.A subspecialty of internal medicine concerned with the study of the physiology and diseases of the digestive system and related structures (esophagus, liver, gallbladder, and pancreas).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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|                   | Adapted from Concept ID: 17163, 17178                                                                                                                                                                                                                                                                                                                                        | <p>Concept Name: Gastrointestinal Diseases<br/>           Concept ID: 17178<br/>           Concept Definition: 0.Diseases in any segment of the GASTROINTESTINAL TRACT from ESOPHAGUS to RECTUM. 1.disorder in any segment of the gastrointestinal tract from the esophagus to the rectum. 2.RAEB: Diseases of the digestive tract (oral cavity to anus) and associated organs (salivary glands, liver, pancreas). 3.RAEB: Use for studies in which the focus is on the digestive tract (oral cavity to anus) and associated organs (salivary glands, liver, pancreas). For most digestive organs there will be no problem; however, liver is frequently used in studies of carcinogens for which it is not normally the target organ. In the latter type case do not code SIC 36. (NCI)</p>                                      |
| <b>Geriatrics</b> | <p>Research concerned with the physiological and pathological aspects of the aged, including the clinical problems of senescence and senility. This includes clinical research involving human subjects above the age of 65 years.</p> <p>Adapted from Concept ID: 17469</p>                                                                                                 | <p>Concept Name: Geriatrics<br/>           Concept ID: 17469<br/>           Concept Definition: 0.The branch of medicine concerned with the physiological and pathological aspects of the aged, including the clinical problems of senescence and senility. 1.field of medicine concerning elderly human health. 2.The branch of medical science that deals with diseases and problems specific to elderly people.</p>                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Immunology</b> | <p>Research of the immune system and its reaction to, as well as its malfunctions in response to COVID-19 infection. This includes research that pertains to the identification and characterization of immune factors; immune physiology; diseases of the immune system in conjunction with COVID-19 infection or complications.</p> <p>Adapted from Concept ID: 152036</p> | <p>Concept Name: Immunology<br/>           Concept ID: 152036<br/>           Concept Definition: The occupation or discipline. 1.Immunology is the study of the immune system and its reaction to pathogens, as well as its malfunctions (autoimmune diseases, allergies, rejection of organ transplants). (from Wikipedia) 2.RAEB: Use for any aspect of immunology: identification and characterization of immune factors; immune system development; immune physiology; immunotherapy; immunodiagnosis; tumor or virus antigen studies; vaccine research; diseases of the immune system (immunodeficiencies, autoimmunity, hematopoietic system neoplasia). Not used for research tools such as antibody tagging if the study is otherwise unrelated to immunology. (NCI)<br/>           Broader Term: Biological Sciences</p> |

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| <b>Impacts on Other Diseases</b>        | <p>Research analyzing the impact of the COVID-19 infection and pandemic control measures on the pre-existing disease or condition the patient is diagnosed with.</p> <p>Adapted from Concept ID: 9599</p>                                                      | <p>Concept Name: Complication<br/>Concept ID: 9566<br/>Concept Definition: 0.something that introduces usually unexpected difficulties, problems, or changes. 1.Any disease or disorder that occurs during the course of (or because of) another disease.</p>                                                                                                                                                                                                                                                                                                                                          |
| <b>Maternal Health</b>                  | <p>Research that analyzes the impact of COVID-19 infection, complications, or pandemic control measures on maternal health including pregnancy, prenatal care, labor and delivery, and childcare.</p> <p>Adapted from Concept ID: 1513012, and 33052</p>       | <p>Concept Name: Maternal and Child Health<br/>Concept ID: 1513012<br/>Usually involves maternal factors (and efforts to modify these factors) that may affect the health of the child or fetus: smoking or exposure to drugs or toxic chemicals during pregnancy, maternal/fetal immunologic interactions. Also use for genetic counseling, pregnancy and/or nursing effects on maternal health.</p> <p>Concept Name: Prenatal Care<br/>Concept ID: 33052<br/>Care provided the pregnant woman in order to prevent complications, and decrease the incidence of maternal and perinatal mortality.</p> |
