

OVERLEAF LINK below <https://www.overleaf.com/1698318488txjrjttfgbbj#d02483>

Language, access to healthcare, and prevention methods during the COVID-19 pandemic among rural Quechua and Shipibo communities in Peru.

^{1*}, ^{2†} and ^{3†}

^{1*}English, University, , , , , .

²Department of Hispanic and Italian Studies, University , , , , , .

³Department of , University of , , , , , .

*Corresponding author(s). E-mail(s): ;

Contributing authors: ; ;

†These authors contributed equally to this work.

Abstract

This article focuses on measures of prevention during the COVID-19 pandemic as articulated by members of several Indigenous communities in Peru: five rural communities in the Cuzco region and two rural communities in the Amazon. 71 Quechua speakers and 38 Shipibo speakers were interviewed by community researchers during the pandemic, using a semi-structured interview protocol. The focus of the interview was access to COVID-related information as well as language use and language attitudes. The data show that mentions of self-care practices (hand-washing, medicinal herbs, steam cures) were more frequent than mentions of social distancing or wearing masks. Access to a day clinic was associated with increased rates of mentioning some prevention methods and a decrease in others. Importantly, receiving information in Spanish increased the rates of mentioning prevention methods in general. Overall, this case study illustrates how several Indigenous communities, who experienced reduced access to health information from non-communal health providers during the pandemic, both mitigated the lack of relevant information and handled the effects of the pandemic.

Keywords: Health access, COVID-19, prevention, Cuzco Quechua, Shipibo

1 Introduction

The COVID-19 pandemic has once again demonstrated that Indigenous communities are among the most negatively affected by infectious disease spread and, concomitantly, among the most affected by the lack of supporting structures in the face of epidemics ([1]). This includes, but is not limited to, the lack of access to adequate healthcare infrastructure and to digitalization and related tools and technologies ([2]), the lack of linguistic access and culturally appropriate materials (Authors XXX), among many other factors. In addition, health policies addressing Indigenous communities' health in the time of the COVID-19 crisis and their implementation were usually characterized by a lack of consultation with the communities and, therefore, typically implemented continuously via top-down infrastructures, contributing to structural marginalization of the communities themselves ([3]). Thus, it is no surprise that Peru found itself in a particular type of crisis during the COVID-19 pandemic. Peru is a country occupying 1,285,220 km² of landmass in South America, home to 56 Indigenous nations, 48 spoken languages, and 2 signed languages ([4]), and simultaneously a country with a large rural population (20.7%). According to INEI ([5]), a continued socio-political turmoil related to various types of internal and external minoritization ([6]), and a complex multilingual educational agenda ([7]). This article reports on the results of a survey conducted during the height of the pandemic among members of several rural communities in Peru, as part of a larger research project. The project is couched in in two (related) frameworks: Quantitative Critical Theory (QuantCrit) and Critical Indigenous Lense and Storytelling (CILS). QuantCrit argues that structural power dynamics drive disparities; data more generally reflect biases; demographics often reflect oppression; data do not speak for themselves and must be discussed as part of the story of the people but also serve as an empirical tool to disrupt inequities. In turn, CILS calls for viewing stories/storytelling as legitimate data; this viewing must be done through a critical lens (as modern institutions systematically marginalize); traditional/Elder knowledge can be trusted (and cited) from the same position as a peer-reviewed academic articles; and finally, researchers are accountable to the land, ancestors, and community. From this angle, this research aims to determine whether members of several indigenous rural communities in Latin America had access to prevention information for health crises such as SARS-CoV-2/COVID-19, and the source of this information within the communities (in particular, how community members received it). Here, 'access to information' as stated above can be viewed from two different perspectives: on the one hand, whether the community was attended at the time by a certified health professional (in the form of a clinic/government-authorized health center staff) or a traditional provider, such as a Medicine Person, *curandero* 'healer', shaman, etc. (as in [8]); on the other hand, whether the information was accessed through local authorities, community members, media (community radio, other types of radio, TV, or social media, such as Facebook). Thus, we examine the nature of the information-spreading network and ask whether, e.g., the information itself, which became slowly available to communities during the health crisis, was delivered by the typical agents of health education or by any other entity. Finally, given the expected spread of information during the health crisis, the article examines the prevention methods for COVID articulated by members of the relevant communities. The data

presented here are novel due to the nature of data-collection methodology as well as its ultimate aims; further, they address an existing gap in the literature in that a) they shed light on the perception of the severity of the crisis as it pertains to the prevention and preparedness mechanisms and measures from within the communities (i.e. what community members consider to be ‘preparatory’ and ‘preventative’), while also demonstrating that responses included reliance on both a) state-issued guidelines, b) traditional practices, as well as c) sometimes equivocal information disseminated through media. The paper is structured as follows. In section 2, we discuss the levels of preparedness and access to information and introduce the research questions and the study. Section 3 presents the research methods employed, followed by the results in Section 4 and the discussion in Section 5.

2 Community Health during COVID-19: Preparedness vis-à-vis Prevention

2.1 Access to goods/material systems

Even before COVID-19, medical anthropologists were concerned about trends in the prevention of various epidemics. In their comprehensive overview, [9] discusses the ebb and flow of anti-epidemic measures used for various diseases, such as SARS, cholera, and Zika. The authors argue that epidemic control measures have traditionally focused on several measures: quarantine, vaccination, vector control, and technological/material measures (such as contact tracing). Lynteris & Poleykett further mention that while the existing literature has typically focused on the socio-political aspects of epidemic measures, more recent literature has pivoted the discussion in public health from prevention to preparedness. According to the World Health Organization (WHO), the former activities include, though not limited to a) "[...]actions aimed at avoiding the manifestation of a disease – [...] actions to improve health through changing the impact of social and economic determinants on health; the provision of information on behavioral and medical health risks, alongside consultation and measures to decrease them at the personal and community level [...]" and b) "[...] empowering people to increase control over their health and its determinants through health literacy efforts and multisectoral action to increase healthy behaviors. This process includes activities for the community-at-large or for populations at increased risk of negative health outcomes [...]" ([10]). Importantly, these guidelines articulate a number of necessary mechanisms related to prevention, such as inclusion of disease prevention programs at the primary and specialized health care levels, as well as access to preventive services, risk communication, and more general mechanisms for building public awareness of the relevant public health emergency. For instance, in several works, Soni & Sinha demonstrate that a virus infection rate is significantly reduced by the availability of hospital beds; that enhanced public awareness, coupled with government interventions (e.g. quarantine), can reduce rates of transmission; and that media awareness reduces rates of infection (and susceptibility) by promoting preventive behaviors (see [11], [12], a.o.). The aforementioned mechanisms, in turn, depend on both early detection/early warning technologies and access to detection systems, which [13] label “vital systems.”

Integration of material goods into these systems suggests that in communities minoritized by racialization, poverty, and linguisticism (in no particular order, [14]), attempts to enact epidemic prevention measures will face additional barriers, despite the potential assistance from the WHO ([15]). For instance, in their critical review of the preparedness of the Mexican indigenous population for COVID-19, [16] addresses the various social, environmental, and health risk factors that created direct barriers to disease prevention. Among these are the lack of access to the internet-based media (through which the information flowed), to material-based health measures (such as running hot water and soap, maintaining drainage in the septic system), and to accurate information regarding co-morbidities in the most socio-linguistically appropriate manner (including the linguistic variety of the community). The review serves as a stark reminder that Indigenous populations throughout the world are among the most vulnerable in terms of income levels and access to health services ([17]) and therefore it is not surprising then that COVID-19 has had an enormous impact on indigenous populations given their pervasively low levels of access to healthcare, i.e., in communities that are not prepared due to the state of the material and related vital systems, prevention mechanisms also falter ([18]). The aforementioned has been true for the Indigenous peoples of Latin America, e.g., which, according to a recent UNESCO report, consists of approximately 50 million people from 500 different ethnic groups. In their scoping overview of 153 studies on the impact of COVID-19 on Indigenous peoples, [1] identify 153 studies across 19 countries that cite inadequate access to healthcare for Indigenous peoples during the first 18 months of the pandemic. (For example, in Brazil, 8000 medical professionals who served Indigenous populations were dismissed by Bolsonaro’s administration immediately before the pandemic, [19]). Research has also independently demonstrated that access to healthcare education and health literacy has been consistently identified as a key determinant of equitable healthcare access among Indigenous populations, influencing individuals’ ability to obtain appropriate care when needed ([20], [21], [18], [22], [23], [24]). Other literature also points to the increased risk of contracting the virus due to the lack of such access ([25], [26], [27], [28], a.o.). Finally, as much research has demonstrated, the living conditions that should have but were not addressed during the pre-pandemic stage allowed the disease to spread. These findings echo [20] (data from 23 countries, 28 populations), which provide evidence of poorer health and social outcomes for Indigenous peoples than for non-Indigenous populations, including access to preventive health systems, whether in terms of prevention or preparedness.

