PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Examining power dynamics in global health governance using topic modeling and network analysis of twitter data
AUTHORS	Bermudez, Gian Franco; Prah, Jennifer

VERSION 1 – REVIEW

REVIEWER	Schaaf, Marta Independent Consultant
REVIEW RETURNED	22-Jul-2021

GENERAL COMMENTS	This paper is clearly argued, well-written, and takes a novel approach to longstanding issues. I have a few minor points and one over-arching point. My over-arching comment is that I think the paper could benefit from one long paragraph (or two shorter paras) that acknowledges some of the limitations of the paper, and that puts the paper in the broader context of discussions and research on agenda setting in global health. From my perspective, the limitations include: the assumption that actual priorities match what is specified in documents; the assumption that money is spent on what it is purportedly spent on; and the exclusive focus on global health actors and processes, as opposed to non health actors and processes (e.g. the dictates of inter-state relations, corporate influence). On the first point, even if your analysis addresses temporality (and it isn't clear to me that it does), folks often know what is fundable prior to donors releasing a strategy or an RFP for example. So, those strategies may be informed by an assumption about what is fundable rather than a dispasionate analysis of what is the most important. On the second point, as people working budget tracking have found, money for a given priority is not necessarily spent on that. In other words, decision-makers may find that have too much for priority x and not enough for y, so they use x money for y, insofar as that is possible. Money for vaccines can't go to HIV, but it can go to cold chain that would benefit both areas. Lastly, as the emerging work on the commercial determinants of health has shown (and some of the older work on Big Tobacco), Big Food, Big Sugar, the fossil fuel industry, Alcohol industry, etc all shape what is and is not included as a global health priority. In addition, the paper's focus on written materials obscures all of the ways that power plays out behind closed doors. These cannot easily be integrated into your analysis, but I think it would be appropriate to acknowledge them. In so doing, you can also situation this paper in the broader frame of the work on agenda setting (see Jeffrey Shiffman for example), on the commerical determinants of health, and on power in implementation processes. Your paper complements this other work, deepening our understanding of how power is manifest and from where it flows.

	Relatedly, in my opionion, it would be helpful to underline the definition of rational. The phrase self-interest is used, and I think it would be good to emphasize this for folks who think that the term "rational" implies a dispassionate analysis of the global burdern of ill health and the forces that cause that ill health. In terms of more minor comments: - In the intro, end of para 4, you state: "Current GHG based on the RAM fails to “justify an obligation to help meet the health needs of others.” This is too cryptic for me. I do not quite understand your point. - Next para: "The actions of powerful global actors in pursuit of their own interests “are not designed to harm health but can have negative side-effects that create health inequities.” Do you mean global health actors or other actors (e.g. corporations etc) - "We hypothesize that GHG operates under RAM and that there are power asymmetries in GHG that limit the range of health priorities as presented by the Commission on Global Governance for Health. " This reads to me like you are working from the basis of health priorities presented by the Commission. I don't think that is what you meant. Can you clarify? - Methods: "For example, the WHO has annual financial reports that break down how much each health area or issue is funded in proportion of their total budget. The most allocated health areas are the revealed priorities of the WHO." WHO gets a LOT of ear-marked funding from BMGF etc. So I do not think that WHO is the best example here. One assumes that they take the funding b/c they would rather address work on the issue being funded that not work at all, because they want to maintain a good relationship with the donor etc...but I would not say that their funding reveals their revealed priorities. - In my opinion, the Barnett and Duval explanations are examples of a manifestation of each type of power, rather than a summary of all possible manifestations of each type. It might be good to note that explicitly.

REVIEWER	Pierson, Leah Harvard Medical School, MD-PhD Program
REVIEW RETURNED	17-Aug-2021

GENERAL COMMENTS	Summary and Impression: The article aims to assess whether global health governance [GHG] acts in accordance with the rational actor model [RAM], which the authors define as “each actor [having] its own set of goals and objectives, and these actors [taking] actions based on analysis of the costs and benefits of various available options.” The authors also aim to better characterize power dynamics in GHG. The authors suggest that “Current GHG based on the RAM fails to ‘justify an obligation to help meet the health needs of others.’” The authors evaluate this by comparing priorities indicated by global health

	actors' tweets, stated priorities in policy documents, and revealed priorities from funding data. I believe the most interesting and important part of this project is the assessment of the alignment between actors' tweets, stated priorities, and funding. In particular, the evaluation of funders' priorities as revealed by their tweets is a novel and fascinating contribution. The paper is generally clear, although some parts could use reorganization. However, the project's framing faces substantial conceptual challenges, particularly with regard to the authors' definition and interpretation of the RAM. These, in turn, render it difficult to interpret the study's findings. In addition, while the project's ambition is commendable, at times, this breadth seems to come at the cost of elaboration and depth. Specific comments Introduction: The project's framing introduces several conceptual challenges. The first two of these challenges are due to one important point of confusion: namely, the authors define what it means for actors to adhere to a RAM in general, but do not clarify how this applies to global health actors specifically: for instance, how do we determine what a global health organization's "goals and objectives" are? Because the authors do not provide an explanation, I assumed that organizations' goals and objectives are conveyed by their mission statements, bylaws, and other founding documents. First, the authors suggest that global health actors act in their own interest and that this "fails to 'justify an obligation to meet the health needs of others.'" But this is an ambiguous claim, given that the overriding goal of global health organizations is to improve global health. These actors thus have an obligation to adhere to their founding documents, all of which provide them with an obligation to promote health. In other words, these organizations have a fundamental obligation to act in accordance with their mandates, which require meeting the health needs of others. Second, the authors hypothesize that global health actors have created health inequities as a result of acting in their own interests (p. 4, line 37). But as previously stated, it is not clear what it means for a global health organization to act in its own interest. On a basic level, the interests of the organization seem to be represented by its founding documents. Thus, adhering to the RAM would involve acting in ways consistent with these documents. But notably, some of the global health actors included in the authors' analysis reference a desire to combat inequities in their mission statements and elsewhere, making this statement hard to parse: indeed, we might expect that for these organizations, acting in accordance with the RAM would reduce—not increase—inequities. Third, many global health inequities have narrowed over the past two decades (for instance, rates of maternal and infant mortality have fallen much faster in LMICs than they have fallen in HICs, meaning that at least by the WHO's definition of health inequity—"systematic differences in the health status of different population groups"—inequities have decreased). Thus, the claim that the

	emergence of new global health actors and increases in funding has contributed to health inequities requires substantially more explanation. (Are the authors referring to inequities between different disease areas, i.e., HIV/AIDS versus mental health?) Defending this claim is also prerequisite to defending the authors' further claim that these inequities have arisen because funders are acting in accordance with the RAM. Methods: The authors aim to assess whether "GHG operates under the RAM" (p. 5, line 8). However, it is unclear how the authors are defining the RAM for global health actors. As previously dicussed, I suspect the authors are using the actors' stated priorities to define each organization's "goals and objectives" (i.e., RAM) and then evaluating whether actors' revealed priorities align with these. However, the authors do not explicitly say this, and other approaches are possible. To some extent, this is clarified later in the paper (under the "Testing if GHG operates under the RAM" section), but this should come sooner and warrants further explanation. Study sample: The study sample is well-defined and reflects the important global health actors. The authors could consider listing in Table 1 (or elsewhere) each actor's global health budgets and number of Twitter followers to convey the magnitude of each actor's involvement and sphere of influence. Data sources: The data sources used make sense. One minor point about this: under the data sources heading, the authors elaborate that "Revealed priorities are derived using a network analysis and descriptive statistics of financial flows in DAH funding data. To obtain the revealed priorities of each global health actor, we use topic modeling in natural language processing (NLP) and a network analysis of the tweets of each global health actor." This description does not seem to belong under this heading and should instead come under the one after. Stated and revealed priorities: I am not well-positioned to evaluate the methods used by the authors here (e.g., the use of Gephi and the Fruchterman-Reingold algorithm), and defer to other reviewers' assessments. Generally, I think the distinction drawn between stated and revealed priorities makes sense. Twitter data: The idea of analyzing global health actors' tweets to determine their priorities is a great one. The strategy for collecting tweets (i.e., gathering at three-month intervals) also makes sense. However, I am somewhat confused by several aspects of the authors' approach to the Twitter analysis.

	First, do the tweets represent stated or revealed priorities? I can see arguments for both and would want the authors to better explain where the tweets fall in this dichotomy. Later (p. 10, line 17), the authors state that the tweets represent revealed priorities, but it is not clear why tweets were categorized as such. (For instance, it is possible to imagine a case where an actor tweeted "We are planning to invest in X going forward," and this would seem to be a stated priority.) I also thought the authors specific invocation of communication studies in analyzing the tweets made little sense. The authors write that: "In the academic area of communications studies, researchers suggest that there are two forms of utility that motivate actors to post content on Twitter. First, intrinsic utility assumes that a user receives inherent satisfaction from posting content on Twitter." This statement seems to apply much more to civilian Twitter users than to organizations or public accounts. For instance, public figures (e.g., Joe Biden's presidential account) likely are not tweeting things because the author derives "inherent satisfaction" from doing so: President Biden likely is not writing or posting most of his own tweets and thereby is not deriving "inherent satisfaction" from tweeting them. The same logic applies to global health funders. It also seems like global health actors may have other motives for tweeting: for instance, to share information. Presumably the WHO tweets its updated vaccine and masking recommendations not just to improve its public image, but to additionally inform the public about its current stance on an important public health issue. (I understand that the tweets analyzed were pre-COVID, but this point applies to other public health matters as well.) Obtaining priorities from Twitter data: As previously stated, I am not experienced with the methods used by the authors and am not well-equipped to assess their use here. Thus, I provide only general comments. However, I would want to see a little more discussion about how the topics were generated using the Latent Dirichlet allocation topic model. Here are some specific examples: • I would expect there to be a fair degree of overlap in tweets referring to "breastfeeding" and "mothers." But among the ten revealed priorities for each organization, some only have "breastfeeding" (e.g., WHO), some only have "mothers" (e.g., US), and some have both (e.g., Gates Foundation). What did the authors do with tweets that mentioned both "breastfeeding" and "mothers"? Do the authors believe that the revealed priorities of an organization that references both breastfeeding and mothers are substantively different than those of an organization that just references breastfeeding, and so on? • Some topics are quite general (e.g., "Poverty", "Treatment", "News"), while others are more specific ("Fisheries", "Hepatitis", "Veterans"). In cases where one topic could be subsumed by another (e.g., "Schools" could be subsumed by "Education"), how did the authors disaggregate these? Testing if GHG Operates under the RAM:

	This first half of this section was extremely helpful, and the authors' approach here made sense. Presenting this section earlier in the paper (i.e., in the introduction) would help forestall some of the aforementioned concerns. I do think the authors glossed over important nuances of the RAM though. First, in the Mintz and DeRouen chapter cited by the authors, Mintz and DeRouen write: "First, actors are assumed to employ purposive action motivated by goal oriented behavior and not simply by habit or social expectations" (p. 58). But is this assumption reasonable for global health actors, who often default into continuing to fund existing programs? Critically, I found the section about benefit maximization to be conceptually unclear. The authors write that: "Actors are assumed to maximize utility while choosing an alternative that provides the highest amount of net personal benefit." But we know, for instance, that some actors do not attempt to maximize utility (i.e., those that care about equity in addition to utility). In addition, this definition raises questions about what constitutes "net personal benefit" means, beyond simply achieving the actor's pre-determined goals. The authors also do not draw a distinction between "net personal benefits" and "maximizing utility," although presumably these can come apart, as implied by the caveat included in the definition. Finally, the authors write that "The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets are revealed to be the priority that the global health actor determines to be benefit maximizing". But presumably, there can be differences between what is actually benefit maximizing and what the actor considers benefit maximizing. Would it be consistent with the RAM for the actor to prioritize its preferred interventions, even if these were not, in fact, benefit maximizing (for instance, in accordance with benefit-cost analysis)? Based on the Mintz and DeRouen text—"utility maximization means that actors will select the alternative that provides the greatest amount of net benefits"—it appears that this behavior would be inconsistent with the RAM. But the authors seem to assume that utility is specific to the agent, which I am not sure is a correct interpretation? Definitions and types of power: This section felt disconnected from the prior ones. It also seems wrong to conclude that "The global health actors which have the most priorities aligned with the stated and revealed priorities of the global health system are determined to have the most influence and power in priority-setting." Isn't it possible that an actor just happens to have priorities that align with the status quo (or that an actor adopted certain priorities because it recognized that there was substantial infrastructure and funding in a given arena)? In the latter case, an actor's priorities being aligned with the priorities of the global health system could reflect a lack of power, rather than an abundance of it. Findings:

	Given that the entire paper has been building to this point, this section felt too short. It would be worth describing some noteworthy examples from a few actors, or describing any places where the rank order preferences differ between funding data and tweets. For instance, the authors could highlight some examples from Supplemental Table 1 in the main text. Furthermore, the decision to define "the pre-determined goal of the global health system" as SDG 3 should have come sooner and warrants further defense. For instance, although the 20 actors have stated commitments to the WHO mission and the SDGs, there are funders that are larger than WHO (i.e., Gates Foundation) who have objectives that differ from the WHO's. The authors also assert that "To maximize benefits of the pre-determined goal of "health for all" and "SDG3: good health and well-being", the global health system prioritizes HIV/AIDS, child health, and maternal health," but this presupposes that the actors are collectively acting in accordance with the RAM, which they may not be. Finally, is it in fact the case that prioritizing HIV/AIDS, child health, and maternal health actually maximizes benefits (in accordance with any economic evaluation technique, such as cost-benefit or cost-effectiveness analysis)? Compulsory and institutional power asymmetries in GHG: I am not well versed in the methods used in this section and therefore cannot evaluate them or the conclusions the authors draw from them. Conclusion: The authors conclude that "The rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs." This claim warrants a little more explanation than it is given here. In addition, the authors should explain how the funding asymmetries they have identified lead to specific inequities (and should provide some evidence to support this), given that the introduction was framed in those terms. Finally, I would include more discussion of the limitations of this analysis.

REVIEWER	Lopreite, Milena Scuola Superiore Sant'Anna, Pisa, IT, Institute of Economics
REVIEW RETURNED	21-Sep-2021

GENERAL COMMENTS	The theme is interesting, as well the methodology is appropriate. A revised paper to improve the legibility and interpretation of the data and the statements reported should include on the side of the methods and the theory discussion some refinements as the following: 1) Pg 5: Please re-write the background and cite more quantitative studies on the global health networks (i.e Lopreite, M, Puliga, M, Riccaboni, M, De Rosis, S (2021) "A social network analysis of the organizations focusing on tuberculosis, malaria and pneumonia", Volume 278, pp.1-10. Social Science and Medicine. DOI: 10.1016/j.socscimed.2021.113940.

	2)Pg 6:The section of the methods is too short: Please write more details about GHG and RAM. 3)Pg 6: Please specify what kind of disease fight the GHN that you classified in the Table 1. 4)Pg 9: Please define better the LDA model 5) Pg 9:Please add more details about the selections of 20 key global actors 6) To analyze the networks I suggest to use network's measure such as size, density, average degree, closness, betweeness, modularity (for the clustering). 7) Please descrive the policy implications of the study 8) A linguistic review is strongly suggested.

VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Dr. Marta Schaaf, Independent Consultant

[General Comment 1] This paper is clearly argued, well-written, and takes a novel approach to longstanding issues.

Author Response: We thank this reviewer for the positive feedback, we appreciate it.

[General Comment 2] I have a few minor points and one over-arching point.

My over-arching comment is that I think the paper could benefit from one long paragraph (or two shorter paras) that acknowledges some of the limitations of the paper, and that puts the paper in the broader context of discussions and research on agenda setting in global health.

From my perspective, the limitations include: the assumption that actual priorities match what is specified in documents; the assumption that money is spent on what it is purportedly spent on; and the exclusive focus on global health actors and processes, as opposed to non-health actors and processes (e.g. the dictates of inter-state relations, corporate influence).

On the first point, even if your analysis addresses temporality (and it isn't clear to me that it does), folks often know what is fundable prior to donors releasing a strategy or an RFP for example. So, those strategies may be informed by an assumption about what is fundable rather than a dispassionate analysis of what is the most important.

On the second point, as people working budget tracking have found, money for a given priority is not necessarily spent on that. In other words, decision-makers may find that have too much for priority x and not enough for y, so they use x money for y, insofar as that is possible. Money for vaccines can't go to HIV, but it can go to cold chain that would benefit both areas.

Lastly, as the emerging work on the commercial determinants of health has shown (and some of the older work on Big Tobacco), Big Food, Big Sugar, the fossil fuel industry, Alcohol industry, etc all shape what is and is not included as a global health priority. In addition, the paper's focus on written materials obscures all of the ways that power plays out behind closed doors. These cannot easily be integrated into your analysis, but I think it would be appropriate to acknowledge them. In so doing, you can also situation this paper in the broader frame of the work on agenda setting (see Jeffrey Shiffman for example), on the commercial determinants of health, and on power in implementation processes. Your paper complements this other work, deepening our understanding of how power is manifest and from where it flows.

Author Response: We thank this reviewer for the suggestion. In response to the reviewer's suggestion, in the revised manuscript, we added the following paragraph(s) in under the new section "Limitations" in the "DISCUSSION" section:

It is necessary to acknowledge the three limitations of this study. First, we assume stated priorities match what is specified in organizational documents. It may be the case that some organizations communicate priorities differently from what is written in their foundational documents. Moreover, what is fundable may not necessarily be what is most important. Second, we assume that health funding is indeed spent on what it is ostensibly spent on when deriving revealed preferences from past health funding data,

although may not be the case. Third, our scope is limited to examining 20 global health actors from 2016 to 2020. There is a multiplicity of non-health actors and processes that likely influence overall health outcomes of populations. Studying the stated and revealed priorities of non-health actors and processes such as foreign relations between nations and the influence of the private sector on health can improve the characterization of current GHG.

Author Response (continued): We are thankful for the reviewer for suggesting adding a section that puts the paper in the broader context of discussions and research on agenda setting in global health. In response to the reviewer's suggestion, we have added the following paragraph under "CONCLUSION" that does this:

Our paper complements the current research on agenda-setting in global health. Jeremy Shiffman's (2016) discussion of how agenda-setting is not purely a rational deliberation of evidence but the convergence of problems, solutions, and political developments.[50] This study attempts to deepen the understanding of the manifestation and influence of power in agenda-setting through the lens of stated and revealed priorities.

[Comment 1] Relatedly, in my opinion, it would be helpful to underline the definition of rational. The phrase self-interest is used, and I think it would be good to emphasize this for folks who think that the term "rational" implies a dispassionate analysis of the global burden of ill health and the forces that cause that ill health.

Author Response: We thank this reviewer for this helpful comment. When we first introduce the rational actor model in the introduction, we include a description of what we mean by being "rational" and "self-interested." In the revised manuscript, we revised the introduction which now reads as follows:

First, global health governance (GHG) has been theorized as operating under the rational actor model (RAM) where "each actor has its own set of goals and objectives, and these actors take actions based on analysis of the costs and benefits of various available options."[13] With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]

Author Response (continued): We appreciate this reviewer's suggestion to emphasize what we mean by "rational" to not simply imply a dispassionate analysis of global burden of disease. Under the section "Testing if GHG operates under the RAM", we added this paragraph to clarify what we mean by "rational:"

“Rational” in this case does not simply mean a dispassionate calculation of costs and benefits. In the case of global health actors, acting rationally means weighing both economic and political factors, and acting according to the three assumptions of RAM.

[Comment 2] In terms of more minor comments:

- In the intro, end of para 4, you state: "Current GHG based on the RAM fails to “justify an obligation to help meet the health needs of others.” This is too cryptic for me. I do not quite understand your point.

Author Response: We thank this reviewer for this helpful comment. This statement is from the existing theory of GHG as operating under the RAM. If GHG operates under the RAM, there is no shared ethical commitment to a common mission. To provide more clarity, we have edited the paragraph which now reads:

Researchers have presented at least two arguments attempting to understand this paradox through the lens of economics, politics, and power. First, global health governance (GHG) has been theorized as operating under the rational actor model (RAM) where “each actor has its own set of goals and objectives, and these actors take actions based on analysis of the costs and benefits of various available options.”[13] With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. GHG based on the RAM fails to “justify an obligation to help meet the health needs of others” and may have contributed to the persistence of global health inequities.[13]

[Comment 3] - Next para: "The actions of powerful global actors in pursuit of their own interests “are not designed to harm health but can have negative side-effects that create health inequities.” Do you mean global health actors or other actors (e.g. corporations etc)

Author Response: We thank this reviewer for this helpful comment. Yes, we mean global health actors in this context. In response to this reviewer’s comment, we now specify “global” health actors in this sentence:

The actions of powerful global health actors in pursuit of their own interests “are not designed to harm health but can have negative side-effects that create health inequities.”[6]

[Comment 4] - "We hypothesize that GHG operates under RAM and that there are power asymmetries in GHG that limit the range of health priorities as presented by the Commission on Global Governance for Health. " This reads to me like you are working from the basis of health priorities presented by the Commission. I don't think that is what you meant. Can you clarify?

Author Response: We thank this reviewer for identifying the need for clarification in this sentence. We are not working from the basis of health priorities presented by the Commission.

To clarify, we have two hypotheses. The first hypothesis is that GHG indeed operates under RAM and can be empirically observed. This hypothesis, if proven true, provides empirical evidence to the theory that GHG operates under the RAM, and in turn, requires all health actors to work together to correct global health injustices through an alternative governance framework based on shared ethical commitments.

The second hypothesis is that there are power asymmetries in GHG that limit the range of health priorities. This hypothesis, if proven true, provides empirical evidence that power asymmetries do exist

and have limited the range of health priorities in GHG, as theorized and argued by the Commission on Global Governance of Health (2014).

To avoid confusion, we removed the last portion of the sentence which now reads:

We hypothesize that GHG operates under RAM and that there are power asymmetries in GHG that limit the range of health priorities.

[Comment 5] - Methods: "For example, the WHO has annual financial reports that break down how much each health area or issue is funded in proportion of their total budget. The most allocated health areas are the revealed priorities of the WHO." WHO gets a LOT of ear-marked funding from BMGF etc. So I do not think that WHO is the best example here. One assumes that they take the funding b/c they would rather address work on the issue being funded that not work at all, because they want to maintain a good relationship with the donor etc...but I would not say that their funding reveals their revealed priorities.

Author Response: We thank the reviewer for this very helpful comment. In response to this reviewer's comment, we have omitted the WHO as a specific example and discussed stated and revealed priorities in a general manner. This section The new section now reads:

Priorities can either be stated or revealed. Stated priorities are those preferences explicitly stated in a health actor's founding documents, websites, and annual reports. The mission statements and the health areas each actor explicitly mention in their official documents and websites are stated priorities. Revealed priorities are preferences that are gleaned from records of past behaviors and choices. Past health funding allocations and accounts of actually implemented programs and policies are revealed priorities. Revealed priorities may or may not be aligned with stated priorities.

[Comment 6] - In my opinion, the Barnett and Duval explanations are examples of a manifestation of each type of power, rather than a summary of all possible manifestations of each type. It might be good to note that explicitly.

Author Response: We thank the reviewer for this very helpful comment. We agree that Barnett and Duvall's explanations is not a summary of all possible manifestations of power. We now explicitly state that the categorization of power by Barnett and Duvall is only one of multiple ways of understanding power. This sentence now reads:

Specifically, one way to categorize power is through the four types introduced by Barnett and Duvall (2005), each manifesting in different manners in global health.[40]

Reviewer: 2

Dr. Leah Pierson, Harvard Medical School

[General Comment 1] Summary and Impression:

The article aims to assess whether global health governance [GHG] acts in accordance with the rational actor model [RAM], which the authors define as “each actor [having] its own set of goals and objectives, and these actors [taking] actions based on analysis of the costs and benefits of various available options.” The authors also aim to better characterize power dynamics in GHG. The authors suggest that “Current GHG based on the RAM fails to ‘justify an obligation to help meet the health needs of others.’”

The authors evaluate this by comparing priorities indicated by global health actors' tweets, stated priorities in policy documents, and revealed priorities from funding data.

Author Response: We thank this reviewer for this fair summary of the objectives and methods of the study.

[General Comment 2] I believe the most interesting and important part of this project is the assessment of the alignment between actors' tweets, stated priorities, and funding. In particular, the evaluation of funders' priorities as revealed by their tweets is a novel and fascinating contribution. The paper is generally clear, although some parts could use reorganization. However, the project's framing faces substantial conceptual challenges, particularly with regard to the authors' definition and interpretation of the RAM. These, in turn, render it difficult to interpret the study's findings. In addition, while the project's ambition is commendable, at times, this breadth seems to come at the cost of elaboration and depth.

Author Response: We thank this reviewer for the overarching comments. The four points presented are welcomed and we respond to each in turn and incorporate our revisions to these comments in the revised manuscript.

First, we appreciate that the reviewer finds the assessment of the alignment between actors' tweets, stated priorities, and funding to be "interesting and important" and that the evaluation of funders' priorities as revealed by their tweets as "novel and fascinating."

Second, we appreciate the reviewer's comment about the paper's general clarity and potential for reorganization. We respond to the reviewer's specific suggestions for reorganization in the comments that follow.

Third, we appreciate the reviewer pointing out the conceptual challenges of the paper. We are aware of the complexity of the Rational Actor Model and how it is a challenge to summarize its key assumptions, ideas, and its application to global health within a section of a paper. As the RAM is a core component of the study, we have made changes to ensure that the concept is made as clear as possible. Changes made are further discussed in response to the specific comments that follow.

Fourth, we appreciate the comment on the project's breadth, elaboration, and depth. We hope that as a result of these revisions the manuscript is improved in depth and elaboration.

[Comment 1] Introduction:

The project's framing introduces several conceptual challenges. The first two of these challenges are due to one important point of confusion: namely, the authors define what it means for actors to adhere to a RAM in general, but do not clarify how this applies to global health actors specifically: for instance, how

do we determine what a global health organization's "goals and objectives" are? Because the authors do not provide an explanation, I assumed that organizations' goals and objectives are conveyed by their mission statements, bylaws, and other founding documents.

Author Response: We thank this reviewer for this helpful comment and as a result, we have revised section the introduction to provide clarity on how RAM applies to global health actors in the introduction section. The new paragraph that introduces RAM is now as follows:

Researchers have presented at least two arguments attempting to understand this paradox through the lens of economics, politics, and power. First, global health governance (GHG) has been theorized as operating under the rational actor model (RAM) where "each actor has its own set of goals and objectives, and these actors take actions based on analysis of the costs and benefits of various available options."[13] With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]

[Comment 2] First, the authors suggest that global health actors act in their own interest and that this "fails to 'justify an obligation to meet the health needs of others.'" But this is an ambiguous claim, given that the overriding goal of global health organizations is to improve global health. These actors thus have an obligation to adhere to their founding documents, all of which provide them with an obligation to promote health. In other words, these organizations have a fundamental obligation to act in accordance with their mandates, which require meeting the health needs of others.

Author Response: We thank this reviewer for this helpful comment. This statement is not a claim that we propose without justification. We agree with the reviewer's point that the implicit "overriding goal of global health organizations is to improve global health," and that provides global health actors "with an obligation to promote health." However, we recognize that are instances where health projects and programs are based on what the funders or implementers perceive is needed by the beneficiary, and not what the beneficiary actually needs or what will promote global health equity.

This imbalance in vertical funding in health promotes dependency of beneficiaries to donors and does not promote the empowerment and provision of equal opportunity to have the agency to achieve their own health goals.

Our findings demonstrate that global health organizations have very broad mandates that go along the lines of "good health for all." However, in practice, preferences and priorities are for narrow and vertical projects and programs that satisfy immediate-term that satisfy funder requirements. This study illustrates that even with massive volumes in global health funding, the existence of significant and severe preventable health inequalities demonstrates that this funding architecture does not necessarily promote equity and justice in global health.

To provide more clarity about the use of this statement, we have added more to the paragraph in the introduction and now reads:

Researchers have presented at least two arguments attempting to understand this paradox through the lens of economics, politics, and power. First, global health governance (GHG) has been theorized as operating under the rational actor model (RAM) where "each actor has its own set of goals and objectives, and these actors take actions based on analysis of the costs and benefits of various available options."[13] With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors,

prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit

objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]

[Comment 3] Second, the authors hypothesize that global health actors have created health inequities as a result of acting in their own interests (p. 4, line 37). But as previously stated, it is not clear what it means for a global health organization to act in its own interest. On a basic level, the interests of the organization seem to be represented by its founding documents. Thus, adhering to the RAM would involve acting in ways consistent with these documents. But notably, some of the global health actors included in the authors' analysis reference a desire to combat inequities in their mission statements and elsewhere, making this statement hard to parse: indeed, we might expect that for these organizations, acting in accordance with the RAM would reduce—not increase—inequities.

Author Response: We thank this reviewer for these helpful comments. We were overboard in how we describe that the increase in global health actors to create health inequities. In the revised manuscript, we have omitted all statements that refer to the increase in global health actors creating inequities. Instead, we note how despite the increase in global health actors and funding, health inequities persist.

In the revised manuscript, the edited parts of the introduction now read:

[…] ***Paradoxically, despite the exponential increases in global health actors and funding, preventable***

global health inequities have persisted. *Some argue that, to an extent, the multiplicity and fragmentation of global health actors contribute to the persistence of inequities and inefficiencies in global health.*

Researchers have presented at least two arguments attempting to understand this paradox through the lens of economics, politics, and power. First, global health governance (GHG) has been theorized as operating under the rational actor model (RAM) where "each actor has its own set of goals and objectives, and these actors take actions based on analysis of the costs and benefits of various available options."[13] With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. ***GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]***

Second, the Lancet-University of Oslo Commission on Global Governance for Health (2014) argues that "power asymmetry and global social norms limit the range of choice and constrain action on health inequity."[6] ***The actions of powerful global health actors in pursuit of their own interests "are not designed to harm health but can have negative side-effects" that may have contributed to the persistence of inequities.****[6] The lack of power of global health beneficiaries and smaller health actors, and the outsized wielded power of large global health funders may also have contributed to the slow rate of reduction in global health inequities.*

[Comment 4] Third, many global health inequities have narrowed over the past two decades (for instance, rates of maternal and infant mortality have fallen much faster in LMICs than they have fallen in HICs, meaning that at least by the WHO's definition of health inequity—"systematic differences in the health status of different population groups"—inequities have decreased). Thus, the claim that the emergence of new global health actors and increases in funding has contributed to health inequities

requires substantially more explanation. (Are the authors referring to inequities between different disease areas, i.e., HIV/AIDS versus mental health?) Defending this claim is also prerequisite to defending the authors' further claim that these inequities have arisen because funders are acting in accordance with the RAM.