| <b>Non-Pharmaceutical Interventions</b> | <p>Research regarding investigating the implementation and/or efficacy of non-pharmacological measures to address the COVID-19 pandemic, including programs designed to prevent and control the spread of infection.</p> <p>Adapted from Concept ID: 85557</p> | <p>Concept Name: Infection Control<br/>Concept ID: 85557<br/>Concept Definition: Programs of disease surveillance, generally within health care facilities, designed to investigate, prevent, and control the spread of infections and their causative microorganisms.</p>                                                                                                                                                                                                                                                                                                                             |
| <b>Nephrology</b>                       | <p>Research that analyzes the effects of COVID-19 infection on the structures, functions, and diseases of the renal system.</p> <p>Adapted from Concept ID: 27712</p>                                                                                          | <p>Concept Name: Nephrology<br/>Concept ID: 27712<br/>Concept Definition: 0.A subspecialty of internal medicine concerned with the anatomy, physiology, and pathology of the kidney.</p>                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Neurology</b>                        | <p>Research that analyzes the effects of COVID-19 infection on the structures, functions, and diseases of the nervous system including effects on senses.</p>                                                                                                  | <p>Concept Name: Neurology<br/>Concept ID: 27855<br/>Concept Definition: 0.A medical specialty concerned with the study of the structures, functions, and diseases of the nervous system. 1.the branch of</p>                                                                                                                                                                                                                                                                                                                                                                                          |

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|                                     | Adapted from Concept ID: 27855, 36658                                                                                                                                                                                                  | <p>medical science that deals with the study of structure, function, and diseases of the nervous system;</p> <p>Concept Name: Esthesia<br/>Concept ID: 36658<br/>Concept Definition: 0.Transduction of physical or chemical changes in the external or internal environment into nerve impulses by specialized receptors, transmission of these impulses by afferent neurons to the effectors, either directly or through the CNS. 1.transduction of stimuli from outside the body and those within the body into nerve impulses by receptors, and the transmission of these impulses by afferent neurons to the cerebral cortex.<br/>Synonym Name: Sensation</p>                                                                                                                                                                                                                                                                       |
| <b>Other Research</b>               | Grants that do not fall into other clinical/scientific areas.                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Pediatric Health</b>             | <p>Research concerned with maintaining health or providing medical care to children from birth to adolescence in the context of COVID-19 infection, complications, or control measures.</p> <p>Adapted from Concept ID 30755, 1578</p> | <p>Concept Name: Pediatrics<br/>Concept ID: 30755<br/>Concept Definition: 0.A medical specialty concerned with maintaining health and providing medical care to children from birth to adolescence.</p> <p>Concept Name: Adolescence<br/>Concept ID: 1578<br/>Concept Definition: 0.period of life beginning with the appearance of secondary sex characteristics and terminating with the cessation of somatic growth; typically between 12 and 20 years of age; when school grades are referenced, this age group is typically grade 5 or 6 and above; also index with appropriate human and clinical research terms. 1.Adolescence is the time period between the beginning of puberty and adulthood. 2.The period of life beginning with the appearance of secondary sex characteristics and terminating with the cessation of somatic growth. The years usually referred to as adolescence lie between 13 and 18 years of age.</p> |
| <b>Pharmaceutical Interventions</b> | These are preclinical and clinical studies analyzing the nature, properties, and actions of drugs as therapeutics for COVID-19 infection. This includes research involving the creation and                                            | <p>Concept Name: New Agents<br/>Concept ID: 1518316<br/>Concept Definition: 0.Research into new physical or chemical means to treat disease.<br/>Broader Term: Funding Category</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |



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|                             | <p>testing of new therapeutics, interventions, vaccines, and repurposing of prior FDA approved therapeutics to treat infection, alleviate symptoms, or offer prophylaxis against COVID-19.</p> <p>Adapted from Concept ID: 1518316, 31330</p>                                                                                                                   | <p>Concept Name: Pharmacology<br/>Concept ID: 31330<br/>Concept Definition: 0.The study of the origin, nature, properties, and actions of drugs and their effects on living organisms. 1.the biological effects of drugs in living organisms or tissues; use this term mainly for intended, desired effects; for harmful or undesired effects, see DRUG ADVERSE EFFECT or TOXICOLOGY. 2.Pharmacology is the study of drugs in all their aspects. It is concerned with the art and science of the preparation, compounding, and dispensing of drugs. (Pharmacology Glossary; <a href="http://www.bumc.bu.edu">http://www.bumc.bu.edu</a>)<br/>Broader Term: Biological Sciences</p>                                                                                                                                                                                                                                            |
| <b>Pulmonology</b>          | <p>Research that analyzes the effects of COVID-19 infection on the respiratory system and respiration disorders.</p> <p>Adapted from Concept ID 35204</p>                                                                                                                                                                                                       | <p>Concept Name: Respiration Disorders<br/>Concept ID: 35204<br/>Concept Definition: Diseases of the respiratory system in general or unspecified or for a specific respiratory disease not available.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Risk Factor Analysis</b> | <p>Research that provides qualitative or quantitative estimation of susceptibility to COVID-19 infection and/or adverse outcomes based on the presence of risk factors, herein defined as inherited, environmental, or behavioral characteristics that affect COVID-19 infection, symptoms, and outcome.</p> <p>Adapted from Concept ID 86930, 35648, 12655</p> | <p>Concept Name: Risk<br/>Concept ID: 35647<br/>Concept Definition: 0.The probability that an event will occur. It encompasses a variety of measures of the probability of a generally unfavorable outcome. 1.Risk is the potential future harm that may arise from some present action. It is often combined or confused with the probability of an event which is seen as undesirable. (from Wikipedia)</p> <p>Concept Name: Risk Assessment<br/>Concept ID: 86930<br/>Concept Definition: 0.The qualitative or quantitative estimation of the likelihood of adverse effects that may result from exposure to specified health hazards or from the absence of beneficial influences. (Last, Dictionary of Epidemiology, 1988) 1.The qualitative or quantitative estimation of the likelihood of adverse effects that may result from exposure to specified health hazards or from the absence of beneficial influences.</p> |

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|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <p>Concept Name: Risk Factors<br/>Concept ID: 35648<br/>Concept Definition: 0.An aspect of personal behavior or lifestyle, environmental exposure, or inborn or inherited characteristic, which, on the basis of epidemiologic evidence, is known to be associated with a health-related condition considered important to prevent.</p> <p>Concept Name: Disease susceptibility<br/>Concept ID: 12655<br/>Concept Definition: 0.A constitution or condition of the body which makes the tissues react in special ways to certain extrinsic stimuli and thus tends to make the individual more than usually susceptible to certain diseases. 1.factors that affect the probability or predisposition of an individual to the development of a disease(s) or disorder(s).</p>              |
| <b>Social Determinants of Health</b> | <p>Social determinants of health (SDOH) are the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks. Research in this area identifies the effect of social determinants on people's health in the context of COVID-19 infection and preventive methods<sup>16</sup></p> <p>Adapted from Concept ID 1171307, 37470, 26192</p> | <p>Concept Name: health disparity<br/>Concept ID: 1171307<br/>Concept Definition: 0.a population-specific difference in the presence of disease, health outcomes or access to care.</p> <p>Concept Name: Infectious Disease Epidemiology<br/>Concept ID: 1512717<br/>Concept Definition: 0.Epidemiology as it relates to infectious diseases.</p> <p>Concept Name: Medical Sociology<br/>Concept ID: 37470<br/>Concept Definition: 0.The study of the social determinants and social effects of health and disease, and of the social structure of medical institutions or professions. 1.Medical sociology is the study of individual and group behaviors with respect to health and illness. Medical sociology is concerned with individual and group responses aimed at assessing</p> |