2.2 Access to culturally and linguistically appropriate channels of information delivery

Aside from low levels of access to material systems (such as vital goods and healthcare), the pandemic unveiled several other disparities that characterize access to resources between indigenous and non-indigenous populations and that have arguably impacted the preparedness of different communities for the crises that had befallen them. For instance, with the brunt of COVID-19 now behind us, though the effects still being examined, [29] report a review of forty studies on risk and crisis communication during this particular crisis in linguistically and culturally diverse communities.

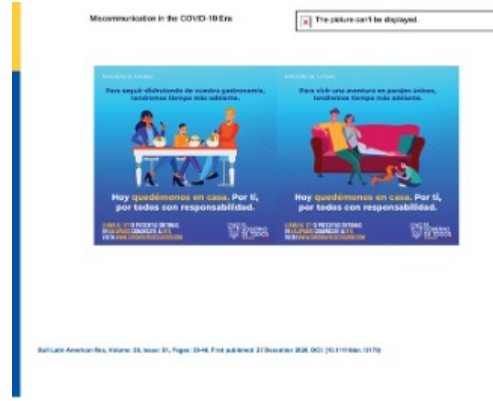


Fig. 1 ‘Stay at Home’ Poster, cited in Garcia et al. (2020), Source: Ministry of Tourism (Ecuador, 2020)

They identify several themes as well as issues with the quality/appropriateness of the translated materials meant to distribute information. Fourteen of the reviewed papers focus on specific countries/regions: Brazil, China and Taiwan, the USA, Nigeria and South Africa, Israel and Qatar, Australia, and a few European countries (Belgium, the UK, Spain, Germany, Scotland, and some others).

One of the issues under discussion, identified by the authors, is the extreme differences in the manner of health information delivery, i.e., the way communication about the pandemic occurred between local, regional, and state-level authorities and indigenous communities. For example in Taiwan, the prevention messages were distributed top-down in Mandarin Chinese and Taiwanese Sign Language, with occasional use of Southern Min, entirely overlooking the Paiwan, Rukai, Kucapungane, and Amis nations (Chen 2020), who live primarily in Taiwan’s rural areas. In Mexico, prevention messages were originally distributed only in Spanish, and only in the later stages of the pandemic in the 35 Indigenous languages which consider Mexico home, overlooking the fact that 4 out of every 5 Indigenous adults are monolingual, and only 18% speak Spanish ([16]). Of course, Mexico and Taiwan were not alone in this: throughout the pandemic, most Indigenous communities, irrespective of the continent on which they were located, did not receive vital communication about risks, symptoms, and prevention strategies (based on suggestions provided by the World Health Organization or the local Centers for Disease Control) in their own languages ([30], [31], [32]). Furthermore, [33] highlights issues arising from the actual messages communicated to Indigenous and non-Indigenous communities across various countries. For example, in Ecuador, Peru, and Bolivia, although efforts were made to communicate preventive messages directly to the communities, they were not culturally appropriate in many cases. Consider the “Stay at home” message (Fig. 1), promoted by the Ecuadorian Ministry of Tourism during the pandemic. Garcia et al. (2020) point out at minimum three issues with this material. First, the message in Fig. 1 is aimed exclusively at the urban context; yet, 52% of Indigenous populations in Latin America live in rural areas ([34]). Second, the message privileges a particular socio-economic profile and the type of family unit, but many Indigenous populations experience levels of access to

material goods that do not match the visual description above and live in familial networks/family units that span well beyond 3.5 ([35]). (For instance, while Indigenous people account for close to 8% of the population of the region, they also make up 14 to 17 percent of the population affected by (extreme) lack of access to material goods (extreme poverty). This is true for close to half of all Indigenous households (43%) — more than double that of other community members, [34]). Finally, the message visible in Fig. 1, contained in the graphic format and in Spanish, is not appropriately translated from its intended source by the World Health Organization (Lee & Wang, 2022). That is, the intended reading of the message – do not socialize to prevent contagion – is entirely ‘lost’ in translation: ‘quedémonos en la casa’ (Fig 1, Lit. “let’s stay at home”) was technically translated into Spanish from the English imperative ‘stay home,’ which only *implies* physical isolation. This type of messaging created an additional barrier to equitable healthcare for already minoritized populations ([36], [18], among others).

In other words Fig. 1 highlights the systemic problems perpetuated by various governmental structures and exemplifies the lack of linguistic and cultural relevance of health education materials to Indigenous and other minoritized populations (Author 2020; [35]). It also points to the disconnect between the dominant-language-based governments and many Indigenous communities, as proposed by [37], among others. The disconnect was even more pronounced at the early stages of the pandemic, when official materials were published in the socially and economically dominant language (e.g., Spanish in Latin America) despite the potential lack of language proficiency among indigenous communities.

2.3 A few notes on prevention

Throughout the pandemic, efforts to reach indigenous communities led to the creation of health education materials, including those addressing protective measures and prevention ([10]), such as the one presented in Fig. 1, which fell short. Like during other epidemics, e.g., Dengue in the Amazon ([38]), H1N1-Swine Flu in Canada ([39]), Ebola in West Africa ([40]), and so forth, prevention mechanisms may have remained inaccessible to Indigenous communities more generally and their individual members in particular (consider, e.g., the parallel to [23]). This included (in)access to the linguistically appropriate and culturally relevant information (such as materials in the language(s) in which community members are proficient), (in)access to the actual methods of information delivery (such as media), and (in)access to centralized preventative care (e.g., healthcare centers as distributors of educational materials as well as providers of prophylaxis, care-kits, masks). Furthermore, the lack of adequate information on protective measures, often managed by healthcare centers of various types, may have led to limited access to information on symptoms, risks, side effects, vaccines, and related constructs that go well beyond medical risks. This exacerbated the increased risk of contagion among the already vulnerable populations (as in [41], a.o.), ultimately related to the general structures of minoritization within healthcare ([42]). In essence, as the research has argued, COVID-19 was (and remains) the “disease of translation”, one that has disproportionately affected communities and individuals who are already minoritized racially, economically, and linguistically. Any attempt to

circumvent the impact of COVID-19 requires shifting the perspective from the center to the periphery, from the conventional to the innovative, challenging the commonly defined place and manner of production of knowledge ([43]: 259), i.e., healthcare education materials targeting prevention mechanisms must be delivered in a manner not only culturally and linguistically appropriate but also consonant with the communities for whom they are meant. This includes, though is not limited to, consideration of the factors identified by the communities themselves as 'true,' 'preventative,' 'disease,' 'cure,' etc. – in other words, while these notions have technical definition in academic medicine, their interpretation in communities may be somewhat (or even altogether) different. This work focuses on how the issues broadly addressed above affected Quechua and Shipibo communities in Peru.