Author Response: We thank the reviewer for this very helpful comment. Similar to the previous comment, and in response to this comment, we have revised the manuscript to omit all statements that say the increase in health actors have led to inequities, and instead say that despite the increase in actors and funding, health inequities persist.

We believe it is important to acknowledge that global health outcomes have improved throughout the years. However, while there has been an exponential increase in actors and funding, significant and severe preventable health inequities still exist. Our revised manuscript now reads:

Paradoxically, despite the exponential increases in global health actors and funding, preventable global health inequities have persisted. Some argue that, to an extent, the multiplicity and fragmentation of global health actors contribute to the persistence of inequities and inefficiencies in global health.

[Comment 5] Methods:

The authors aim to assess whether "GHG operates under the RAM" (p. 5, line 8). However, it is unclear how the authors are defining the RAM for global health actors. As previously dicussed, I suspect the authors are using the actors' stated priorities to define each organization's "goals and objectives" (i.e., RAM) and then evaluating whether actors' revealed priorities align with these. However, the authors do not explicitly say this, and other approaches are possible. To some extent, this is clarified later in the paper (under the "Testing if GHG operates under the RAM" section), but this should come sooner and warrants further explanation.

Author Response: We thank this reviewer for this helpful comment. As a result of this comment, we have revised this manuscript to explain RAM and how it applies to global health a bit more in the introduction to provide better clarity. Most of the explanation, however, as this reviewer states, is still under the section "Testing if GHG operates under the RAM." The introduction section that introduces RAM in the context of global health actors now reads:

…global health governance (GHG) has been theorized as operating under the rational actor model (RAM) where "each actor has its own set of goals and objectives, and these actors take actions based on analysis of the costs and benefits of various available options."[13] With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]

[Comment 6] Study sample:

The study sample is well-defined and reflects the important global health actors. The authors could consider listing in Table 1 (or elsewhere) each actor's global health budgets and number of Twitter followers to convey the magnitude of each actor's involvement and sphere of influence.

Author Response: We thank this reviewer for this very helpful suggestion. As a result of this reviewer's comment, we have added the number of Twitter followers of each actor to convey the magnitude of each actor's involvement and sphere of influence. These revisions have been made to Table 1 which now reads:

Table 1. Summary of Global Health Actors. Characteristics of the 20 global health actors analyzed in this study.

Nature of Work in Global Health	Organizational Category	Twitter Username	Global Health Actor	Number of Twitter Followers (as of October 2021)
Channels of Developmental Assistance for Health	Global health initiative	gavi	Gavi, the Vaccine Alliance	153,000
		UNITAID	Unitaid	17,200
		GlobalFund	Global Fund to Fight AIDS, Tuberculosis and Malaria	240,100
	Multilateral Development Bank	WorldBank	World Bank	3,500,000
	United Nations System	WHO	World Health Organization	10,000,000
		UNAIDS	Joint United Nations Programme on HIV/AIDS (UNAIDS)	286,800
		UNFPA	United Nations Population Fund (UNFPA)	260,800
		UNICEF	United Nations Children's Fund (UNICEF)	8,900,000

Funding Organizations	National Government	USAID	United States Agency for International Development (USAID)	843,200
		DFID_UK*	United Kingdom Department for International Development (UK DFID)*	1,000,000
	Philanthropic Organization	gatesfoundation	Bill and Melinda Gates Foundation	2,100,000
Implementing Institutions	Global CSO/NGO	MSF	Doctors Without Borders (MSF)	165,100
		PATHtweets	PATH	59,500
		SavetheChildren	Save the Children	2,700,000
		Oxfam	Oxfam International	836,300
	United Nations System	FAO	Food and Agriculture Organization (FAO)	469,600
		UNDP	United Nations Development Programme (UNDP)	1,600,000
	National Government	CDCgov	Centers for Disease Control and Prevention (CDC)	4,300,000
		ECDC_EU	European Centre for Disease Prevention and Control (ECDC)	90,600
		NIH	National Institutes of Health	1,400,000

			(NIH)	

* UK DFID is now the Foreign, Commonwealth, and Development Office. During the time of the analysis, the UK's agency for aid was known as DFID.

[Comment 7] Data sources:

The data sources used make sense. One minor point about this: under the data sources heading, the authors elaborate that "Revealed priorities are derived using a network analysis and descriptive statistics of financial flows in DAH funding data. To obtain the revealed priorities of each global health actor, we use topic modeling in natural language processing (NLP) and a network analysis of the tweets of each global health actor." This description does not seem to belong under this heading and should instead come under the one after.

Author Response: We thank this reviewer for this very helpful comment. As a result of this comment, we have revised the manuscript to move the sentences that describe how stated and revealed priorities were derived to the next two sections. The section on data sources now reads as follows:

We analyze stated and revealed priorities of 20 key global health actors from three data sources – policy documents, DAH funding data, and tweets. Table 2 summarizes each data source, how they were collected, how they were analyzed, and what types of priorities can be derived.

[Comment 8] Stated and revealed priorities:

I am not well-positioned to evaluate the methods used by the authors here (e.g., the use of Gephi and the Fruchterman-Reingold algorithm) and defer to other reviewers' assessments. Generally, I think the distinction drawn between stated and revealed priorities makes sense.

Author Response: We thank this reviewer for this very helpful comment. We underscore that the distinction drawn between stated and revealed priorities makes sense.

[Comment 9] Twitter data:

The idea of analyzing global health actors' tweets to determine their priorities is a great one. The strategy for collecting tweets (i.e., gathering at three-month intervals) also makes sense. However, I am somewhat confused by several aspects of the authors' approach to the Twitter analysis.

First, do the tweets represent stated or revealed priorities? I can see arguments for both and would want the authors to better explain where the tweets fall in this dichotomy. Later (p. 10, line 17), the authors state that the tweets represent revealed priorities, but it is not clear why tweets were categorized as such. (For instance, it is possible to imagine a case where an actor tweeted "We are planning to invest in X going forward," and this would seem to be a stated priority.)

Author Response: We thank this reviewer for this helpful comment. We thank the reviewer for identifying a potential point of confusion and allowing us the opportunity to amend in our revised manuscripts. For the purpose of this study, we consider tweets only to be revealed priorities. We have added the following explanation to the "Twitter data" section to provide more clarity:

While tweets can represent both stated and revealed priorities, for this study, we use tweets to represent revealed priorities. Since this study analyzes tweets in aggregation, our findings reveal the top themes discussed by each actor from 2016-2020. Because we do not analyze each tweet at an individual level, tweets are considered revealed priorities and not stated priorities.

[Comment 10] I also thought the authors specific invocation of communication studies in analyzing the tweets made little sense. The authors write that: “In the academic area of communications studies, researchers suggest that there are two forms of utility that motivate actors to post content on Twitter. First, intrinsic utility assumes that a user receives inherent satisfaction from posting content on Twitter.”

This statement seems to apply much more to civilian Twitter users than to organizations or public accounts. For instance, public figures (e.g., Joe Biden’s presidential account) likely are not tweeting things because the author derives “inherent satisfaction” from doing so: President Biden likely is not writing or posting most of his own tweets and thereby is not deriving “inherent satisfaction” from tweeting them. The same logic applies to global health funders.

Author Response: We thank the reviewer for this helpful comment. The invocation of communication studies in analyzing the tweets was done to present current theories on why individuals or organizations choose to tweet. We view “intrinsic utility” for organizations as receiving benefit from communicating their work to large amounts of users. As a result of this reviewers comments, we have revised the manuscript, in particular edited the section to provide more clarity of what we mean by “inherent utility” for global health actors. The new section now reads as follows:

First, intrinsic utility assumes that a user receives inherent satisfaction from posting content on Twitter.[19] While global health actors do not necessarily receive the same “inherent satisfaction” as individual Twitter users, global health actors acquire more intrinsic utility as their communications reach a greater number of users.

[Comment 11] It also seems like global health actors may have other motives for tweeting: for instance, to share information. Presumably the WHO tweets its updated vaccine and masking recommendations not just to improve its public image, but to additionally inform the public about its current stance on an important public health issue. (I understand that the tweets analyzed were pre-COVID, but this point applies to other public health matters as well.)

Author Response: We thank this review for this very helpful comment. Connected to the previous response, and in response to this comment, we added an explanation about how sharing more information to more people falls under the “intrinsic utility” received by global health actors. We have revised this section to provide more clarity which now reads:

First, intrinsic utility assumes that a user receives inherent satisfaction from posting content on Twitter.[19] While global health actors do not necessarily receive the same “inherent satisfaction” as individual Twitter users, global health actors acquire more intrinsic utility as their communications reach a greater number of users.

[Comment 12] Obtaining priorities from Twitter data:

As previously stated, I am not experienced with the methods used by the authors and am not well-equipped to assess their use here. Thus, I provide only general comments. However, I would want to see a little more discussion about how the topics were generated using the Latent Dirichlet allocation topic model. Here are some specific examples:

• I would expect there to be a fair degree of overlap in tweets referring to “breastfeeding” and “mothers.” But among the ten revealed priorities for each organization, some only have “breastfeeding” (e.g., WHO), some only have “mothers” (e.g., US), and some have both (e.g., Gates Foundation). What did the authors do with tweets that mentioned both “breastfeeding” and “mothers”? Do the authors believe that the revealed priorities of an organization that references both breastfeeding and mothers are substantively different than those of an organization that just references breastfeeding, and so on?

• Some topics are quite general (e.g., “Poverty”, “Treatment”, “News”), while others are more specific (“Fisheries”, “Hepatitis”, “Veterans”). In cases where one topic could be subsumed by another (e.g., “Schools” could be subsumed by “Education”), how did the authors disaggregate these?

Author Response: We thank this reviewer for this very helpful for these very helpful comments. As a result, we have made revisions to the revised manuscript. We have described the model in further detail and answered this reviewer's questions in the revised supplementary document on methods which now reads as follows:

- *What did the authors do with tweets that mentioned both "breastfeeding" and "mothers"? Do the authors believe that the revealed priorities of an organization that references both breastfeeding and mothers are substantively different than those of an organization that just references breastfeeding, and so on?*

    - o For context, LDA topic modeling is a form of "unsupervised machine learning" where the data used is "unlabeled." This means that when we ran the algorithm, we did not define what statements will be categorized as "breastfeeding" and what will be categorized as "mothers." We also did not define what words would fall under any other topics that were generated by the model. The only input from us is was how many topics we want the LDA algorithm to categorize the corpus of text. In our analysis, we generated 10 topics for each of the 20 actors. The LDA algorithm generates topics based on a generative probabilistic model that assumes each topic is a mixture over an underlying set of words, and each corpus of text is a mixture of sets of topic probabilities. In a nutshell, the algorithm analyzes all the words in all the tweets of a specific actor. It then generates probabilities of each unique word appearing with other words in a certain tweet or sentence. Topics are then generated by the model based on these sets of probabilities.

- *Some topics are quite general (e.g., "Poverty", "Treatment", "News"), while others are more specific ("Fisheries", "Hepatitis", "Veterans"). In cases where one topic could be subsumed by another (e.g., "Schools" could be subsumed by "Education"), how did the authors disaggregate these?*

    - o We did not have any input in categorizing any of the topics generated. The topics generated are based on the words and language used by each respective actor in their tweets. The algorithm uses the words/language used by the actor in their tweets to generate topics. We did not make any other edits to the topics after they were generated.

[Comment 13] Testing if GHG Operates under the RAM:

This first half of this section was extremely helpful, and the authors' approach here made sense. Presenting this section earlier in the paper (i.e., in the introduction) would help forestall some of the aforementioned concerns.

Author Response: We thank this reviewer for this very helpful comment. As a response to this comment, in the revised manuscript, we have made revisions to the introduction as follows:

Researchers have presented at least two arguments attempting to understand this paradox through the lens of economics, politics, and power. First, global health governance (GHG) has been theorized as operating under the rational actor model (RAM) where "each actor has its own set of goals and objectives, and these actors take actions based on analysis of the costs and benefits of various available options."[13] With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit

objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]

[Comment 14] I do think the authors glossed over important nuances of the RAM though. First, in the Mintz and DeRouen chapter cited by the authors, Mintz and DeRouen write: “First, actors are assumed to employ purposive action motivated by goal oriented behavior and not simply by habit or social expectations” (p. 58). But is this assumption reasonable for global health actors, who often default into continuing to fund existing programs?

Author Response: We thank this reviewer for this helpful comment. In response to this comment, we note that we believe that this assumption is reasonable for global health actors since the reason why actors continue to fund existing programs is because these programs align with the goals of the majority of funders and implementing institutions. This is evidenced by study findings which demonstrate that the funding organizations prioritize certain vertical health areas, thereby incentivizing channels and implementing institutions to align their priorities to the funder in order to receive funding.

[Comment 15] Critically, I found the section about benefit maximization to be conceptually unclear. The authors write that: “Actors are assumed to maximize utility while choosing an alternative that provides the highest amount of net personal benefit.” But we know, for instance, that some actors do not attempt to maximize utility (i.e., those that care about equity in addition to utility). In addition, this definition raises questions about what constitutes “net personal benefit” means, beyond simply achieving the actor’s pre-determined goals. The authors also do not draw a distinction between “net personal benefits” and “maximizing utility,” although presumably these can come apart, as implied by the caveat included in the definition. Finally, the authors write that “The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets are revealed to be the priority that the global health actor determines to be benefit maximizing”. But presumably, there can be differences between what is actually benefit maximizing and what the actor considers benefit maximizing. Would it be consistent with the RAM for the actor to prioritize its preferred interventions, even if these were not, in fact, benefit maximizing (for instance, in accordance with benefit-cost analysis)? Based on the Mintz and DeRouen text—"utility maximization means that actors will select the alternative that provides the greatest amount of net benefits”—it appears that this behavior would be inconsistent with the RAM. But the authors seem to assume that utility is specific to the agent, which I am not sure is a correct interpretation?

Author Response: We thank this reviewer for these helpful comments. It’s very helpful to have the opportunity to further explain RAM. In the RAM, “maximize utility,” refers to maximizing the net personal benefits however defined by the health actor. It can be defined as financial benefits, ethical benefits such as equity, or however else the health actor defines their utility. In this case, “personal benefit” and “utility” are interchangeable. Individual “utility maximization” is consistent with RAM. Even if the actor measures their utility or personal benefit from the achievement of equity, then the actor still acts according to RAM. In response to the reviewer’s helpful comment, we have revised the section of the manuscript that discusses RAM’s third assumption of benefit maximization which now reads:

To test the third assumption of benefit maximization, we compare the stated and revealed priorities from all three data sources. The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets are revealed to be the priority that the global health actor determines to be benefit maximizing. An alignment of a preference across the three different sources can lead us to believe with high probability that it is the actor’s benefit maximizing preference.