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|                     |                                                                                                                                                                                                                                                                                                                                             | <p>well-being, maintaining health, acting upon real or perceived illness, interacting with health care systems, and maximizing health in the face of physiologic or functional derangement. It also analyzes the impact of the psychological conditions resulting from our environment on our health.</p> <p>Concept Name: Minority Groups<br/> Concept ID: 26192<br/> Concept Definition: 0.A subgroup having special characteristics within a larger group, often bound together by special ties which distinguish it from the larger group. 1.A minority is a group that is outnumbered by persons who do not belong to it, often people with different nationality, religion, culture or lifestyle from that of the mainstream in the society. (Wikipedia) 2.RAEB: Racial or ethnic groups officially recognized by the U.S. government as minority populations.</p>                                                     |
| <b>Transmission</b> | <p>Research that describes or models the transmission of COVID-19 focusing on where and how transmission occurs. This includes research specifically addressing when infected individuals are most contagious, disease duration, and the period in which infectivity or illness resolves.</p> <p>Adapted from Concept ID 242781, 242649</p> | <p>Concept Name: Disease transmission<br/> Concept ID: 242781<br/> Concept Definition: 0.The transmission of infectious disease or pathogens. When transmission is within the same species, the mode can be horizontal (DISEASE TRANSMISSION, HORIZONTAL) or vertical (DISEASE TRANSMISSION, VERTICAL).<br/> 1.transmission of an infectious disease by direct contact with an affected individual, the individual's discharges or by indirect means such as by a vector.<br/> 2.The transmission of infectious disease or pathogens. When transmission is within the same species, the mode can be horizontal (disease transmission, horizontal) or vertical (disease transmission, vertical). (NCI)</p> <p>Concept Name: Horizontal Disease Transmission<br/> Concept ID: 242649<br/> Concept Definition: 0.The transmission of infectious disease or pathogens from one individual to another in the same generation.</p> |

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| <b>Virology</b> | <p>Research analyzing the characteristics of the virus SARS-CoV-2, including molecular viral components pertaining to replication, infectivity, and genetic variability.</p> <p>Adapted from Concept ID 597650, 42774, 34848, 597652, 597653</p> | <p>Concept Name: virus characteristic<br/>Concept ID: 597650<br/>Concept Definition: features that help to identify, distinguish or describe recognizably; classification systems of viruses; includes infection routes, staining patterns, replication requirements, etc.</p> <p>Concept Name: Virus Replication<br/>Concept ID: 42774<br/>Concept Definition: 0.The process of intracellular viral multiplication, consisting of the synthesis of PROTEINS; NUCLEIC ACIDS; and sometimes LIPIDS, and their assembly into a new infectious particle. 1.process of forming progeny virus from input virus; involves expression and replication of viral genomic nucleic acid and the assembly of progeny virus particles.</p> <p>Concept Name: Virus Receptors<br/>Concept ID: 34848<br/>Concept Definition: 0.Specific molecular components of the cell capable of recognizing and interacting with a virus, and which, after binding it, are capable of generating some signal that initiates the chain of events leading to the biological response. 1.viruses must first bind to their target cell's surface before infection can proceed; this is mediated by specific molecular receptors for certain viral antigens, many of which have other known functions; e.g., the MHC-II receptor CD4 is also an HIV receptor. 2.Cell surface molecules that are capable of interacting with virus particles, thereby mediating their entry into the cell or otherwise eliciting a cellular response.</p> <p>Concept Name: virus infection mechanism<br/>Concept ID: 597653<br/>Concept Definition: 0.multi-step process by which a virus binds to, enters, and replicates within a host</p> |
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|  |  | <p>cell; includes both surface and intracellular interactions between host and virus.</p> <p>Concept Name: virus genetics<br/>Concept ID: 597652<br/>Concept Definition: 0.heredity, especially the mechanisms of hereditary transmission and the variation of inherited characteristics among a virus or viruses; the genetic constitution of viruses. 1.The branch of science concerned with the means and consequences of viral transmission and generation of the components of biological inheritance.</p> |
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