Several issues have been discussed in the literature regarding the COVID-19 pandemic and previous epidemics, including prevention strategies implemented by community members themselves. One of the issues under examination is the actual methods used by the communities for preventing and protecting against the virus, which combine traditional community practices (using particular herbs and special baths) and research-based methods such as masks, and social distancing. We label them self-care. Another issue is how some of these methods were propagated by the local and central governments (e.g., paths for implementation of the WHO and CDC guidance, as affected by political ideologies and fueled by misinformation, thus resulting in the WHO/CDC, federal, state, and local misalignments, [44], [45]). Yet another is a set of 'preparedness steps,' often articulated as 'preventative' or 'protective measures' ([46]), generated by individuals within communities. For example, [47] show that the lack of information about prevention mechanisms in Peru had a tight connection to the other effects of the "COVID infodemic" – the proliferation of misinformation in the absence of culturally appropriate (and trustworthy) health education, both in terms of treatment and prevention ([48], [49], [50]). It is also notable that although certain preventative measures were initially encouraged by the government, they were not necessarily representative of the WHO/CDC advice, nor were they expected to be followed due to limited access to the information. This access was restricted for various reasons: low levels of a) informational (including orthographic) literacy in many communities, b) access to actual medical professionals – individuals able to interpret the ever-evolving and life-threatening new information, and finally, a) the ability to ascertain the state of affairs within the community/-ies of interest. As the literature has since shown, surveillance of Indigenous communities has not typically been conducted from Indigenous perspectives or guided by the communities' ethics, nor has it been democratic in its management of crises (see [51]). This includes sweeping digital community surveys, which, as [52] and [53] argue, while effective in crisis prevention and mitigation, must be conducted in a way that allows communities not only to design the tools themselves but also to maintain agency over the results.

In alignment with this approach, the investigative team in this study directly collaborated with several researchers from different Indigenous communities who sought information about their communities' levels of preparedness for the pandemic, methods for prevention used by community members, the perceptions of the general impact of the pandemic, and the level of access to the relevant information. Community researchers were involved from start to finish – in the creation and validation of

research tools, in identifying participants, in collecting and interpreting data, and in returning the data to the communities (see section 3.3). A series of exploratory, participatory studies was designed early in the pandemic and directly addressed the questions articulated in the previous sections. Below, we discuss one of the studies in this large project (<http://google.sites.....com>), which asks which information (about the crisis) highly proficient speakers of Indigenous languages were more likely to mention alongside their perceptions of their linguistic experiences and attitudes. In this article, we focus on the prevention measures that our participants, all of whom reside in Peru, were likely to mention at the height of the COVID-19 pandemic (October 2020-April 2021). Based on previous studies, we ask the following research questions:

RQ1: Are there any differences across groups in the probability of mentioning prevention measures according to the language of the survey?

RQ2: Which factors affect the probability of mentioning prevention/protection measures (e.g. access to a day clinic [*posta*] and the language in which the participant received information about COVID-19 [Quechua/Shipibo vs. Spanish])?

3 Methodology

3.1 Participants

A total of 109 individuals participated in the study: $N = 71$ speakers of Cusco Quechua (age: 18-77, mean = 44.92; 34 M, 37 F) and $N = 38$ speakers of Ucayali Shipibo (age: 18-81, mean = 44.44; 19 M, 19 F) via non-random sampling procedures. The participants were selected by the community researchers themselves. Several criteria for participant selection were employed: a) general knowledge of the Indigenous language (i.e., the ability to have the interview be conducted in Quechua or Shipibo, respectively, given the fact that one of the goals of the study was language documentation); b) reasonable balance in gender profile (approaching 50F/50M); c) age (18+); d) stratified community standing (including but not limited to Elders and other community leaders); d) multiple communities of speakers per language (given the difference in size of the population). Finally, about 25,000 Shipibo-speakers reside in about 150 rural Amazonian communities; data were collected from two such communities (1.3% of reported communities; 1.5% of all reported speakers). Approximately 1.5 million Quechua speakers reside in hundreds of rural communities in the Cusco region; data were collected from five such communities, to which our community researchers had access during COVID-19 (2% of reported communities; 0.005% of all reported speakers). Although the datasets do not align perfectly, they aim to be representative of the broader community's views. Among the Shipibo participants, 29% ($N = 11$) are ethnically Iskonawa but describe themselves as part of the Shipibo community. 99% of participants self-identify as Indigenous and as belonging to their current linguistic community. All Quechua interviews were conducted in rural communities of the Cusco region, in the provinces of Anta, Acomayo, Quispicanchis, Paucartambo, and Paruro; the Shipibo interviews were conducted in the Ucayali region, in the districts of Bema Jema Nueva Era and the Native Community Callería. The study was carried out from September 2020 to February 2021. During this period, these communities'

access to formal healthcare was at levels I1-I3 (Quechua) and I1-I2 (Shipibo) [54] – i.e. the facilities without hospital beds [55].

3.2 Tool

A questionnaire was designed as a data collection tool utilizable for in different cultural/linguistic contexts (as a language-independent tool for language documentation and reclamation) as well as adaptable for different types of community needs (including but not limited to COVID). The main aim of the tool creation was to ensure that different communities could rely on it for a variety of reasons while engaging in language reclamation (Authors 2023). Simultaneously, the tool offers an opportunity for overall comparisons, both within a particular country and globally. Such use of consistent research tools across Indigenous communities allows researchers to identify regional disparities in healthcare access while maintaining methodological validity, a practice recommended in Indigenous health research globally and in Latin America specifically ([56]).

Further, the use of consistent research tools across Amazonian and Andean Indigenous communities allows researchers to identify regional disparities in healthcare access while maintaining methodological validity, a practice recommended in Indigenous health research globally and in Latin America specifically ([57], [56]). To that end, both Shipibo (Amazonian) and Quechua (Andean) communities in our study are rural small-scale farming communities located in Peru, albeit in different regions, and were expected to receive the same type and level of communication regarding the pandemic from the federal government ([58], [59]). However, despite the initial slowing down of the spread of the virus, by mid-2020, Peru had one of the highest mortality rates in the world ([60]). Some reasons have been argued to include a) large informal economy, b) limited access to healthcare in Indigenous regions ([61]0), and c) structural health inequalities [16], Defensoría del Pueblo 2020).

A semi-structured interview was conducted by the Indigenous members of the Research Team during September 2020-February 2021: L1 Quechua speakers and two Shipibo speakers. All of the community researchers are bilingual in the Indigenous language of the community and Spanish (2L1, where L1 = first language, a.k.a. 'native'); one of the researchers is also an L1 speaker of Iskonawa).

The questionnaire, which served as the basis of the interview, was created first in the common language of communication among all of the members of the research team – Spanish, - and later translated into Quechua and Shipibo. Each version of the questionnaire was validated by two community researchers who are also L1 speakers of the relevant language.

The tool, initiated by, and developed with, the community researchers, consists of a 65-question interview which targets (i) demographics, (ii) language experiences and attitudes, (iii) general disease prevention, management, and access to healthcare education, and (iv) perception of the disease based on the list of 'myths' produced and propagated by the World Health Organization, translated into the relevant Indigenous languages (see [62]). Both the tool and the protocol are open access and available at <http://.....>, as well as in Authors et al. (2022) and Author & Author (2023). Before

conducting the interviews, the community researchers participated in Zoom training sessions on interviewing techniques. Interviews were recorded using a cell phone, computer, voice recorder, or in person: Quechua interviews were conducted either by phone or in person; all Shipibo interviews were conducted in person. In addition to the audio recordings, the community researchers also completed a data sheet recording participants' responses to multiple-choice and open-ended questions in the structured questionnaire. This created two sets of data – an audio file and an electronic file per participant - which ultimately resulted in a corpus (see below). Data coding was performed manually by various members of the research team, using information from the data sheets completed by the interviewers during data collection. The information was later corroborated once the recordings were transcribed and translated by community researchers. All transcriptions and translations were reviewed and validated by another community researcher.

All protocols were approved by the Institutional Research Boards of University and University (protocols #20063 and 2020-0751, respectively). The procedures and other methods were carried out in accordance with the relevant guidelines and regulations aligned with the Belmont Report and EU/UK GDPR. Informed consent was obtained from all participants prior to data collection – both for data collection and publication.