[Comment 16] Definitions and types of power:

This section felt disconnected from the prior ones. It also seems wrong to conclude that "The global health actors which have the most priorities aligned with the stated and revealed priorities of the global health system are determined to have the most influence and power in priority-setting." Isn't it possible that an actor just happens to have priorities that align with the status quo (or that an actor adopted certain priorities because it recognized that there was substantial infrastructure and funding in a given arena)? In the latter case, an actor's priorities being aligned with the priorities of the global health system could reflect a lack of power, rather than an abundance of it.

Author Response: We thank the reviewer for these very helpful comments. It is helpful that the reviewer pointed out the disconnect of this section from prior ones. The purpose of this section is to introduce the definitions and types of power before explaining how power dynamics are charactized in GHG. As a result to this reviewer's comments, we revised the manuscript to improve the flow and clarity of the methods section, we combined this section "Definitions and types of power" with the next section "Characterizing power dynamics in GHG." The section now reads:

Characterizing power dynamics in GHG

We use the following typology of power when characterizing power dynamics in GHG. "Power is exercised everywhere in global health although its presence may be more apparent in some instances than others,"[39] one global health researcher notes. The power concept in global health does not stray far from Robert Dahl's (1957) definition in his seminal study where he describes "A has power over B to the extent that he can get B to do something B would not otherwise do."[40] Specifically, one way to categorize power is through the four types introduced by Barnett and Duvall (2005), each manifesting in different manners in global health.[41] Supplementary Table 5 summarizes Barnett and Duvall's four types of power. First, compulsory power is defined as "direct control of one actor over the conditions of existence or the actions of another."[41] In global health, compulsory power can be seen in how donor countries dictate the conditions in low and middle-income countries (LMICs) through development aid.[42] Second, institutional power is "the control actors exercise indirectly over others through diffuse relations of interactions."[41] High-income countries control funding allocations for LMICs through institutional power via their contributions to the WHO and other multilateral organizations. Third, structural power refers to the "constitution of subjects' capacities in direct structural relation to one another."[41] The structural and historical disempowerment of indigenous populations have resulted in their disproportionate outcomes in health.[43,44] Fourth, "productive power works through diffuse constitutive relations to produce the situated social capacities of actors."[40] Research institutions funded by high-income countries direct what health issues are studied and addressed.[45]

To characterize the power dynamics manifested in GHG, we analyze the interplay of stated and revealed priorities between funding organizations, channels of DAH, and implementing organizations. Particularly, we identify which global health actors have the most influence in setting global health priorities. The global health actors which have the most priorities aligned with the stated and revealed priorities of the global health system are determined to have the most influence and power in priority-setting.

[Comment 17] Findings:

Given that the entire paper has been building to this point, this section felt too short. It would be worth describing some noteworthy examples from a few actors, or describing any places where the rank order

preferences differ between funding data and tweets. For instance, the authors could highlight some examples from Supplemental Table 1 in the main text.

Author Response: We thank this reviewer for this very helpful comment. As a result of this reviewer's comment, we have revised the manuscript to include a detailed example of the findings. As well, we continue to include in the revised manuscript supplemental table 1 which will be useful for readers to go through the findings for each of the 20 global health actors. The example added to the "DISCUSSION" section now reads:

As an example, USAID's pre-determined goal is protecting national security through the providing aid the health areas of child and maternal health, HIV/AIDS, malaria, and tuberculosis as stated on their official website.[46] In 2019, 49% of aid from USAID support HIV/AIDS, 22% supported child and maternal health, and 7% to malaria.[47] The topic modelling for USAID's tweets shows that HIV/ADIS, child and maternal health, and malaria are the top themes tweeted about by the organization from 2016-2020 (See Supplementary Table 1). USAID behaves under the RAM since their revealed priorities from past funding behavior and from tweets align with their pre-determined goal.

[Comment 18] Furthermore, the decision to define "the pre-determined goal of the global health system" as SDG 3 should have come sooner and warrants further defense. For instance, although the 20 actors have stated commitments to the WHO mission and the SDGs, there are funders that are larger than WHO (i.e., Gates Foundation) who have objectives that differ from the WHO's.

Author Response: We thank this reviewer for this very helpful comment. As a result of this reviewer's comment, we have revised the manuscript to introduce SDG 3 earlier in the "METHODS" section under the sub-section "Testing if GHG operates under the RAM" which now reads:

We also test the three assumptions at the global health system level. Pre-determined goals are obtained from stated priorities from collective stated commitments to global health based on Sustainable Development Goal 3 (SDG-3) of "good health and well-being" as all 20 of the actors in this study have stated commitments to this goal.

[Comment 19] The authors also assert that "To maximize benefits of the pre-determined goal of "health for all" and "SDG3: good health and well-being", the global health system prioritizes HIV/AIDS, child health, and maternal health," but this presupposes that the actors are collectively acting in accordance with the RAM, which they may not be.

We thank this reviewer for this helpful comment. In the revised manuscript, when it is stated that "to maximize benefits of the pre-determined goal of "health for all" and "SDG3: good health and well-being", the global health system prioritizes HIV/AIDS, child health, and maternal health," it reports findings that each of the 20 actors and the global health system collectively operate under the RAM. This is because they each fulfill the 3 assumptions of the RAM after triangulating evidence from official documents, Twitter, and past funding data.

[Comment 20] Finally, is it in fact the case that prioritizing HIV/AIDS, child health, and maternal health actually maximizes benefits (in accordance with any economic evaluation technique, such as cost-benefit or cost-effectiveness analysis)?

We thank this reviewer for this very helpful comment. In response to this helpful comment, we have revised the manuscript and added a section in the conclusion which now reads:

The priorities of funders of HIV/AIDS, child health, and maternal health have been prioritized from 2016-2020. While global health has seen improvements in these three areas, the existence of significant and severe preventable health inequalities demonstrates that this funding architecture does not necessarily promote equity and justice in global health. Additionally, other core health issues such as horizontal health system improvements do not appear to be prioritized that may have led to the persistence of global health inequity

[Comment 21] Conclusion:

The authors conclude that “The rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs.” This claim warrants a little more explanation than it is given here.

Author Response: We thank this reviewer for this very helpful comment. In the revised manuscript, this sentence is revised is to summarize the deeper discussion of findings in the “DISCUSSION” section. We have revised this sentence as follows:

As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs.

[Comment 22] In addition, the authors should explain how the funding asymmetries they have identified lead to specific inequities (and should provide some evidence to support this), given that the introduction was framed in those terms.

Author Response: We thank this reviewer for this helpful comment. As a result of this reviewer’s comment, in the revised manuscript, in the revised conclusion, this is noted.

To contextualize current literature on how funding asymmetries have affected health inequities, we reference Birn (2014) and discussing how “philantrocapitalists” have an outsized influence on global health agenda setting, and McGoey (2012) who argues that while new large funders have contributed to good causes may not necessarily have ethical foundations for their work. The conclusion now reads:

We find empirical evidence at the global level showing that GHG operates under the RAM. Additionally, we find that at the global level, there is asymmetric compulsory and institutional power held by funding organizations, allowing global health priorities to be set by funders that have the money to spend on global health. In the past years, these funders have been the United States, United Kingdom, and the Gates Foundation. As shown by the triangulated evidence, the rational choice for all global health actors

is to align their priorities with those of funding organizations in order to continue with their programs. These findings are in alignment with current literature discussing how "philantrocapitalists" and large funders having an outsized influence on global health agenda setting even without necessarily having an ethical framework for decision-making.[48,49]

Our paper complements the current research on agenda-setting in global health. Jeremy Shiffman's (2016) discussion of how agenda-setting is not purely a rational deliberation of evidence but the convergence of problems, solutions, and political developments.[50] This study attempts to deepen the

understanding of the manifestation and influence of power in agenda-setting through the lens of stated and revealed priorities.

The priorities of funders of HIV/AIDS, child health, and maternal health have been prioritized from 2016-2020. While global health has seen improvements in these three areas, the existence of significant and severe preventable health inequalities demonstrates that this funding architecture does not necessarily promote equity and justice in global health. Additionally, other core health issues such as horizontal health system improvements do not appear to be prioritized that may have led to the persistence of global health inequity. We have empirical evidence supporting the arguments that current GHG operates under the RAM, and existing power asymmetries limit the range of choice for health policies and programs that aim to reduce inequities. If "health for all" and the SDG3 targets are to be achieved, then there must be a reassessment of current GHG under the RAM.

[Comment 23] Finally, I would include more discussion of the limitations of this analysis.

Author Response: Thank you to this reviewer for this helpful comment. As a result of this helpful comment, under the "CONCLUSION" section which now reads. We have included a new section on "Limitations" under the "DISCUSSION" section of this paper which reads:

It is necessary to acknowledge the three limitations of this study. First, we assume stated priorities match what is specified in organizational documents. It may be the case that some organizations communicate priorities differently from what is written in their foundational documents. Moreover, what is fundable may not necessarily be what is most important. Second, we assume that health funding is indeed spent on what it is ostensibly spent on when deriving revealed preferences from past health funding data, although may not be the case. Third, our scope is limited to examining 20 global health actors from 2016 to 2020. There is a multiplicity of non-health actors and processes that likely influence overall health outcomes of populations. Studying the stated and revealed priorities of non-health actors and processes such as foreign relations between nations and the influence of the private sector on health can improve the characterization of current GHG.

Reviewer: 3

Dr. Milena Lopreite, Scuola Superiore Sant'Anna, Pisa, IT

[General Comment] The theme is interesting, as well the methodology is appropriate.

Author Response: We thank the reviewer for this helpful comment and appreciate that the reviewer finds the theme interesting and methodologically appropriate.

[Comment 1] A revised paper to improve the legibility and interpretation of the data and the statements reported should include on the side of the methods and the theory discussion some refinements as the following:

1) Pg 5: Please re-write the background and cite more quantitative studies on the global health networks (i.e Lopreite, M, Puliga, M, Riccaboni, M, De Rosis, S (2021) “”, Volume 278, pp.1-10. Social Science and Medicine. DOI: 10.1016/j.socscimed.2021.113940.

Author Response: We thank this reviewer for this helpful comment. As a result of this reviewer's comment, we have referenced Lopreite et al. 2021 and Quisell et al. 2018 in discussing the usefulness of network analysis in studying global and public health. The revision now reads as follows:

Network analysis is an analytic method that has proved to be useful in understanding relational dynamics across actors in global and public health. (Lopreite et al. 2021 and Quisell et al. 2018).

[Comment 2] 2)Pg 6:The section of the methods is too short: Please write more details about GHG and RAM.

Author Response: We thank the reviewer for this helpful comment. In the revised manuscript, we include the following sections within the methods section: "Study Sample," "Patient and Public Involvement," "Data Sources," "Drawing stated priorities from policy documents," "Deriving revealed priorities from funding data," "Twitter data," "Obtaining priorities from Twitter data," "Testing if GHG operates under the RAM," "Characterizing power dynamics in GHG." Our revised manuscript includes supplementary document on methods details our methods.

Our revised methods section now reads as follows:

METHODS

We test if GHG operates under the RAM and characterize the power dynamics in GHG through the lens of global health priority-setting. All global health actors have certain preferences for health issues and act in alignment with these priorities.

Priorities can either be stated or revealed. Stated priorities are those preferences explicitly stated in a health actor's founding documents, websites, and annual reports. The mission statements and the health areas each actor explicitly mention in their official documents and websites are stated priorities. Revealed priorities are preferences that are gleaned from records of past behaviors and choices. Past health funding allocations and accounts of actually implemented programs and policies are revealed priorities. Revealed priorities may or may not be aligned with stated priorities.

We use evidence for both stated and revealed priorities from 2016 to 2020 to test both of our research questions.

Study Sample

We identified 20 key global health actors based on a consensus among three past studies that mapped the global health network using quantitative and qualitative methodologies.[4,14,15] As shown in Table 1, the key global health actors were categorized based on their nature of work in global health. Global health actors were either funding organizations, channels of developmental assistance for health (DAH) or implementing institutions. While most actors fall into more than one of these categories in practice, for the integrity of this analysis, organizations were limited to only one category based on the nature of their main line of work.

Patient and public involvement

Patients and the public were not involved in the development of the research questions and outcome measures.

Data Sources

We analyze stated and revealed priorities of 20 key global health actors from three data sources – policy documents, DAH funding data, and tweets. Table 2 summarizes each data source, how they were collected, how they were analyzed, and what types of priorities can be derived.

Drawing stated priorities from policy documents

Stated priorities are obtained from a manual content analysis of policy documents, annual reports, and official websites of global health actors.

Available policy documents, annual reports, and relevant official communications from the websites of each global health actor within the timeframe of the study were collected. Documents not published between 2016 and 2020 were not collected. Manual content analysis was conducted to evaluate the available policy documents for each global health actor and identify their respective stated priorities.

The stated priorities drawn from these documents were commonly obtained from official statements that fall under the following headings: "strategic priorities," "program priorities," "strategic objectives," "focus areas," "strategic work areas," "program focus," "Strategy 20XX-20XX," "strategic goals," "priority areas," among others. The first column of Supplementary Table 1 contains the stated priorities obtained from each actor.

Deriving revealed priorities from funding data

Revealed priorities are derived using a network analysis and descriptive statistics of financial flows in DAH funding data. To obtain the revealed priorities of each global health actor, we use topic modeling in natural language processing (NLP) and a network analysis of the tweets for each global health actor. Further explanation of data collection from each source follows.

Data from the Institute for Health Metrics and Evaluation's (IHME) Developmental Assistance for Health Database was collected for 2019.[16] The database includes approximately 800,000 transactions of financing for health programs and aid from funding organizations to channels of DAH and to implementing countries.

Descriptive statistics were conducted to determine the allocations of funding for each health area and geographic region for the 20 global health actors in 2019.

Network analysis is an analytic method that has proved to be useful in understanding relational dynamics across actors in global and public health.[17,18] Network analysis was conducted to observe the funding

relationships between global health actors. Gephi 0.9.2 was used in constructing and analyzing the network map. The network modelled in the study allows for a graphical visualization of the flows of global health funding in 2019. The network map was designed such that each global health actor is represented by a node and lines or "edges" indicate a flow of funding in global health. The Fruchterman-Reingold algorithm was used in modelling the network map. The algorithm "calculates the optimal layout so that nodes with less strength and less connections are placed further apart, and those with more and/or stronger connections are placed closer to each other."[19] The thickness of edges represents the amount of funding transferred between actors. The modelled network map can be found and will be discussed in the findings section.

Twitter data

Using the Twitter API, we collected all the tweets of each global health actor by username from November 2016 to May 2020 in three month intervals. This means that all the tweets of each global health actor were collected for each day in the months of February, May, August, and November for each year. An interval of three months was decided for two reasons. First, a variation in the issues, topics, and themes that global health actors tweet can be observed in three month intervals. Initial small sample testing indicates that collecting all the tweets of every month for each actor yields redundancy in issues and topics observed. Redundancy is eliminated in three month intervals. Second, it also allows for efficient usage of the data request limits of the Twitter API. As Twitter limits the number of tweets one is able to collect from the Twitter API, this interval is an efficient way of collecting data for all 20 global health actors for the timeframe. A total of 74,241 tweets were collected from 2016 to 2020 for the 20 global health actors. Supplementary Tables 2 and 3 further describe the tweets collected.

Using Twitter as a data source plays an important role in analyzing GHG, examining whether it operates under the RAM, and characterizing power dynamics. In the academic area of communications studies, researchers suggest that there are two forms of utility that motivate actors to post content on Twitter. First, intrinsic utility assumes that a user receives inherent satisfaction from posting content on Twitter.[20] While global health actors do not necessarily receive the same "inherent satisfaction" as individual Twitter users, global health actors acquire more intrinsic utility as their communications reach a greater number of users. Second, image-related utility assumes that the perceptions of others,[21,22] and seeking status or prestige are strong motivators for posting content.[23,24] As global health actors operate best with high public approval, posting content on Twitter can improve public perception. Twitter is the ideal platform for global health actors to simultaneously share their work to a greater number of individuals and to improve their public perception. The utility received from using Twitter explains the social media's ubiquity among global health actors.

Because Twitter limits each post to 280 characters, the platform promotes short, frequent, and straightforward manners of communication. The tweets of global health actors are regular ways of communicating their work, preferences, and priorities to the public.[25–28] The tweets of global health actors act as an archive, a record of historical preferences, priorities, goals, and implemented programs.[29]

While tweets can represent both stated and revealed priorities, for this study, we use tweets to represent revealed priorities. Since this study analyzes tweets in aggregation, our findings reveal the top themes discussed by each actor from 2016-2020. Because we do not analyze each tweet at an individual level, tweets are considered revealed priorities and not stated priorities.

Obtaining revealed priorities from Twitter data

NLP is a subfield in artificial intelligence, computer science, and linguistics at the intersection of the human language and computers. NLP is concerned about how to utilize computers to process and analyze large quantities of human language data. We use NLP in analyzing the tweets of the global health actors for two reasons. First, NLP allows for the efficient analysis of tens of thousands of rows of text data that could not be done manually.[30–32] Second, NLP allows for a technique called topic

modeling where an algorithm generates lists of words that are frequently used together.[33–35] These lists of words can then be interpreted to identify specific themes, topics, or issues to identify the top 10

priorities of each global health actor from 2016 to 2020. The results of the topic modeling are then used in a network analysis that visualizes where each actor converges or diverges in global health priorities with other actors.

As seen in Table 3, ten topics were generated using the Latent Dirichlet Allocation (LDA) topic model for each global health actor's tweets to reveal their priorities from 2016 to 2020. LDA is a generative probabilistic modeling method where words in a corpus of text that are frequently used together are categorized into topics.[36] This follows the assumption that documents, or in this case Twitter profiles, can be broken down into multiple topics that are identified by certain combinations of words.

Additionally, we model a network map from the priorities generated using the LDA topic model also using the Fruchterman-Reingold algorithm. This network map visualizes the similarities in priorities between the 20 actors. Data used for this network map can be found in Supplementary Table 4. This network map is compared with the network map generated using financial data from IHME in the findings section. This comparison between network maps can illustrate if priorities from tweets and from financial data are aligned.

Testing if GHG operates under the RAM

By combining evidence for stated and revealed priorities of 20 key global health actors, we can determine if GHG operates under the RAM.

The rational actor model (RAM) in international cooperation is categorized as the "linchpin of foreign policy decision making."[37] This approach is rooted in expected utility theory in microeconomics introduced by von Neumann and Morgenstern in the 1940s and subsequent theories of rationality.[38]

RAM is most useful in explanations of economic behavior if the three conditions of the rationality assumption are fulfilled.[37] First, it is assumed that an actor's goal is pre-determined before intentionally acting to achieve it.[37] Second, actors are assumed to "display consistent preferences as manifested in the ability to rank the preferences in transitive order."[37] Third, actors are assumed to maximize utility while choosing an alternative that provides the highest amount of net personal benefit.[37]

"Rational" in this case does not simply mean a dispassionate calculation of costs and benefits. In the case of global health actors, acting rationally means weighing both economic and political factors, and acting according to the three assumptions of RAM.

GHG operates under RAM if each of the 20 global health actors and the global health system collectively fulfill the three assumptions of pre-determined goal, rank order preferences, and benefit maximization.

To test the first assumption of pre-determined goal, we determine the stated priorities of each global health actor from policy documents. We test whether there exist explicit statements on goals and priorities and note what health areas or issues are the stated priorities of each global health actor.

To test the second assumption of consistent rank order preferences, we compare revealed priorities from DAH funding data and revealed priorities from tweets. From the DAH funding data, we can determine rank order preferences based on which health issues are allocated the most funding in 2019. From tweets, we can determine rank order preferences based on the top 10 topics each global health actor tweeted about from 2016 to 2020. If there is consistency in rank order preferences between the revealed

priorities from DAH funding data and revealed priorities from tweets, then the second assumption is fulfilled.

To test the third assumption of benefit maximization, we compare the stated and revealed priorities from all three data sources. The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets are revealed to be the priority that the global health actor determines to be benefit maximizing. An alignment of a preference across the three different sources can lead us to believe with high probability that it is the actor's benefit maximizing preference.

We also test the three assumptions at the global health system level. Pre-determined goals are obtained from stated priorities from collective stated commitments to global health based on Sustainable Development Goal 3 (SDG-3) of "good health and well-being" as all 20 of the actors in this study have stated commitments to this goal. Consistent rank order preferences are derived from the alignment between aggregated DAH funding allocations of all global health actors and the most common topics generated from tweets across all global health actors. The consistent preferences across stated and revealed priorities are inferred to be what the global health systems decides to be benefit maximizing.

If each global health actor fulfills the three assumptions, and if the global health system collectively fulfills the three assumptions, then GHG operates under the RAM.

Characterizing power dynamics in GHG

We use the following typology of power when characterizing power dynamics in GHG. "Power is exercised everywhere in global health although its presence may be more apparent in some instances than others,"[39] one global health researcher notes. The power concept in global health does not stray far from Robert Dahl's (1957) definition in his seminal study where he describes "A has power over B to the extent that he can get B to do something B would not otherwise do."[40] Specifically, one way to categorize power is through the four types introduced by Barnett and Duvall (2005), each manifesting in different manners in global health.[41] Supplementary Table 5 summarizes Barnett and Duvall's four types of power. First, compulsory power is defined as "direct control of one actor over the conditions of existence or the actions of another."[41] In global health, compulsory power can be seen in how donor countries dictate the conditions in low and middle-income countries (LMICs) through development aid.[42] Second, institutional power is "the control actors exercise indirectly over others through diffuse relations of interactions."[41] High-income countries control funding allocations for LMICs through institutional power via their contributions to the WHO and other multilateral organizations. Third, structural power refers to the "constitution of subjects' capacities in direct structural relation to one another."[41] The structural and historical disempowerment of indigenous populations have resulted in their disproportionate outcomes in health.[43,44] Fourth, "productive power works through diffuse constitutive relations to produce the situated social capacities of actors."[40] Research institutions funded by high-income countries direct what health issues are studied and addressed.[45]

To characterize the power dynamics manifested in GHG, we analyze the interplay of stated and revealed priorities between funding organizations, channels of DAH, and implementing organizations. Particularly, we identify which global health actors have the most influence in setting global health priorities. The

global health actors which have the most priorities aligned with the stated and revealed priorities of the global health system are determined to have the most influence and power in priority-setting.

[Comment 3] 3)Pg 6: Please specify what kind of disease fight the GHN that you classified in the Table 1.

Author Response: We thank the reviewer for this helpful comment. As a result of this reviewer's comment, we note that not all actors are disease specific in their explicit missions. The stated priorities (explicit mission statements) and revealed priorities (from Tweets and from funding data) of each of the 20 global health actors are detailed in Supplementary Table 1.

[Comment 4] 4)Pg 9: Please define better the LDA model

Author Response: We thank this reviewer for this helpful comment. As a result of this reviewer's comment, suggesting further explanation of the Latent Dirichlet Allocation (LDA) topic modeling, we have revised the manuscript. In the revised manuscript, we have described the model in further detail in the supplementary document on methods. The revised supplementary document on methods includes the following:

Topic modelling

1. Topic Modeling was conducted to identify the 10 most tweeted global health issues/topics by each actor in each of the 15 months in the study.

2. The 10 most tweeted global health issues/topics were used to describe the set of issues/problems a specific global health actor prioritizes in a given month.
3. Latent Dirichlet Allocation (LDA) was used in topic modeling.
4. Topic modeling answers the questions:

    a. "What are the most prioritized issues among the identified global health actors from 2016 to 2020?"

    b. "When did global health actors have pandemic preparedness as a priority in the three years leading up to the COVID-19 pandemic?"

    c. "What are the trends in prioritization of global health issues between and among different types of global health actors?

FAQs about how LDA was used in this study

- What did the authors do with tweets that mentioned both "breastfeeding" and "mothers"? Do the authors believe that the revealed priorities of an organization that references both breastfeeding and mothers are substantively different than those of an organization that just references breastfeeding, and so on?

    o For context, LDA topic modeling is a form of "unsupervised machine learning" where the data used is "unlabeled." This means that when we ran the algorithm, we did not define what statements will be categorized as "breastfeeding" and what will be categorized as "mothers." We also did not define what words would fall under any other topics that were generated by the model. The only input from us is was how many topics we want the LDA

algorithm to categorize the corpus of text. In our analysis, we generated 10 topics for each of the 20 actors. The LDA algorithm generates topics based on a generative probabilistic model that assumes each topic is a mixture over an underlying set of words, and each corpus of text is a mixture of sets of topic probabilities. In a nutshell, the algorithm analyzes all the words in all the tweets of a specific actor. It then generates probabilities of each unique word appearing with other words in a certain tweet or sentence. Topics are then generated by the model based on these sets of probabilities.

- Some topics are quite general (e.g., “Poverty”, “Treatment”, “News”), while others are more specific (“Fisheries”, “Hepatitis”, “Veterans”). In cases where one topic could be subsumed by another (e.g., “Schools” could be subsumed by “Education”), how did the authors disaggregate these?

    - We did not have any input in categorizing any of the topics generated. The topics generated are based on the words and language used by each respective actor in their tweets. The algorithm uses the words/language used by the actor in their tweets to generate topics. We did not make any other edits to the topics after they were generated.

Code for topic modelling

```
#	Impo

rting

modules

import

pandas as pd


#	Read data into tweets_df
tweets_df = pd.read_csv('tweets_nov2016-may2020.csv')


#	Print head

tweets.head()


#	Remove the columns
tweets_df = tweets_df[["username","user_id","created_at","tweet"]]


#	Print out the
first rows of tweets_df
tweets_df.head()


#	Create dataframe for each month in analysis
tweets_feb = tweets.loc[tweets.created_at.str.contains("Feb")]


tweets_feb_17 = tweets_feb.loc[tweets_feb.created_at.str.contains("2017")]

tweets_feb_18 = tweets_feb.loc[tweets_feb.created_at.str.contains("2018")]

tweets_feb_19 = tweets_feb.loc[tweets_feb.created_at.str.contains("2019")]

tweets_feb_20 = tweets_feb.loc[tweets_feb.created_at.str.contains("2020")]
```

```
tweets_may = tweets.loc[tweets.created_at.str.contains("May")]
tweets_may_17 = tweets_may.loc[tweets_may.created_at.str.contains("2017")]
tweets_may_18 = tweets_may.loc[tweets_may.created_at.str.contains("2018")]
tweets_may_19 = tweets_may.loc[tweets_may.created_at.str.contains("2019")]

tweets_may_20 = tweets_may.loc[tweets_may.created_at.str.contains("2020")]


tweets_aug = tweets.loc[tweets.created_at.str.contains("Aug")]
tweets_aug_17 = tweets_aug.loc[tweets_aug.created_at.str.contains("2017")]
tweets_aug_18 = tweets_aug.loc[tweets_aug.created_at.str.contains("2018")]

tweets_aug_19 = tweets_aug.loc[tweets_aug.created_at.str.contains("2019")]


tweets_nov = tweets.loc[tweets.created_at.str.contains("Nov")]
tweets_nov_16 = tweets_nov.loc[tweets_nov.created_at.str.contains("2016")]
tweets_nov_17 = tweets_nov.loc[tweets_nov.created_at.str.contains("2017")]

tweets_nov_18 = tweets_nov.loc[tweets_nov.created_at.str.contains("2018")]
tweets_nov_19 = tweets_nov.loc[tweets_nov.created_at.str.contains("2019")]


# Helper function
def plot_10_most_common_words(count_data, count_vectorizer):

  import matplotlib.pyplot as plt
  words = count_vectorizer.get_feature_names()
  total_counts = np.zeros(len(words))
  for t in count_data:
    total_counts+=t.toarray()[0]


  count_dict = (zip(words, total_counts))
  count_dict = sorted(count_dict, key=lambda x:x[1], reverse=True)[1:23]
  words = [w[0] for w in count_dict]
```

```
counts = [w[1] for w in count_dict]
x_pos = np.arange(len(words))

plt.figure(2, figsize=(15, 2))
plt.subplot(title=f'10 Most Common Words')
```

```
  sns.set_context("notebook", font_scale=1.25, rc={"lines.linewidth": 2.5})

  sns.barplot(x_pos, counts, palette='husl')

  plt.xticks(x_pos, words, rotation=90)

  plt.xlabel('words')

  plt.ylabel('counts')

  plt.show()


# Import Libraries

from sklearn.feature_extraction.text import CountVectorizer

import numpy as np


import matplotlib.pyplot as plt

import seaborn as sns


import re

import string


#           Identify top 10 keywords, issues,
topics of each actor for a given month tweets
= tweets_nov_16[tweets_nov_16["username"]
== username] tweets =
tweets_df[tweets_df['username'].isin(usernam
e)]
printable = set(string.printable)

tweets['paper_text_processed'] = tweets['tweet'].map(lambda x: re.sub('[,\.!?]', '', x))


tweets['paper_text_processed'] =
tweets['tweet'].map(lambda x: x.encode('ascii','ignore'))
exclusionList =
['amp','https','RT','people','know','living','new','2018','latest'
,'use', 'week',
'ECDC_EU','thank','Thank','DYK','USAID','today','world','m
illion','country',


        'foreignoffice','UK','billgates','melindagates','2019','des','33', 'DFID',
        '000','day','like','year','old','live','UNITAID','PATHtweets','PATH','par
        a',
        'WorldBank','LIVE','WHOAFRO','WHOWPRO','WHOSEARO','WH
        OEMRO','GlobalFund','WHO_Europe','la'
```

```
        ]

exclusions = '|'.join(exclusionList)

tweets['paper_text_processed'] = tweets['tweet'].map(lambda x: re.sub(exclusions, '', x))


tweets['paper_text_processed'] =
tweets['paper_text_processed'].map(lambda x: x.lower())
tweets['paper_text_processed'].head()


sns.set_style('w
hitegrid')
%matplotlib
inline


count_vectorizer = CountVectorizer(stop_words='english')


count_data =
count_vectorizer.fit_transform(tweets['paper_text_
processed']) import warnings

warnings.simplefilter("ignore")

plot_10_most_common_words(count_data, count_vectorizer)


#           LDA Topic Modeling
import warnings

warnings.simplefilter("ignore", DeprecationWarning)

# Load the LDA model from sk-learn

from sklearn.decomposition import LatentDirichletAllocation as LDA


# Helper function

def print_topics(model, count_vectorizer, n_top_words):

  words = count_vectorizer.get_feature_names()

  for topic_idx, topic in enumerate(model.components_):


    print("\nTopic #%d:" % topic_idx)

    print(" ".join([words[i]

           for i in topic.argsort()[:-n_top_words - 1:-1]]))


#           Tweak the two
parameters below
```

```
number_topics = 5
number_words = 10
#          Create and fit the LDA model
lda = LDA(n_components=number_topics, n_jobs=-1)

lda.fit(count_data)


#          Print the topics found by
the LDA model print("Topics
found via LDA:")
print_topics(lda,
count_vectorizer,
number_words)
```

[Comment 5] 5) Pg 9:Please add more details about the selections of 20 key global actors

Author Response: We thank the reviewer for this helpful comment. As a result of this reviewer's comment, in the revised manuscript, in the supplementary material, please note details about the selections of 20 key global actors can be found under the section "Study sample" in "METHODS" and

also in the supplementary document that further describes our methods. In the revised supplementary document on methods, it reads:

Rationale for choosing the 20 global health actors

1. Hoffman & Cole (2018), Frenk & Moon (2013), and Szlezak et al. (2010) were the basis for the 20 global health actors in this study.[4, 15, 16]

    a. Hoffman & Cole (2018) used the related search function in Google in order to systematically map global health actors – 20 global health actors were identified as most important based on their methodology and was validated by 9 identified global health experts.

    b. Frenk & Moon (2013) identifies 9 primary types of actors in global health with 24 examples in their study on pluralism and other challenges in global health.

    c. Zlezak et al. (2010) describes their 8 identified types of actors in global health as a partnership in their article that argues for the norms and roles of each actor in the transition of global health.