3.3 Collaborative research

The study follows the Participatory Action Research (PAR) model, which involves collaboration between community researchers and academics (e.g., [63], [64]). In this, our approach to public health inquiry/examination is novel, as the research team consisted of academics, non-academics (policy and medical professionals), and, crucially, community researchers from several Indigenous communities (Andean: Quechua and Amazonian: Shipibo-Konibo). Following the guidelines articulated in [65]) (see also the discussion in section 2), the study was initiated by members of the Indigenous communities; the core questions came directly from the community researchers – members of the research team originally from, and living in, the relevant Indigenous communities; the questionnaire was validated by other members of the same communities. In other words, both the rationale, the data collection tool, the participant pool, the resulting dataset, and even the statistical analyses were designed not only in consultation but in direct collaboration with members of the relevant communities. Further, aligned with the PAR frame of the study, several types of questions were explored – both community-external and -internal. Among these were questions related to perceptions of government-imposed measures (e.g., quarantine) and community-driven practices (e.g., the use of plants). The research results have been returned to the communities in several formats and continue to be returned in these formats. For instance, immediately after data processing, infographics reflecting the results were shared with communities (and beyond, see <https://...-covid19/results/peru>); local community-based cinematographers created and produced educational video-materials for distribution within (and beyond) their communities, which have elicited local discussions (see <https://...-covid19/audiovisual-materials-for-healthcare-education>); community-based members of the Research Team became the first authors of the resulting corpora

(published open-access, see M... et al. 2022 and C... et al. 2022); the resulting scientific articles (Authors et al. 2023) were translated into the participating Indigenous languages (Quechua and Shipibo) by qualified members of the relevant communities and distributed open-access; all translators were compensated equitably as members of the research team; community members have engaged in other data reporting procedures, e.g., translations of a previous publication into Quechua and Shipibo, as well as videocasts (<http://youtube....>). Finally, in line with the arguments in [53], the indigenous community members who collected the data, along with all community members, remain the copyright owners of the resulting dataset.

4 Results

4.1 A brief note about descriptive results

The study yielded several types of results. First, it has offered descriptive details from the questionnaire, which served as the basis for the interviews (see section 3.2) and is discussed at length in Authors (2023) and Authors (2026). For example, regarding access to healthcare facilities, Quechua-speaking participants reported distances to the nearest clinic (I1-I3) ranging from 4.4 km (the closest) to 28.7 km. In some communities, there were no community health practitioners or healers of any type (traditional or western-medicine trained) - a fact that reveals the lack of access to systematic healthcare more generally.

In Authors (2026), we also discuss community-perceived risk factors for contracting and managing the symptoms of the virus. For instance, some participants expressed concern that COVID-19 develops after eating bats or something dirty (*'por comer sucio'*; Quechua pool); others noted the risk of communicating with non-Indigenous members of the local community, such as *mestizos* and *gringos* (Shipibo pool). Across the participant pools, we observe the perceived vulnerability of elders, children, and people with chronic diseases (Table 1). Finally, several data points reveal participants' reactions to the WHO "mythbusters" regarding causes, risks, prevention, and disease management (Table 2). For instance, most participants (in both pools) expressed that drinking hot drinks (e.g. medicinal teas) prevents coronavirus: 71.83% among the Quechua participants and 68.42% among the Shipibo-speaking participants considered this to be true. Similarly, 60.56% of Quechua and 37.47% of Shipibo-speaking participants believed in bleach as a preventive or curative measure. Many other data were obtained, including perceptions of the severity of the disease (Table 3), mentions of prevention more generally (across the dataset) and as an answer to the 'prevention' question (Fig 2), as well as of concepts propagated by the government and WHO in particular, such as mask use, social isolation, and other measures (Table 4). In Table 5, we also observe communities' perception of the government participation in health education (albeit indirectly); see Authors (2024) and Authors (2026). For the full data set, see <https://osf.io/gv9xk/files/turp4>.

In other words, the resulting data set offered many possibilities for analysis. In what follows, we focus on a particular line of inquiry and include question-and-answer pairs that directly address prevention.

✓ fx - HowToPreventSick (exact words)	cy
no juntarse con otros, uso de barbijo, quedarse en casa	
lavado las manos con jabón, distanciamiento	
na	
uso de mascarilla, distanciamiento, aislamiento, esas de manos y heridas medicinales	
usar mascarilla y lavarse las manos, en una asamblea una enfermera nos explicó como cuidarnos para que no nos contagien pero vinieron después que nos enfermamos	
lavar las manos, tomar té	
usar mascarilla	
cuidarse y alimentarse bien	
hacer hojas de ají huacra y tomar como té	
cuidarse con plantas	
no salir de la casa, tomar nuestras plantas	
hacer té que ya no uso mascarilla	
cuidarse	
hacerse baños con sachá ají	
al presidente decir usar mascarilla, guantes y no estar cerca de otros	
bañarse con plantas	
cuidarse, no salir mucho	
se forma varias plantas	
cuidarse, quedarse en casa	
tomar remedio, pastilla, succion con matito	
plantas medicinales bonas, sin fupon, matito, limon	
após sachá, quion	
lavar la mano, poner la mascarilla, lavar la mano	
lavar las manos, ver tiempo, poner la mascarilla, tomar distancia	
preparando plantas medicinales	
tomar quion, matito, escallito, após, tomar jugo de naranja hervido, cebolla	
poner mascarilla, hacer alcohol en la mano, quedarse en casa	
na	
quedar en casa	

Fig. 2 Responses to "How can you prevent COVID-19?"; an excerpt from the dataset

Table 1 Perceived vulnerable population: Quechua vs. Shipibo

Category	Quechua (N)	Shipibo (N)	Total
WhoGetsSickComorbidity	21	10	31
WhoGetsSickObesity	6	0	6
WhoGetsSickMalnourished	15	1	16
WhoGetsSickElderly	40	32	72
WhoGetsSickKids	14	1	15
WhoGetsSickCity	9	0	9
WhoGetsSickMestizos	1	5	6
Total	106	49	155

4.2 Coding and Analysis

Given the exploratory nature of the study and the urgent need to return the relevant information to communities and medical professionals working directly with them, several analyses were conducted on the resulting data set. Here, we report an analysis of participants' probabilities of mentioning various prevention measures for COVID-19. In particular, since study used the PAR methodology, we followed the community members' lead in considering the labels for some of the variables. In that, some methods of protective care were participant-centered (initiated and administered by participants, such as hand-washing and plant use); others were externally/government-mandated (e.g. distancing and masking).

We fit a series of Bayesian logistic hierarchical regression models using the brms package (v 2.20.4; [66]) in R (v 4.3.2; R Core Team, 2021 [67]). All priors were weakly informative and regularizing. More details on the modeling process, including the code used to fit the models, are provided in the Supplementary Materials (<https://osf.io/hcgfe/files/byg4w>). For each prevention method, a mention was coded as 1, and the absence of a mention as 0. All categorical variables were sum-coded. The prior on the global intercept, the grand mean probability of a mention, was a normal

Table 2 Responses to WHO statements: Quechua vs. Shipibo by Gender

Category	Gen.	Quechua (N=71)				Shipibo (N=38)			
		True (T)		False (F)		True (T)		False (F)	
		n	%	n	%	n	%	n	%
Hot Bath	F	6	8.45	30	42.25	11	28.95	8	21.05
	M	11	15.49	20	28.17	13	34.21	6	15.79
Be Cold	F	20	28.17	14	19.72	7	18.42	12	31.58
	M	18	25.35	14	19.72	8	21.05	11	28.95
Virus	F	27	38.03	7	9.86	17	44.74	2	5.26
	M	23	32.39	9	12.68	18	47.37	1	2.63
Bug Bites	F	22	30.99	14	19.72	2	5.26	16	42.11
	M	20	28.17	13	18.31	3	7.89	15	39.47
Warm Drinks	F	28	39.44	9	12.68	12	31.58	7	18.42
	M	23	32.39	10	14.08	14	36.84	5	13.16
No Improv.	F	21	29.58	11	15.49	19	50.00	0	0.00
	M	20	28.17	14	19.72	19	50.00	0	0.00
Alcohol	F	21	29.58	15	21.13	13	34.21	6	15.79
	M	20	28.17	11	15.49	15	39.47	4	10.53
Quarantine	F	33	46.48	1	1.41	17	44.74	2	5.26
	M	32	45.07	1	1.41	19	50.00	0	0.00
Bleach	F	9	12.68	27	38.03	9	23.68	10	26.32
	M	18	25.35	16	22.54	11	28.95	8	21.05