2. The identified global health actors across the 3 studies were compared, and the 20 actors that were identified most important by all 3 studies were chosen.

[Comment 6] 6) To analyze the networks I suggest to use network's measure such as size, density, average degree, closness, betweeness, modularity (for the clustering).

Author Response: We thank the reviewer for this helpful comment. As a result of this reviewer's comment, we have added more detail about the analysis each network map in the supplementary material. The revised manuscript now reads as follows:

How network maps were analyzed

- **What is network analysis?** Network analysis is an analytic method that has proved to be useful in understanding relational dynamics across actors in global and public health. (Lopreite et al. 2021 and Quisell et al. 2018).

- **Why use network analysis for the study?** Network analysis was conducted to observe the funding relationships between global health actors.

- **What tool was used?** Gephi 0.9.2 was used in constructing and analyzing the network map.

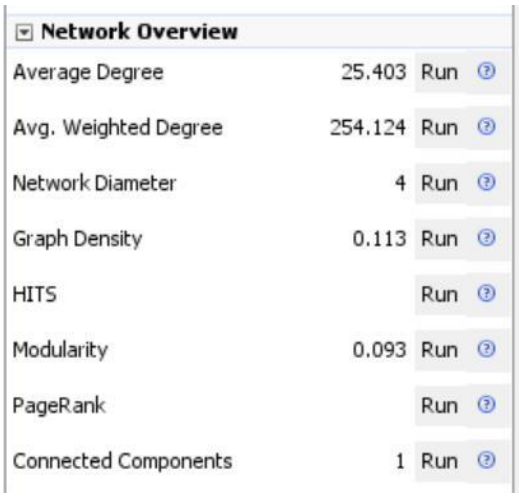
- **How was the network map designed?**

    - The network modelled in the study allows for a graphical visualization of the flows of global health funding in 2019.
    - The network map was designed such that each global health actor is represented by a

node and lines or “edges” indicate a flow of funding in global health.

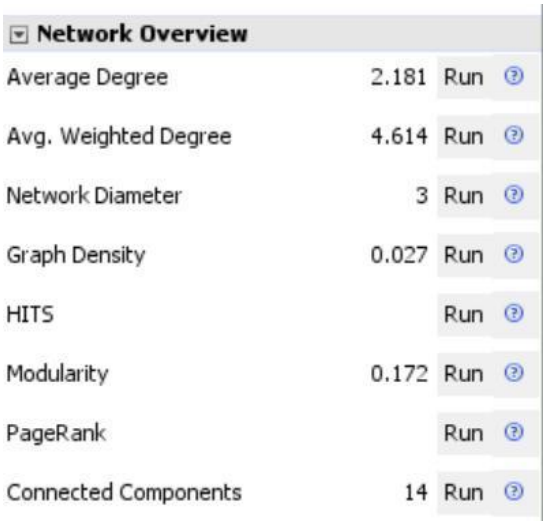
- The Fruchterman-Reingold algorithm was used in modelling the network map.
    - The algorithm “calculates the optimal layout so that nodes with less strength and less connections are placed further apart, and those with more and/or stronger connections are placed closer to each other.”[18]
    - The thickness of edges represents the amount of funding transferred between actors.
    - The modelled network map can be found and will be discussed in the findings section.

DAH funding data network analysis summary statistics



Network Overview		
Average Degree	25.403	Run
Avg. Weighted Degree	254.124	Run
Network Diameter	4	Run
Graph Density	0.113	Run
HITS		Run
Modularity	0.093	Run
PageRank		Run
Connected Components	1	Run

Twitter data network analysis summary statistics



Network Overview		
Average Degree	2.181	Run
Avg. Weighted Degree	4.614	Run
Network Diameter	3	Run
Graph Density	0.027	Run
HITS		Run
Modularity	0.172	Run
PageRank		Run
Connected Components	14	Run

Author Response (continued): Full tables of statistics reports for (1) DAH funding data network analysis and (2) Twitter network analysis can be found in the revised supplementary methods in the revised menuscript.

[Comment 7] 7) Please descrive the policy implications of the study

Author Response: We thank the reviewer for this helpful comment. As a result of this reviewer's comment, we have described the policy implications of the study in the "DISCUSSION" and recently edited "CONCLUSION" sections. The revised manuscript now reads as follows:

DISCUSSION

GHG operates under RAM

[…]

Since each global health actor and the global health system collectively fulfills the three assumptions, we find that GHG operates under the RAM. However, this does not imply cooperation of global health actors. This finding demonstrates the fact that each global health actor operates based on their rational self-interest and that the global health system operates based on the pursuit of only some of the stated priorities. Who determines which priorities are pursued by the global health system? The findings on power dynamics in GHG reveal the actors who determine global priorities.

Compulsory and institutional power asymmetries in GHG

[…]

Both network analyses of revealed priorities from DAH funding data and from tweets show how there is asymmetric levels of power held by the United States, United Kingdom, and the Gates Foundation in comparison to other actors. Figure 2 reveals how these three funding organizations are the largest funders for the work of the Global Fund, WHO, World Bank, US Foundations, UN organizations, and Gavi. The IHME DAH database reveals that 24% of all DAH funding was allocated to HIV/AIDS, 21% to child health, and 12% to maternal health – the three top priorities of funding organizations.[16] Only 14% was allocated to health system strengthening and 2% to non-communicable diseases.[16]

Figure 1 reveals how the most common topics generated across all global health actors include Africa, HIV/AIDS, child health, women health, and infectious diseases. These are the same health issues highly prioritized by the United States, United Kingdom, and Gates Foundation. Comparing figures 1 and 2, we find that these three funding organizations have outsized influence in priority-setting. Funding organizations have outsized influence because of how much DAH funding these three organizations have provided in comparison to other funding organizations. We find that the programs implemented and issues prioritized from 2016 to 2020 as documented through the tweets of the actor revolve around the main priorities of funding organizations of HIV/AIDS, child health, maternal health, infectious disease, and Africa. This outsized influence of global health funders limits the range of funded programs and policies that effectively reduce health inequities, especially making it difficult for smaller implementers to fund local programs and policies that do not neatly align with the priorities of major funders.

Limitations

It is necessary to acknowledge the three limitations of this study. First, we assume stated priorities match what is specified in organizational documents. It may be the case that some organizations communicate priorities differently from what is written in their foundational documents. Moreover, what is fundable may not necessarily be what is most important. Second, we assume that health funding is indeed spent on what it is ostensibly spent on when deriving revealed preferences from past health funding data, although may not be the case. Third, our scope is limited to examining 20 global health actors from 2016 to 2020. There is a multiplicity of non-health actors and processes that likely influence overall health outcomes of populations. Studying the stated and revealed priorities of non-health actors and processes such as foreign relations between nations and the influence of the private sector on health can improve the characterization of current GHG.

CONCLUSION

We find empirical evidence at the global level showing that GHG operates under the RAM. Additionally, we find that at the global level, there is asymmetric compulsory and institutional power held by funding

organizations, allowing global health priorities to be set by funders that have the money to spend on global health. In the past years, these funders have been the United States, United Kingdom, and the Gates Foundation. As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs. These findings are in alignment with current literature discussing how "philantrocapitalists" and large funders having an outsized influence on global health agenda setting even without necessarily having an ethical framework for decision-making.[48,49]

Our paper complements the current research on agenda-setting in global health. Jeremy Shiffman's (2016) discussion of how agenda-setting is not purely a rational deliberation of evidence but the convergence of problems, solutions, and political developments.[50] This study attempts to deepen the understanding of the manifestation and influence of power in agenda-setting through the lens of stated and revealed priorities.

The priorities of funders of HIV/AIDS, child health, and maternal health have been prioritized from 2016-2020. While global health has seen improvements in these three areas, the existence of significant and severe preventable health inequalities demonstrates that this funding architecture does not necessarily promote equity and justice in global health. Additionally, other core health issues such as horizontal health system improvements do not appear to be prioritized that may have led to the persistence of global health inequity. We have empirical evidence supporting the arguments that current GHG operates under the RAM, and existing power asymmetries limit the range of choice for health policies and programs that aim to reduce inequities. If "health for all" and the SDG3 targets are to be achieved, then there must be a reassessment of current GHG under the RAM.

[Comment 8] 8) A linguistic review is strongly suggested.

Author Response: We thank the reviewer for this helpful comment. As a result of this reviewer's comment, in the revised manuscript, we have sought to ensure the manuscript is written clearly and effectively for the readers of this journal.

VERSION 2 – REVIEW

REVIEWER	Schaaf, Marta Independent Consultant
REVIEW RETURNED	12-Dec-2021

GENERAL COMMENTS	I think the manuscript is much improved and note that the authors had to address extensive documents from three different reviewers coming from a variety of perspectives. The key thing I would suggest is that the authors be a little more forthcoming in their discussion of limitations. The paper hypothesis and methods are based on some assumptions that people who have worked in global health governance might question. For example, the both USAID documents and tweets result from careful deliberation and concern about complaints from the minority party. It is not surprising that

	these two sources suggest similar priorities. Also, tweets may not show revealed priorities so much as priorities that the actor wants to communicate. For example, the actor may address abortion but chose not to tweet about this. They may engage in some area that is too complicated to discuss in 140 characters, or in something that is boring to tweet about. What happens behind closed doors in unknowable, so all methods have limitations. I just think it is best to fully acknowledge the limitations here. In that spirit, the authors know best what they are intending to convey, so I leave it up to them if they think these comments should be addressed in the limitations.

REVIEWER	Pierson, Leah Harvard Medical School, MD-PhD Program
REVIEW RETURNED	15-Dec-2021

GENERAL COMMENTS	I thank the authors for their thorough responses to my comments, and think the paper is improved as a result. The authors' response has clarified a few additional points that I think are worth making in the text or clarifying. This is my understanding of what the authors are trying to argue: The US, UK, and Gates Foundation set priorities → Global health actors align their priorities to match those of the aforementioned funders because they are adhering to the RAM → The prioritized goals are a hodgepodge of different organizations' mission statements, leading to poor cooperation across groups and potentially inequities I think what the authors can instead prove in this paper is somewhat more limited: 1) The US, UK, and Gates Foundation set priorities that are correlated with global health actors' priorities 2) Global health actors act in accordance with the RAM (as the authors define it) insofar as their funding, tweets, and mission statements consistently prioritize certain objectives 3) It's worrisome for global health actors to adhere to the RAM *if* doing so leads them to prioritize goals that do not maximize health gains or minimize inequities. In other words, assuming that funders' priorities affect—rather than are simply correlated with—global health actors' priorities *and* that funders prioritize the wrong things, this is a suboptimal model for GHG.

	I think the authors cannot prove in this paper: 4) Several of the claims made in the introduction and the conclusion, specifically pertaining to the idea that multiple bad outcomes flow from global health actors adhering to the RAM and that the relationships between the power data and RAM data are causal. For instance: a. "Prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives." b. "GHG based on the RAM fails to 'justify an obligation to help meet the health needs of others' and may have contributed to the persistence of global health inequities." c. "As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs." Simply doing (1) and (2) makes this paper a valuable contribution. My remaining suggestions are that the authors clarify a few key points pertaining to (1) and (2), walk back assertions they make but do not prove related to (4), and instead argue for (3). With regard to (1) and (2), it's not clear to me why the authors present the RAM data before the power dynamics data, given that the logical flow of the argument as I now understand it. This is just a suggestion, and I understand the authors may have good reasons for presenting the results in the order they do, but I think the argument would have been clearer to me had the power data been presented first. With regard to (2), in their response to my original comments, the authors state that "In the RAM, 'maximize utility,' refers to maximizing the net personal benefits however defined by the health actor. It can be defined as financial benefits, ethical benefits such as equity, or however else the health actor defines their utility." They also elaborate that "acting rationally means weighing both economic and political factors, and acting according to the three assumptions of RAM." Both of these are extremely helpful clarifications, and both should be made in the text, as the authors are using "utility" in a way that is different from the definition used by economists in developing the theory from which the RAM is derived.

	Also with regard to (2), I think the authors need to say a bit more about why tweets ought to count equally to funding in revealing organizations' preferences. With regard to (4), the authors suggest that it's suboptimal for global health actors to adhere to the RAM. But they assess whether organizations adhere to the RAM by evaluating whether "The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets," asserting that these priorities "are revealed to be the priority that the global health actor determines to be benefit maximizing." If acting in accordance with the RAM simply means holding some consistent priorities, it's not clear why it's inherently bad for global health actors to act in accordance with the RAM. For instance, the authors note that "To maximize benefits of their predetermined goal of 'strengthening Europe's defences against infectious diseases', the EU CDC prioritizes infectious disease surveillance, reporting, and research." Is the EU CDC doing something wrong here by adhering to the RAM? The EU CDC seems to be acting in ways that are consistent with what it set out to do (i.e., "strengthening health systems"), and it's not clear what the problem with the organization's overriding goal is. My understanding is that the authors think it's suboptimal for global health actors to adhere to the RAM for three reasons. First, it's not simply that global health actors are behaving in ways that are consistent, but additionally that they are "choosing an alternative that provides the highest amount of net personal benefit." Second, the authors suggest that global health actors align their priorities to match those of powerful funders, which is a problem because the funders often set the wrong priorities. Third, the authors suggest that actors adhering to the RAM leads to poor coordination across actors. I think all three claims extend beyond the scope of what the authors can prove in this paper. First, the authors do not argue for or prove that the consistent priorities are necessarily the benefit maximizing ones. The weak link between "acting in ways that are consistent" and "maximizing benefits" is illustrated by the example they highlight of USAID. They note that "To maximize benefits for national security and interests, USAID prioritizes HIV/AIDS and child and maternal health in Africa." But just because USAID is consistently prioritizing HIV/AIDS and MCH in Africa, why does it follow that doing so maximizes benefits for national security? One might think that USAID could better promote national security by directing foreign aid to important

	strategic allies of the U.S. (Indeed, the U.S. has long been criticized for devoting the majority of foreign aid to Israel for this very reason.) This weak link between "consistent priorities" and "maximizing benefits" should be argued for or acknowledged as a limitation. Second, the authors suggest that it is suboptimal for actors to adhere to the RAM because the U.S., U.K., and Gates Foundation may set the wrong priorities; for instance, they argue that "insufficient attention is paid to horizontal or health systems strengthening projects." So, to the extent that global health actors prioritize the priorities of major funders, this leads to a systematic misprioritization of global health projects. But these shortcomings do not appear directly connected to the discussion of the RAM for two reasons. First, organizations *could* act in accordance with the RAM and *not* prioritize the issues favored by the U.S., U.K. and Gates Foundation. Second, to the extent that global health actors do align their priorities to match those of major funders, this simply seems like a failure of the organizations at the top of the funding hierarchy to prioritize the right goals. If funders did set optimal priorities, then it would seemingly be good for global health actors to adhere to the RAM. Third, although the authors state that "With each actor acting on their own set of explicit goals... prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives", it is clear from the authors' analysis that organizations do share a commitment to a set of common global health goals: for instance, combatting HIV/AIDS and other infectious diseases and improving MCH. As previously stated, it seems like the authors are instead suggesting that these goals are incomplete or wrong, rather than that coordination is impossible when actors adhere to the RAM. As previously stated, this manuscript represents a valuable contribution, but I believe it presently makes claims that extend beyond what the data shows (i.e., that certain correlations are causal, that adhering to the RAM compounds inequities, and so on). For these reasons, I recommend highlighting the assumptions, caveats, and limitations underlying the argumentative links they posit (i.e., doing 3, as I described above, rather than 4).

VERSION 2 – AUTHOR RESPONSE

Reviewer 1 Comments

[Comment 1] I think the manuscript is much improved and note that the authors had to address extensive documents from three different reviewers coming from a variety of perspectives.

Author Response: We thank this reviewer for this positive feedback, we appreciate it.

[Comment 2] The key thing I would suggest is that the authors be a little more forthcoming in their discussion of limitations.

Author Response: We thank this reviewer for this helpful suggestion. To be more forthcoming in our discussion of limitations, we have added to the "Limitations" section of our manuscript which now reads:

"It is necessary to acknowledge the limitations of this study. First, we assume stated priorities match what is specified in organizational documents. It may be the case that some organizations communicate priorities differently from what is written in their foundational documents. Moreover, what is fundable may not necessarily be what is deemed important. Second, we assume that health funding is indeed spent on what it is ostensibly spent on when deriving revealed preferences from funding data, which may not always be true. Third, our scope is limited to examining 20 global health actors from 2016 to 2020. There are non-health actors and processes that likely influence health outcomes. Studying the stated and revealed priorities of non-health actors and processes such as foreign relations between nations and the influence of the private sector on health can improve the characterization of current GHG. Fourth, tweets may only reveal priorities that the actor wants to communicate. As organizations have teams that plan communications, priorities derived from Twitter may be limited and not reveal all priorities. While what happens behind closed doors in GHG is unknowable, tweets can reveal some of the implicit priorities of actors. Fifth, we derived benefit-maximizing preferences by identifying consistently top-ranking preferences across stated priorities from policy documents and revealed preferences from tweets and funding data. This manner of identifying benefit-maximizing preferences is indirect and does not necessitate that it is indeed what the actor believes is a benefit-maximizing preference. To be certain about what is benefit-maximizing can only be done by directly asking health actors. However, even within organizations, there are inconsistencies about what members think are benefit-maximizing. We acknowledge this indirect manner of deriving benefit-maximizing priorities is a limitation."

[Comment 3] The paper hypothesis and methods are based on some assumptions that people who have worked in global health governance might question. For example, both the USAID documents and tweets result from careful deliberation and concern about complaints from the minority party. It is not surprising that these two sources suggest similar priorities. Also, tweets may not show revealed priorities so much as priorities that the actor wants to communicate. For example, the actor may address abortion but chose not to tweet about this. They may engage in some area that is too complicated to discuss in 140 characters, or in something that is boring to tweet about. What happens behind closed doors in unknowable, so all methods have limitations.

Author Response: We thank the reviewer for this very helpful comment. We agree with the reviewer with how policy documents and tweets are a result of careful deliberation. We also agree with the comment on how tweets may not show revealed priorities so much as priorities that the actor wants to communicate. In response to the helpful comment, we have revised the manuscript and added the following point in the “Limitations” section:

“Fourth, tweets may only reveal priorities that the actor wants to communicate. As organizations have teams that plan communications, priorities derived from Twitter may be limited and not reveal all priorities. While what happens behind closed doors in GHG is unknowable, tweets can reveal some of the implicit priorities of actors.”

[Comment 4] I just think it is best to fully acknowledge the limitations here. In that spirit, the authors know best what they are intending to convey, so I leave it up to them if they think these comments should be addressed in the limitations.

Author Response: We thank this reviewer for this helpful suggestion. To fully acknowledge the limitations of our study, we have added to the “Limitations” section of our manuscript which now reads:

“It is necessary to acknowledge the limitations of this study. First, we assume stated priorities match what is specified in organizational documents. It may be the case that some organizations communicate priorities differently from what is written in their foundational documents. Moreover, what is fundable may not necessarily be what is deemed important. Second, we assume that health funding is indeed spent on what it is ostensibly spent on when deriving revealed preferences from funding data, which may not always be true. Third, our scope is limited to examining 20 global health actors from 2016 to 2020. There are non-health actors and processes that likely influence health outcomes. Studying the stated and revealed priorities of non-health actors and processes such as foreign relations between nations and the influence of the private sector on health can improve the characterization of current GHG. Fourth, tweets may only reveal priorities that the actor wants to communicate. As organizations have teams that plan communications, priorities derived from Twitter may be limited and not reveal all priorities. While what happens behind closed doors in GHG is unknowable, tweets can reveal some of the implicit priorities of actors. Fifth, we derived benefit-maximizing preferences by identifying consistently top-ranking preferences across stated priorities from policy documents and revealed preferences from tweets and funding data. This manner of identifying benefit-maximizing preferences is indirect and does not necessitate that it is indeed what the actor believes is a benefit-maximizing preference. To be certain about what is benefit-maximizing can only be done by directly asking health actors. However, even within organizations, there are inconsistencies about what members think are benefit-maximizing. We acknowledge this indirect manner of deriving benefit-maximizing priorities is a limitation.”

With the reviewer’s guidance, we hope the revised manuscript can be a valuable contribution to this journal.

Reviewer 2 Comments

[Comment 1] I thank the authors for their thorough responses to my comments, and think the paper is improved as a result. The authors' response has clarified a few additional points that I think are worth making in the text or clarifying.

Author Response: We thank this reviewer for this positive feedback, we appreciate it. We have responded to and clarified the additional points the reviewer has identified in the responses that follow.

[Comment 2] This is my understanding of what the authors are trying to argue:

The US, UK, and Gates Foundation set priorities → Global health actors align their priorities to match those of the aforementioned funders because they are adhering to the RAM → The prioritized goals are a hodgepodge of different organizations' mission statements, leading to poor cooperation across groups and potentially inequities

Author Response: We thank this reviewer for this helpful comment and provide relevant responses to suggested revisions to follow.

[Comment 3] I think what the authors can instead prove in this paper is somewhat more limited:

- The US, UK, and Gates Foundation set priorities that are correlated with global health actors' priorities
- Global health actors act in accordance with the RAM (as the authors define it) insofar as their funding, tweets, and mission statements consistently prioritize certain objectives
- It's worrisome for global health actors to adhere to the RAM if doing so leads them to prioritize goals that do not maximize health gains or minimize inequities. In other words, assuming that funders' priorities affect-rather than are simply correlated with-global health actors' priorities and that funders prioritize the wrong things, this is a suboptimal model for GHG.

Author Response: We thank this reviewer for this very helpful comment. We agree with the three points identified by the reviewer are what the paper can justifiably argue. In response to this helpful comment, we have revised the manuscript and argued for (1), (2), and (3). We state the revisions made in our response to comments 4, 7, 8, 9, 10, 11, 12, and 13.

[Comment 4] I think the authors cannot prove in this paper:

- Several of the claims made in the introduction and the conclusion, specifically pertaining to the idea that multiple bad outcomes flow from global health actors adhering to the RAM and that the relationships between the power data and RAM data are causal. For instance:

    > "Prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives."
    >
    > "GHG based on the RAM fails to 'justify an obligation to help meet the health needs of others' and may have contributed to the persistence of global health inequities."
    >
    > "As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs."

Author Response: We thank this reviewer for this very helpful comment. We agree that the points identified cannot justifiably be argued in this paper. In response to this helpful comment, we have walked back these arguments and revised the manuscript as follows:

- In the third paragraph of the introduction, we have walked back the claims that cannot be proven by this paper as identified by the reviewer (see comments 4a and 4b).

  The end of the third paragraph used to read as:

  "With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]"

  We have removed the statement noted in comments 4a and 4b. After revisions, the end of the third paragraph now reads:

  "Under RAM, each actor acts on their own set of explicit and implicit goals. Explicit goals come in the form of mission statements, bylaws, and other founding documents. Implicit goals are priorities revealed from past decisions and behaviors. It is theorized that under RAM, prioritization in GHG is based on the aggregation of individual explicit and implicit objectives."

- In the first paragraph of the conclusion, we have walked back the claim that cannot be proven by this paper as identified by the reviewer (see comment 4c).

  The section of the first paragraph of the conclusion used to read as:

  "As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs. "

  After revisions, this section of the first paragraph of the conclusion now reads:

  "We find that there is a correlation between the priorities of large funders and the priorities of channels of DAH and implementing institutions. This correlation in conjunction with GHG operating under the RAM and the asymmetric power held by funders raises issues. What is worrying is that GHG under the RAM grants large funders majority of the power to determine

where GHG resources go, and ultimately influencing outcomes. Effectively, this limits the range of health issues that are adequately funded. Additionally, if outcomes are unfavorable, funding organizations do not have full accountability even if they have outsized influence in GHG priority-setting. It is an issue that implementing organizations, especially smaller local organizations, who have the closest relationship with target populations, have little to no say in how resources are distributed in GHG under the RAM. GHG under the RAM can only lead to equitable health outcomes if and only if major funding organizations have a joint commitment towards the same goals of health equity and justice. If funders set priorities that is grounded on equity and justice, then it would be good for all actors to adhere to the RAM and seek funding by aligning their

priorities with funder priorities. In this situation, all actors' individual goals will be aligned with the funding organizations' goals of equity and justice."

[Comment 5] Simply doing (1) and (2) makes this paper a valuable contribution. My remaining suggestions are that the authors clarify a few key points pertaining to (1) and (2), walk back assertions they make but do not prove related to (4), and instead argue for (3).

Author Response: We thank this reviewer for this very helpful comment. We agree with the strategy of arguing for points (1), (2), and (3) and walking back assertions related to (4). In response to this helpful comment, we have revised the manuscript accordingly. We have detailed the revisions in the following comments that dive deeper into each point from the reviewer.

[Comment 6] With regard to (1) and (2), it's not clear to me why the authors present the RAM data before the power dynamics data, given that the logical flow of the argument as I now understand it. This is just a suggestion, and I understand the authors may have good reasons for presenting the results in the order they do, but I think the argument would have been clearer to me had the power data been presented first.

Author Response: We thank this reviewer for this very helpful comment. We present the RAM data before the power dynamics data because it is necessary to first identify and describe how health actors currently make prioritization decisions before assessing if the GHG under the RAM may be concerning through the lens of power dynamics in GHG. In terms of the flow of questions being asked, we first aim to answer the question: "Do global health actors and GHG as a whole act according to the RAM?" then ask, "Is there a concern that global health actor and GHG as a whole operate under the RAM?". We believe that presenting the RAM data before the power dynamics data helps with the flow of the argument. If we find that funding organizations act under the RAM, we know that they make prioritizing decisions according to their pre-determined, consistently top-ranked personal benefit-maximizing preference. The same goes with the prioritization decisions of channels of DAH and implementing institutions if they are found to operate under the RAM. Once we know if actors and GHG as a whole operate under the RAM, then we assess whether this may be a concern in terms of achieving equitable and just health outcomes. We make this assessment by revisiting the revealed and stated priorities and analyzing them through the lens of power dynamics, equity, and justice.

[Comment 7] With regard to (2), in their response to my original comments, the authors state that "In the RAM, 'maximize utility,' refers to maximizing the net personal benefits however defined by the health actor. It can be defined as financial benefits, ethical benefits such as equity, or however else the health actor defines their utility." They also elaborate that "acting rationally means weighing both economic and political factors, and acting according to the three assumptions of RAM." Both of these are extremely helpful clarifications, and both should be made in the text, as the authors are using "utility" in a way that is different from the definition used by economists in developing the theory from which the RAM is derived.

Author Response: We thank this reviewer for this very helpful comment. We are glad that the reviewer found this description of the RAM helpful in understanding the meaning of “utility” in this context. In response to this helpful comment, we have added the following paragraph to the section “Testing if GHG operates under the RAM” to help clarify terms used in the manuscript:

"'To maximize utility' in this study refers to maximizing the net personal benefits however defined by the health actor. It can be defined as financial benefits, ethical benefits such as equity, or however else the health actor defines their utility."

[Comment 8] Also with regard to (2), I think the authors need to say a bit more about why tweets ought to count equally to funding in revealing organizations' preferences.

Author Response: We thank the reviewer for this very helpful comment. We appreciate the reviewer pointing out the need to describe why tweets ought to count equally to funding in revealing organizations' preferences. In response to the helpful comment, we have revised the manuscript and added the following paragraph in the section "Twitter data":

"We consider tweets equally to funding data as they both reveal priorities through documentation of past decisions, preferences, and goals. Funding data is a record of priorities in the form of financial flows and transactions towards certain global health issues. Twitter is a record of priorities in the form of programs, policies, and opinions deemed important and necessary to communicate with the world. Because of their archival nature, both funding data and tweets reveal priorities through complementing records of decisions."

[Comment 9] With regard to (4), the authors suggest that it's suboptimal for global health actors to adhere to the RAM. But they assess whether organizations adhere to the RAM by evaluating whether "The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets," asserting that these priorities "are revealed to be the priority that the global health actor determines to be benefit maximizing." If acting in accordance with the RAM simply means holding some consistent priorities, it's not clear why it's inherently bad for global health actors to act in accordance with the RAM. For instance, the authors note that "To maximize benefits of their predetermined goal of 'strengthening Europe's defences against infectious diseases', the EU CDC prioritizes infectious disease surveillance, reporting, and research." Is the EU CDC doing something wrong here by adhering to the RAM? The EU CDC seems to be acting in ways that are consistent with what it set out to do (i.e., "strengthening health systems"), and it's not clear what the problem with the organization's overriding goal is.