Table 3 Severity: "Can COVID-19 be cured?" (N = 109)

Answer	n	%
Yes	99	90.83
No	6	5.50
NA	4	3.67
Total	109	100.00

Table 4 Prevention mentions: Shipibo vs. Quechua

Measure	Shipibo		Quechua	
	n	%	n	%
Use of Masks	5	13.16	34	47.89
Social Distance	7	18.42	35	49.30

(Gaussian) distribution centered at zero with a standard deviation of 1.25, implying that, with 95% confidence, the average probability of a mention was between 8% and 92%. The priors on all population-level parameters were standard normal distributions, and the prior on the varying intercepts per participant was an exponential distribution with rate 1. These priors were selected in order to allow the data to generally have the majority of the influence over parameter estimates while making the

Table 5 What government talks about: Death only or cure, Quechua vs. Shipibo by Gender

Category	Gen.	Quechua (N=71)				Shipibo (N=38)			
		True (T)		False (F)		True (T)		False (F)	
		n	%	n	%	n	%	n	%
Govt Death	F	35	49.30	0	0.00	18	47.37	0	0.00
	M	28	39.44	4	5.63	18	47.37	1	2.63

model skeptical of large values, which would push predicted values at the extreme edges of the probability space between zero and one.

The variables included in the model presented here were as follows: SurveyLang: the language of the interview (Quechua vs. Shipibo), Method: the prevention measure (masks, self-care, social distancing), Posta: whether participants had access to a day clinic (Yes vs. No). HeardOfLang: what language participants reported hearing information about the pandemic (Spanish, the indigenous language, or both). We also fit several interactions between the variables described above. The first was the interaction of SurveyLang and Method, which allowed the probabilities of mentioning the different prevention methods to vary across the two communities. The second was the interaction of SurveyLang and Posta, as there was reason to believe that access to a day clinic would affect these two communities differently. The third interaction, between SurveyLang and HeardOfLang, allowed us to explore how the language used to disseminate information about the pandemic reached the two communities differently. The last interaction was between Method and Posta, as we believed that access to a clinic could affect the mention of the three prevention methods differently. As detailed in the Supplementary Materials, we first built a model with the variables listed above, with no interactions. The second model reported here included the interactions described in the previous paragraph. A third model included additional variables: the interview date, the participant’s age, whether the participant had access to a traditional healthcare professional, when (or if) the participant started learning Spanish, and the number of contexts in which the participant reported using Spanish. These three models were compared using the Leave-one-out Information Criterion (LOOIC), which indicated that the predicted out-of-sample predictive accuracy of the interaction model was improved compared to the model without the interactions. However, adding these extra variables to the interaction model yielded similar predictive accuracy, and we therefore report the more parsimonious model in the text. All of the models’ diagnostic values indicated model convergence (R-hat and effective sample sizes), and the model fit was assessed through posterior predictive check. We also compared models through the LOO information criterion, and there were no problematic values, indicating that the model was a reasonable fit to the data. This information is reported in the supplementary materials.

4.3 Findings

The main effects of the four predictors in the interaction model are shown in Figure 3. As the categorical predictors in our model were sum-coded, these effects represent

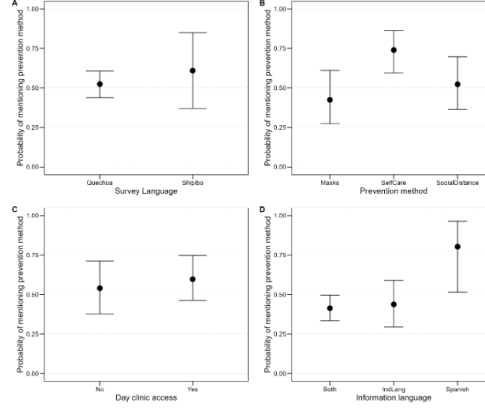


Fig. 3 Plots of the four main effects from the interaction model. Visualized are the back-transformed predicted probabilities of a mention for an average person and the 95% confidence interval. Panel A is the main effect of survey language. Panel B is the main effect of prevention method. Panel C is the main effect of day-clinic access. Panel D is the main effect of information language

changes in the predicted probability of the variable in question, averaged across all levels of the other predictors. The interactions from our model are plotted below as predicted probabilities in Figure 3. We note that this analysis should be taken as a structured exploration of the data, as we did not build a model with the intent of testing a specific hypothesis.

Figure 3A demonstrates that participants interviewed in Quechua versus Shipibo mentioned similar amounts of prevention measures overall (differences in either direction are compatible with our model), in essence illustrating (from this analysis) that we are not confident that the actual *number* of (types of) preventative measures considered by the two different socio-linguistic groups differ overall. In Figure 3B, we observe the difference between masking and distancing versus other types of self-care initiated by community members: while our model is not confident that mentions of distancing were more or less probable than masking, it is more confident that mentions of other types of self-care methods (including handwashing and traditional approaches) were more common than mentions of masking (Prob.>99%) and distancing (Prob.>99%). In Figure 3C, we see that access to a day clinic did not increase the probability of mentioning prevention measures overall. In Figure 3D, which includes both language groups, we see that mentions of different prevention methods were similar among participants who reported hearing COVID-related information in the indigenous language or in both languages; however, participants who reported hearing this information only in Spanish mentioned more preventive measures overall (Prob.=99%) – i.e. hearing COVID-19 related information in the dominant language (Spanish) may have resulted in a higher probability of mentioning relevant preventive strategies in the Indigenous language.

In turn, in Figures 4 (A-D), we visualize the interaction between the survey language (i.e., the community’s language: Quechua vs. Shipibo) and the previous results directly. Figure 4A illustrates the interaction between the community language and the language(s) that participants reported hearing information about the virus. For

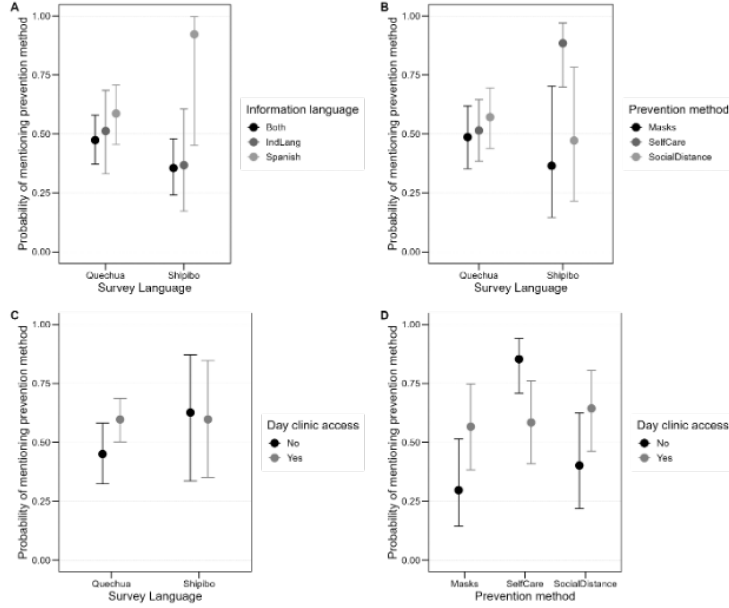


Fig. 4 Plots of the four interactions included in the interaction model. Visualized are the back-transformed predicted probabilities of a mention for an average person. Panel A is the interaction between the survey language and the information language. Panel B is between the survey language and the prevention method. Panel C is between survey language and day-clinic access. Panel D is between the prevention method and the day-clinic access.