Author Response: We thank the reviewer for this very helpful comment. We appreciate the reviewer identifying the weakness of the argument of the RAM "failing 'to justify an obligation to help meet the health needs of others' and may have contributed to the persistence of global health inequities." We agree with the reviewer that actors simply adhering to the RAM is not inherently negative. In the case of the EU CDC as pointed out by the reviewer, we agree that the EU CDC is not doing anything wrong by adhering to the RAM.

We have walked back the assertion that simply acting according to the RAM is bad for global health actors. In addition, we have added explanations to why it is worrying that GHG operates under the RAM while funding organizations have outsized influence in GHG decision-making. In response to this comment, we have walked back these arguments and revised the manuscript as follows:

2) In the third paragraph of the introduction, we have walked back the claims that cannot be proven by this paper as identified by the reviewer (see comments 4a and 4b).

The end of the third paragraph used to read as:

"With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]"

After revisions, the end of the third paragraph now reads:

"Under RAM, each actor acts on their own set of explicit and implicit goals. Explicit goals come in the form of mission statements, bylaws, and other founding documents. Implicit goals are priorities revealed from past decisions and behaviors. It is theorized that under RAM, prioritization in GHG is based on the aggregation of individual explicit and implicit objectives."

5. In the first paragraph of the conclusion, we have walked back the claim that cannot be proven by this paper as identified by the reviewer (see comment 4b).

The section of the first paragraph of the conclusion used to read as:

"As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs. "

After revisions, this section of the first paragraph of the conclusion now reads:

"We find that there is a correlation between the priorities of large funders and the priorities of channels of DAH and implementing institutions. This correlation in conjunction with GHG operating under the RAM and the asymmetric power held by funders raises issues. What is worrying is that GHG under the RAM grants large funders majority of the power to determine where GHG resources go, and ultimately influencing outcomes. Effectively, this limits the range of health issues that are adequately funded. Additionally, if outcomes are unfavorable, funding organizations do not have full accountability even if they have outsized influence in GHG priority-setting. It is an issue that implementing organizations, especially smaller local organizations, who have the closest relationship with target populations, have little to no say in how resources are distributed in GHG under the RAM. GHG under the RAM can only lead to equitable health outcomes if and only if major funding organizations have a joint commitment towards the same goals of health equity and justice. If funders set priorities that is grounded on equity and justice, then it would be good for all actors to adhere to the RAM and seek funding by aligning their priorities with funder priorities. In this situation, all actors' individual goals will be aligned with the funding organizations' goals of equity and justice."

[Comment 10] My understanding is that the authors think it's suboptimal for global health actors to adhere to the RAM for three reasons. First, it's not simply that global health actors are behaving in ways that are consistent, but additionally that they are "choosing an alternative that provides the highest amount of net personal benefit." Second, the authors suggest that global health actors align their priorities to match those of powerful funders, which is a problem because the funders often set the wrong priorities. Third, the authors suggest that actors adhering to the RAM leads to poor coordination

across actors. I think all three claims extend beyond the scope of what the authors can prove in this paper.

Author Response: We thank the reviewer for this very helpful comment. We appreciate the reviewer for pointing out the weakness in the previous argument about the implications of global health actors adhering to the RAM.

We agree with the first point made by the reviewer that actors operating under the RAM is not inherently negative as they are “choosing an alternative that provides the highest amount of net personal benefit."

To the second point, we maintain our argument that health actors align their priorities with funding organizations but do not immediately interpret this as a negative behavior. This is because for health actors to achieve their self-interest of receiving funding to operate, they must have alignment with the priorities of funders. We revised this argument and now say that global health actors operating under the RAM may raise issues since funding organizations have outsized influence and can ultimately decide which global health issues are and are not prioritized.

To the third point, we agree with the reviewer that actors adhering to the RAM does not necessarily lead to poor coordination.

As mentioned in the responses to the previous comments, we have walked back our argument that health actors simply adhering to the RAM is suboptimal. In response to this comment, we have walked back this argument, clarified our argument, and revised the manuscript as follows:

The section of the first paragraph of the conclusion used to read as:

“As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs. “

After revisions, this section of the first paragraph of the conclusion now reads:

“We find that there is a correlation between the priorities of large funders and the priorities of channels of DAH and implementing institutions. This correlation in conjunction with GHG operating under the RAM and the asymmetric power held by funders raises issues. What is worrying is that GHG under the RAM grants large funders majority of the power to determine where GHG resources go, and ultimately influencing outcomes. Effectively, this limits the range of health issues that are adequately funded.

Additionally, if outcomes are unfavorable, funding organizations do not have full accountability even if they have outsized influence in GHG priority-setting. It is an issue that implementing organizations, especially smaller local organizations, who have the closest relationship with target populations, have little to no say in how resources are distributed in GHG under the RAM. GHG under the RAM can only lead to equitable health outcomes if and only if major funding organizations have a joint commitment towards the same goals of health equity and justice. If funders set priorities that is grounded on equity and justice, then it would be good for all actors to adhere to the RAM and seek funding by aligning their priorities with funder priorities. In this situation, all actors' individual goals will be aligned with the funding organizations' goals of equity and justice."

[Comment 11] First, the authors do not argue for or prove that the consistent priorities are necessarily the benefit maximizing ones. The weak link between "acting in ways that are consistent" and "maximizing benefits" is illustrated by the example they highlight of USAID. They note that "To maximize benefits for national security and interests, USAID prioritizes HIV/AIDS and child and maternal health in Africa." But just because USAID is consistently prioritizing HIV/AIDS and MCH in Africa, why does it follow that doing so maximizes benefits for national security? One might think that USAID could better promote national security by directing foreign aid to important strategic allies of the U.S. (Indeed, the U.S. has long been criticized for devoting the majority of foreign aid to Israel for this very reason.) This weak link between "consistent priorities" and "maximizing benefits" should be argued for or acknowledged as a limitation.

Author Response: We thank this reviewer for this very helpful comment. We agree with the reviewer in that consistency between revealed and stated priorities is not strongly linked with benefit-maximizing priorities of actors. In response to this helpful comment, we have added to the “Limitations” section of our manuscript which now reads:

“It is necessary to acknowledge the limitations of this study. […] Fifth, we derived benefit-maximizing preferences by identifying consistently top-ranking preferences across stated priorities from policy documents and revealed preferences from tweets and funding data. This manner of identifying benefit-maximizing preferences is indirect and does not necessitate that it is indeed what the actor believes is a benefit-maximizing preference. To be certain about what is benefit-maximizing can only be done by directly asking health actors. However, even within an organization, there are inconsistencies about what members think are benefit-maximizing for the organization. We acknowledge this indirect manner of deriving benefit-maximizing priorities is a limitation. If feasible in future studies, directly asking health actors their benefit-maximizing priorities can overcome this limitation.”

We have also revised the section in “Testing if GHG operates under the RAM” to be clear about this method of deriving benefit-maximizing preferences. The section used to read as:

“To test the third assumption of benefit maximization, we compare the stated and revealed priorities from all three data sources. The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets are revealed to be the priority that the global health actor determines to be benefit maximizing. An alignment of a preference across the three different sources can lead us to believe with high probability that it is the actor’s benefit maximizing preference.”

After revisions, the section in “Testing if GHG operates under the RAM” now reads:

“To test the third assumption of benefit maximization, we compare the stated and revealed priorities from all three data sources. The priorities that are consistent across stated priorities from policy documents and revealed priorities from DAH funding data and from tweets are revealed to be the priority that the global health actor determines to be benefit maximizing. An alignment of a preference across the three different sources can lead us to believe with some certainty that it is the actor’s benefit-maximizing

preference. While an indirect method of determining benefit-maximizing preference, believe this is the best method of doing so with the data that is available in this study."

[Comment 12] Second, the authors suggest that it is suboptimal for actors to adhere to the RAM because the U.S., U.K., and Gates Foundation may set the wrong priorities; for instance, they argue that "insufficient attention is paid to horizontal or health systems strengthening projects." So, to the extent that global health actors prioritize the priorities of major funders, this leads to a systematic misprioritization of global health projects. But these shortcomings do not appear directly connected to the discussion of the RAM for two reasons.

First, organizations could act in accordance with the RAM and not prioritize the issues favored by the U.S., U.K. and Gates Foundation.

Second, to the extent that global health actors do align their priorities to match those of major funders, this simply seems like a failure of the organizations at the top of the funding hierarchy to prioritize the right goals. If funders did set optimal priorities, then it would seemingly be good for global health actors to adhere to the RAM.

Author Response: We thank this reviewer for this very helpful comment. We appreciate the reviewer pointing out the weakness of this argument. We agree with the reviewer's two points.

We agree with the reviewer's first point that organizations can act in accordance with the RAM and not prioritize the issues favored by the US, UK, and Gates Foundation. While this is possible, it would be difficult for an organization to receive funding from the US, UK, and Gates Foundation if they do not align their priorities, goals, and programs with these funders. This leads to organizations that have less attention and resources as their priorities, goals, and programs are not favored by large funders. This raises issues as there may be health actors that have priorities, goals, and programs that are grounded on equity and have the potential to create positive impact but do not have enough resources to operate effectively.

We agree with the reviewer's second point that if health actors align priorities with major funders, then poor health outcomes are indicative of a failure of "the organizations at the top of the funding hierarchy to prioritize the right goals." If funders set priorities that benefited health equity and justice, then it would be good for health actors to adhere to RAM. What raises issues is that adhering to the RAM grants large funders majority of the power to determine where most of GHG resources go, and ultimately influencing short- and long-term outcomes. It is an issue that implementing organizations, especially smaller local organizations (that have the closest relationship to the population), have little to no say in how resources are distributed in GHG.

In response to this very helpful comment, we have walked back this argument, clarified our argument, and revised the manuscript as follows:

The section of the first paragraph of the conclusion used to read as:

“As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs. “

After revisions, this section of the first paragraph of the conclusion now reads:

“We find that there is a correlation between the priorities of large funders and the priorities of channels of DAH and implementing institutions. This correlation in conjunction with GHG operating under the

RAM and the asymmetric power held by funders raises issues. What is worrying is that GHG under the RAM grants large funders majority of the power to determine where GHG resources go, and ultimately influencing outcomes. Effectively, this limits the range of health issues that are adequately funded.

Additionally, if outcomes are unfavorable, funding organizations do not have full accountability even if they have outsized influence in GHG priority-setting. It is an issue that implementing organizations, especially smaller local organizations, who have the closest relationship with target populations, have little to no say in how resources are distributed in GHG under the RAM. GHG under the RAM can only lead to equitable health outcomes if and only if major funding organizations have a joint commitment towards the same goals of health equity and justice. If funders set priorities that is grounded on equity and justice, then it would be good for all actors to adhere to the RAM and seek funding by aligning their priorities with funder priorities. In this situation, all actors' individual goals will be aligned with the funding organizations' goals of equity and justice."

[Comment 13] Third, although the authors state that "With each actor acting on their own set of explicit goals... prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives", it is clear from the authors' analysis that organizations do share a commitment to a set of common global health goals: for instance, combatting HIV/AIDS and other infectious diseases and improving MCH. As previously stated, it seems like the authors are instead suggesting that these goals are incomplete or wrong, rather than that coordination is impossible when actors adhere to the RAM.

Author Response: We thank this reviewer for this very helpful comment. We appreciate the reviewer for pointing out the weakness in this argument. We agree that actors operating under the RAM are aligned in certain priorities.

In response to this comment, we have walked back this argument to follow the reviewer's point (2) from Comment 3. As mentioned in previous comments, we no longer argue that actors operating under the RAM is inherently negative but can be worrying along with the outsized power and influence of funders. We revised the manuscript as follows:

- In the third paragraph of the introduction, we have walked back the claims that cannot be proven by this paper as identified by the reviewer (see comments 4a and 4b).

  The end of the third paragraph used to read as:

  "With each actor acting on their own set of explicit goals in the form of mission statements, bylaws, and other founding documents, and implicit goals revealed from past decisions and behaviors, prioritization in GHG is not based on a shared ethical commitment to a common global health goal co-created by various health actors but is based on the aggregation of individual explicit and implicit objectives. GHG based on the RAM fails to "justify an obligation to help meet the health needs of others" and may have contributed to the persistence of global health inequities.[13]"

After revisions, the end of the third paragraph now reads:

“Under RAM, each actor acts on their own set of explicit and implicit goals. Explicit goals come in the form of mission statements, bylaws, and other founding documents. Implicit goals are

priorities revealed from past decisions and behaviors. It is theorized that under RAM, prioritization in GHG is based on the aggregation of individual explicit and implicit objectives."

- In the first paragraph of the conclusion, we have walked back the claim that cannot be proven by this paper as identified by the reviewer (see comment 4b).

  The section of the first paragraph of the conclusion used to read as:

  "As shown by the triangulated evidence, the rational choice for all global health actors is to align their priorities with those of funding organizations in order to continue with their programs. "

  After revisions, this section of the first paragraph of the conclusion now reads:

  "We find that there is a correlation between the priorities of large funders and the priorities of channels of DAH and implementing institutions. This correlation in conjunction with GHG operating under the RAM and the asymmetric power held by funders raises issues. What is worrying is that GHG under the RAM grants large funders majority of the power to determine where GHG resources go, and ultimately influencing outcomes. Effectively, this limits the range of health issues that are adequately funded. Additionally, if outcomes are unfavorable, funding organizations do not have full accountability even if they have outsized influence in GHG priority-setting. It is an issue that implementing organizations, especially smaller local organizations, who have the closest relationship with target populations, have little to no say in how resources are distributed in GHG under the RAM. GHG under the RAM can only lead to equitable health outcomes if and only if major funding organizations have a joint commitment towards the same goals of health equity and justice. If funders set priorities that is grounded on equity and justice, then it would be good for all actors to adhere to the RAM and seek funding by aligning their priorities with funder priorities. In this situation, all actors' individual goals will be aligned with the funding organizations' goals of equity and justice."

[Comment 14] As previously stated, this manuscript represents a valuable contribution, but I believe it presently makes claims that extend beyond what the data shows (i.e., that certain correlations are causal, that adhering to the RAM compounds inequities, and so on). For these reasons, I recommend highlighting the assumptions, caveats, and limitations underlying the argumentative links they posit (i.e., doing 3, as I described above, rather than 4).

Author Response: We thank the reviewer for believing that this manuscript represents a valuable contribution. As outlined in each of our responses for the comments above, we have argued for what can justifiably be argued with our evidence, walked backed some arguments, and highlighted the assumptions and limitations of the study, by doing (1), (2), and (3) and walking back (4) from Comment

With the reviewer's guidance, we hope the revised manuscript can be a valuable contribution to this journal.

VERSION 3 – REVIEW

REVIEWER	Pierson, Leah Harvard Medical School, MD-PhD Program
REVIEW RETURNED	21-Mar-2022

GENERAL COMMENTS	Thank you for responding thoroughly to my comments! I have no further recommendations.