Quechua speakers, we are uncertain whether hearing the information in a different language affects rates of mentioning prevention factors, with only weak evidence that hearing it in Spanish may be better than hearing it in both languages (Prob. = 90%). For Shipibo speakers, we are more confident that hearing information in Spanish led to increased mentions compared to hearing it in Shipibo (Prob. = 98%) or in both languages (Prob. = 99%). The interaction terms from our model have 93% of the posterior on one side of zero, suggesting that the language of information affected these two groups differently, although the qualitative patterning of the association appears similar. In other words, the overall data presented in Figure 3D may be skewed by community membership. In Figure 4B, we plot the predicted probabilities of mentioning the three different prevention measures according to the survey language: masks, (other types of) self-care, and distancing. For Quechua speakers, we are uncertain whether they mention different prevention methods at different rates. For reference, the largest difference between distancing measures and masks has 82% of the posterior on one side of zero, which means that we are not particularly confident of this difference. In contrast, we are more than 99% confident that Shipibo speakers mention (other types of) self-care methods more than masking and distancing. In other words, the overall data presented in Figure 3B may be skewed by community membership. We are also more than 98% confident in the interactions, indicating that the relative patterns of mentioning the different methods differ across the two communities. In Figure 4C, we plot the predicted probability of mentioning prevention

measures overall, as a function of the interaction between survey language and access to a clinic (a.k.a. "posta"). We are confident that Quechua speakers reported more measures when they had access to a clinic than when they did not (Prob. = 97%), but we are uncertain of the effect of having access to a clinic for Shipibo speakers. In other words, the data presented in Figure 3C may be skewed by community membership. While we are reasonably confident in the difference for Quechua speakers but not for Shipibo speakers, we are only 89% confident that Quechua and Shipibo speakers differ in their access to a day clinic. In Figure 4D, we plot the predicted probabilities of mentioning the different prevention measures, depending on whether participants reported having access to a clinic. We are confident that having access to a clinic is associated with a higher probability of mentioning masks and distancing (Probs. = 99%), and we are also confident that clinic access is associated with lower probabilities of mentioning self-care (Prob. > 99%). In other words, government-run healthcare facilities may be responsible for direct propagation of information about masking and distancing – methods advocated by the WHO, CDC, i.a).

5 Discussion

First, we discuss our results when all categorical predictors were sum-coded; the effects represent changes in the predicted probability of the variable in question, averaged over all levels of the other predictors.

The absence of SurveyLanguage (Quechua vs. Shipibo) effects could indicate that, despite differences in geolocation or lack of information, views about prevention are similar among Indigenous communities in our study (note, however, section 6).

The fact that *other types of self-care methods* were mentioned more than *masking* and *distancing* is consistent with traditional and culturally-based practices of health management (e.g., steam-baths, herbal teas, 'cleanliness' i.a.), but this also indicates that government messages that had focused on distancing and masking either did not reach these communities or were not processed as relevant, appropriate, or trustworthy – associated with Spanish only. Both of these findings are consistent with what has generally been discussed regarding Indigenous health education and access during the pandemic and previous crises ([35]).

The aforementioned is also true of other aspects of healthcare. In our study, having access to a clinic increased the probability of mentioning more prevention measures such as masks and distancing (for which scientific evidence of effectiveness has been demonstrated but which were typically propagated by external sources) *in addition to self-care methods* (which are individual-initiated, such as hand-washing, use of medicinal plants, steam cures), especially among the Quechua group. This higher probability highlights the important role that government healthcare facilities play in the dissemination of preventive measures, at least for some Indigenous communities. The fact that for both groups, having access to a clinic is associated with a higher probability of mentioning masks and social distancing and lower probabilities of mentioning self-care is also a clear indication that proper access to healthcare facilities increases the chances, at least for the participants in this study, of accessing information beyond the realm of their own communities (and practices). While having access to more

information does not necessarily mean access to better information, in this case, information about masking and social distancing could have played an important role in preventing the spread of COVID-19.

Yet, most participants in the study have access only to healthcare facilities of levels 1-3; these facilities, being 5-28km away from the communities themselves, may be less likely to serve as actual deliverers (and mitigators) of healthcare education. In other words, the types of facilities and their distances may be factors in these results. The aforementioned suggests that the absence of such facilities exacerbates the already-existing barrier to equitable healthcare for Indigenous populations (see [36], [18], [24] and references therein).

When considering interactions with the groups separately, we observe that hearing the information in Spanish increased the likelihood of mentioning multiple prevention methods, especially for the Shipibo group. Further, Shipibo speakers were more likely to mention self-care methods than other prevention methods. These results suggest the prevalence of more information available in the socially and economically dominant language. The limited information available to Indigenous groups in Peru (Alvarez-Risco et al. 2020) is further aggravated by the higher likelihood of accessing prevention information in the socially/economically dominant language (at least for participants in the Shipibo group).

Qualitative analysis of the dataset (e.g. Fig 2) suggests that community members did not have reliable information from the government structures (including government-run health centers) and, instead, relied either on healthcare intervention government-delivered and hearsay statements without understanding the rationale behind them (e.g. avoiding 'dirty' environments or 'bad air' as in the case of 'hand washing' and 'use of masks') or their own culturally-based protocols (e.g. the various use of plants); see Fig 2. Indeed, given the a) lack of clear information flowing top-down, and b) unavailability of accessible and reliable healthcare systems, the participants in our study turned to lateral, community defined systems for prevention.

Overall, our findings point to a dire need for access to health information through state-run healthcare facilities, in combination with the existing traditional knowledge in Indigenous communities. Yet, the fact that hearing information in Spanish led to increased mentions of prevention methods (compared to hearing it either the Indigenous language only or in both) for both groups is indicative of the fact that differences in access to the socially dominant language creates a clear informational divide within Indigenous communities – one that separates those who have access to the language of prevention discourse and those who do not, more generally mirroring the effects of the digital divide ([68]).

The results discussed add to the other observations we noted, aligning our study with previous research on misinformation and the disconnect from government-based structures and the associated healthcare education materials.

6 Limitations

The study has several limitations. First, by the time the study began (September 2020), evidence-based prevention methods were already established: mask-wearing,

physical distancing, hand hygiene, and avoiding large gatherings. However, later studies demonstrated that while masks and isolation remained evidence-supported measures, hand hygiene was no longer considered a preventive/protective measure ([69]). Second, in many communities the CDC/WHO guidance could not be followed: in rural communities a) masks were often unavailable in required numbers, b) hand hygiene was not possible because of the lack of access to clean running water, and c) living situations did not necessarily lend themselves to isolation/distancing and avoidance of gathering. Thus, both the communities and the intercultural health professionals working in them had needed to know which measures were used by individual members irrespective of the alignment with the WHO/CDC guidelines. Third, some interviews were conducted in person while others by phone (recorded during one of the pandemic peak periods (2021-2022)); it is possible that this may have affected the overall responses. Additionally, participants were contacted through word of mouth, making the sample nonrandom; for that reason, we do not make claims that can be generalized to all Cuzco Quechua-speaking populations or to all Shipibo-speaking communities. Another important limitation of the study is the fact that vaccines - an important preventive measure - emerged towards the end of data collection; thus, questions about participants' perceptions of them were not included.

7 Conclusions

In closing, we are reminded of the arguments previously articulated elsewhere. For instance, in his Research Manifesto for Indigenous Urgencies, Lambert (2022) states:

“COVID-19 provides a regrettably powerful example of the embedding of vulnerabilities into Indigenous worlds. This latest pandemic revealed the conditions of vulnerability had originated with oppressive external forces, just as the authorities within health sectors remain an outcome of these histories.” (Lambert 2022: 78)

In this report, we used a variety of terms typically associated with non-Indigenous perspectives on health (see [70], among others), focusing on *prevention*, *healthcare education centers*, *government*, etc. The data presented in our study, not surprisingly, demonstrate that the dominant systems of healthcare education, including prevention (many of which rely on access(ibility) of healthcare more generally), require changes. Importantly, this work did not aim to ascertain which procedures could, or should, be considered 'erroneous,' nor did we aim to advocate for any particular alternatives. Instead, the work a) reports the views of communities (and individuals in them) and b) demonstrates that certain factors (such as an approach to health education that does not take into consideration culturally-anchored framing) may inhibit perceptions and actions towards combating an epidemic as might have been desired by top global or local officials. For example, the data suggest, albeit indirectly, that communities in our study do not use government-based resources because they lack access to them or do not trust their relevance ([71]).

Yet, the results also point to resistance to inadequate measures. One of these was the questionnaire itself, which was community-initiated and -centered and addressed the procedures utilized by the communities themselves. In this questionnaire and the subsequent data analyses, a variety of measures utilized by communities in the fight

against COVID-19 hold the status of ‘preventive’ in a broader sense - the view also supported by interculturally-trained medical professionals who served as consultants on the project, see [72].

Elsewhere (Authors, in prep), we turn to other approaches to the dataset examined here. For instance, as discussed in [73], throughout the pandemic, nurse technicians who themselves are Indigenous utilized several traditional methods in the treatment of symptoms of COVID-19; the “Matico Squad”, a group of young Shipibo volunteers, provided similar care to patients with COVID-19 through the use of traditional medicinal approaches combined with western medicine ([74]). In fact, as part of this project, we collaborated with Shipibo-Konibo videographers (Bernabé Mahua and Gabriela Delgado) who documented such efforts in a series of videos about the Shipibo-Konibo people’s response to the pandemic (<http://...com>). In one of the videos, the Matico Squad’s experience is narrated, and it is explicitly stated that the Squad did not follow all government directives regarding isolation. Quite the opposite: they treated patients not only with traditional medicinal plants, but as part of recovery procedures, family members were allowed to visit. This ran directly against government-mandated health policy but exemplified clear decolonial practices in the context of lack of attention and proper information: based not on traceability but, rather, on the notion of community solidarity. The fact that Shipibo videographers recorded their own healing initiatives and experiences during the pandemic underscores the relevance of Indigenous ownership of healing practices and data about their experiences ([53], [72]). These initiatives, of course, do not relieve the state of the responsibility to invest in the proper dissemination of health information to Indigenous communities.

All of the above leads us to a particular conclusion with regard to policy (incidentally, articulated in other works on the matter including various United Nations reports, including the discussions at the UN Permanent Forum on Indigenous Issues): at a minimum, a successful ‘preventive campaign’ ought to include materials that consider: a) traditionally/culturally-bound methods of (self-)healthcare, centered on the community-internal practices (note: both Quechua and Shipibo reside in the same country but have very different cultural profiles); b) the language in which the health education materials are delivered (Indigenous vs. dominant), but also the impact of the knowledge of the dominant language on following the protocols; c) the fact that restricted access to healthcare centers (clinics and equipment often associated with them, such as gloves and masks) may be resulting in communities’ reliance on measures dissonant with the protocols articulated by the WHO, CDC, and other agencies; d) that information about a crisis communicated by the government (based, e.g., on the research from the Global North) may not be conceptually interpreted in the intended manner: semantics and pragmatics of “quarantine,” “virus,” “disease,” “cure,” etc., do not align neatly cross-linguistically/-culturally.

In other words, pivoting this discussion back to the tenets of QuantCrit and CILS, we call for general policy changes towards creation and distribution of prevention and other materials in communities during crises – these communities should not only be consulted but also represented in the creation of the relevant materials. Incidentally, such an a move not only directly aligns with the recent UN recommendations on Indigenous health ([75]) but also has the potential to ensure that individual members

are more likely to trust and follow the protocols established by academic scientific research.

All cited bib entries are printed at the end of this article:

Supplementary information. See accompanying supplementary files

Acknowledgements. We thank XXXX [to be added in the final round].

Please refer to Journal-level guidance for any specific requirements.

Declarations

Some journals require declarations to be submitted in a standardised format. Please check the Instructions for Authors of the journal to which you are submitting to see if you need to complete this section. If yes, your manuscript must contain the following sections under the heading ‘Declarations’:

- **Funding:** This research has been funded by the National Science Foundation: #2...9 to XXX and #2...2 to YYY.
- **Conflict of interest/Competing interests:** There is no conflict of interest
- **Ethics approval and consent to participate**
Informed consent for data collection and publication was obtained from all participants prior to data collection. Consent was obtained without any form of coercion and with participants’ explicit understanding of the purpose for which their data will be used. Consent was obtained in the participants’ first language. Because participants’ literacy in Indigenous or dominant languages could not be assumed, consent was obtained orally (ascent). Audio recordings of the ascent are available for each participant.
Ethics approval has been obtained. All protocols were approved by the Institutional Research Boards of University and University (IRB protocols #20063 and #2020-0751, respectively). The procedures and other methods were carried out in accordance with the relevant guidelines and regulations as articulated in the ethical principles regarding all research involving human participants as subjects, set forth in the Belmont Report and the EU/UK GDPR requirements.
- **Consent for publication** Informed consent for data collection and publication was obtained from all participants prior to data collection. Consent was obtained without any form of coercion and with participants’ explicit understanding of the purpose for which their data will be used. Consent was obtained in the participants’ first language. Because the participants’ knowledge of literacy in the Indigenous or dominant languages could not be assumed, consent was collected orally (ascent). Audio of ascent is available for each participant.
- **Data availability**
The data are now publicly available in the form of published corpora (Macedo et al. 2022 and Chavez et al. 2022).
- **Materials availability** <https://osf.io/hcgfe/files/byg4w>
- **Code availability** <https://osf.io/hcgfe/files/byg4w>
Supplemental materials accompany this manuscript
- **Author contribution** ‘Authors contributed equally’

If any of the sections are not relevant to your manuscript, please include the heading and write ‘Not applicable’ for that section.

Editorial Policies for:

Springer journals and proceedings: <https://www.springer.com/gp/editorial-policies>

Nature Portfolio journals:

<https://www.nature.com/nature-research/editorial-policies>

Scientific Reports: <https://www.nature.com/srep/journal-policies/editorial-policies>

BMC journals: <https://www.biomedcentral.com/getpublished/editorial-policies>

Appendix A Section title of first appendix

An appendix contains supplementary information that is not an essential part of the text itself but which may be helpful in providing a more comprehensive understanding of the research problem or it is information that is too cumbersome to be included in the body of the paper.

References

- [1] Pickering, K., et al.: Indigenous peoples and covid-19 **18**, 033001 (2023) <https://doi.org/10.1088/1748-9326/acb804>
- [2] Kuhn, N., et al.: Decolonizing risk communication **9**(3) (2020)
- [3] Hiraldo, D., James, K., Carroll, S.: Indigenous sovereignty in pandemic **6** (2021)
- [4] Ministerio de Cultura del Perú: Lenguas indígenas (2024). <https://bdpi.cultura.gob.pe/lenguas>
- [5] Instituto Nacional de Estadística e Informática: Perfil sociodemográfico del Perú (2017). <https://censo2017.inei.gob.pe/resultados-definitivos-de-las-comunidades-nativas-y-campesinas-2017/>
- [6] Barrenechea, R., Encinas, D.: Perú 2021: Democracia por defecto **42**(2), 407–438 (2022) <https://doi.org/10.4067/S0718-090X2022005000115>
- [7] Ministerio de Educación del Perú: Resolución Ministerial 519-2018 (2018). <https://www.gob.pe/institucion/minedu/normas-legales/196935-519-2018-minedu>
- [8] Gietaneh, W., Simieneh, M.M., Endalew, B., Tarekegn, S., Petrucka, P., Eyayu, D.: Traditional healers’ roles, and the challenges they face in the prevention and control of local disease outbreaks and pandemics: The case of the east gojjam

- zone in northwestern ethiopia. *Frontiers in Tropical Diseases* **4**, 978528 (2023) <https://doi.org/10.3389/ftd.2023.978528>
- [9] Lynteris, C., Poleykett, B.: The anthropology of epidemic control: Technologies and materialities **37**(6), 433–441 (2018) <https://doi.org/10.1080/01459740.2017.1368554>
 - [10] World Health Organization Regional Office for the Eastern Mediterranean: Health promotion and disease prevention. Accessed: 2026-04-08 (n.d.). <https://www.emro.who.int/about-who/public-health-functions/health-promotion-disease-prevention.html>
 - [11] Soni, K., Sinha, A.K.: Dynamics of epidemic model with conformable fractional derivative. *Results in Control and Optimization* (2025). Available online 21 June 2025
 - [12] Soni, K., Shyamsunder, Sinha, A.K.: Memory-driven dynamics of hepatitis b transmission incorporating media awareness. *Advanced Theory and Simulations* (2026) <https://doi.org/10.1002/adts.70394>
 - [13] Collier, S.J., Lakoff, A.: Vital systems security **32**(2), 19–51 (2015) <https://doi.org/10.1177/0263276413510050>
 - [14] Skutnabb-Kangas, T., Phillipson, R.: *The Handbook of Linguistic Human Rights*. John Wiley & Sons, ??? (2022)
 - [15] World Health Organization: Strengthening national emergency preparedness. Accessed: 2026-04-08 (n.d.). <https://www.who.int/activities/strengthening-national-emergency-preparedness>
 - [16] León-Martínez, L.: Critical review of indigenous health risk factors **733**, 139357 (2020)
 - [17] United Nations Economic Commission for Latin America and the Caribbean: *Economic survey of Latin America and the Caribbean* (2021)
 - [18] Power, T., Wilson, D., Best, O., Brockie, T., Bearskin, L.B., Millender, E., Lowe, J.: Covid-19 and indigenous peoples: An imperative for action. *Journal of clinical nursing* **29**(15-16), 2737 (2020)
 - [19] Ferrante, L., Fearnside, P.M.: Protect indigenous peoples **368**, 251 (2020) <https://doi.org/10.1126/science.abc0073>
 - [20] Anderson, I., Robson, B., Connolly, M., et al.: Indigenous and tribal peoples' health: A population study **388**(10040), 131–157 (2016) [https://doi.org/10.1016/S0140-6736\(16\)00345-7](https://doi.org/10.1016/S0140-6736(16)00345-7)
 - [21] Lima, C.K.T., Carvalho, P.M.M., Lima, I.A.S., et al.: The emotional impact

- of coronavirus 2019-ncov (new coronavirus disease) **287**, 112915 (2020) <https://doi.org/10.1016/j.psychres.2020.112915>
- [22] Smylie, J., Firestone, M.: Back to the basics: Identifying and addressing underlying challenges in achieving high quality and relevant health statistics for indigenous populations in canada **31**(1), 67–87 (2015) <https://doi.org/10.3233/SJI-150864>
 - [23] La Ruche, G., Tarantola, A., Barboza, P., Vaillant, L., Gueguen, J., Gastellu-Etchegorry, M., *et al.*: The 2009 pandemic h1n1 influenza and indigenous populations of the americas and the pacific. *Eurosurveillance* **14**(42), 19366 (2009)
 - [24] Organization, W.H.: COVID-19 and Indigenous peoples (2021)
 - [25] Teixeira, S.C.: Circumnavigating the challenges of covid-19 for indigenous people: Perspectives for public health **186**, 127–128 (2020) <https://doi.org/10.1016/j.puhe.2020.06.024>
 - [26] Mosby, I., Swidrovich, J.: Vaccine hesitancy **193**, 381–383 (2021)
 - [27] Pratt, C.Q., Chard, A.N., LaPine, R., Galbreath, K.W., Crawford, C., Plant, A., Stiffarm, G., Rhodes, N.S., Hannon, L., Dinh, T.-H.: Use of stay-at-home orders and mask mandates to control covid-19 transmission—blackfeet tribal reservation, montana, june–december 2020 **70**, 514–518 (2021) <https://doi.org/10.15585/mmwr.mm7014a3>
 - [28] Pastor, M., Speer, P., Gupta, J., Han, H., Ito, J.: Community power and health equity: closing the gap between scholarship and practice. *NAM perspectives* **2022**, 10–31478 (2022)
 - [29] Krystallidou, D., Braun, S.: Risk and crisis communication during covid-19 in linguistically and culturally diverse communities: A scoping review of the available evidence. In: Blumczynski, P., Wilson, S. (eds.) *Languages of COVID-19: Translational and Multilingual Perspectives on Global Healthcare*, pp. 128–143. Routledge, London (2022)
 - [30] Berger, D.N., Bulanin, N., García-Alix, L., Jensen, M.W., Leth, S., Alvarado, E., Madsen, D.M., Parellada, A., Petersen, L.M.L., Rose, G., *et al.*: *El mundo indígena 2020*. Lima, Perú: IWGIA (2020)
 - [31] Zhang, J., Wu, Y.: Multilingual logistics communication **39** (2020)
 - [32] Li, J., Zhang, J., Piller, I.: Multilingualism during disasters and emergencies. In: — (ed.) *Multilingualism During Disasters and Emergencies*, pp. 383–393. Routledge, ??? (2023). <https://doi.org/10.4324/9781003214908-30>

- [33] García, G., Haboud, M., Howard, R., et al.: Miscommunication in covid-19 **39**, 39–46 (2020)
- [34] United Nations Development Programme: Indigenous population and COVID-19 (2020)
- [35] IWGIA: The Indigenous World 2022 (2022)
- [36] Williamson, G.: Healthcare access disparities among marginalized communities. *Global Perspectives in Health, Medicine, and Nursing* **3**(1), 11–22 (2024)
- [37] Prout, S.: The Entangled Relationship Between Indigenous Spatiality and Government Service Delivery. Centre for Aboriginal Economic Policy Research (CAEPR), Australian National University, Canberra, ACT, Australia (2008)
- [38] Charette, M., et al.: Dengue incidence in peruvian amazon **102**(1), 180–186 (2020)
- [39] Richardson, K.: Indigenous health protection **12** (2012)
- [40] Buseh, A.G., Stevens, P.E., Bromberg, M., Kelber, S.T.: The ebola epidemic in west africa **63**(1), 30–40 (2015) <https://doi.org/10.1016/j.outlook.2014.06.004>
- [41] O’Sullivan, T., Bourgoin, M.: Vulnerability in an influenza pandemic: Looking beyond medical risk **11**(16), 1–18 (2010)
- [42] Kristeva, J., Moro, M.R., Ødemark, J., Engebretsen, E.: The cultural crossings of care: A call for translational medical humanities. In: *Routledge Handbook of the Medical Humanities*, pp. 34–40. Routledge, London (2019)
- [43] Arnaldi, M.: Translational futures: notes on ecology and translation from the covid-19 crisis. In: *The Languages of COVID-19*, pp. 249–266. Routledge, ??? (2022)
- [44] Sellnow-Richmond, D.D., George, A.M., Lukacovic, M.N., Salazar, S.E., Sellnow, D.D.: A comparative analysis of u.s. state government communication and resident compliance to cdc covid-19 guidelines. *Journal of Applied Communication Research* **51**(4), 380–403 (2023) <https://doi.org/10.1080/00909882.2023.2165885>
- [45] Kim, D.K.D., Kreps, G.L.: An analysis of government communication in the united states during the covid-19 pandemic: Recommendations for effective government health risk communication. *World Medical & Health Policy* **12**(4), 398–412 (2020) <https://doi.org/10.1002/wmh3.363>
- [46] Oppenheim, B., et al.: Global preparedness **4** (2019)
- [47] Alvarez-Risco, A., Mejia, C.R., Delgado-Zegarra, J., et al.: The peru approach against the covid-19 infodemic: Insights and strategies **103**(2), 583–586 (2020)

<https://doi.org/10.4269/ajtmh.20-0536>

- [48] Bhattacharya, S., Singh, A.: Unravelling the infodemic: A systematic review of misinformation dynamics during the covid-19 pandemic **10**, 1560936 (2025) <https://doi.org/10.3389/fcomm.2025.1560936>
- [49] World Health Organization: COVID-19 infodemic (2026). <https://www.who.int>
- [50] The Lancet Infectious Diseases: The covid-19 infodemic **20**(8), 875 (2020) [https://doi.org/10.1016/S1473-3099\(20\)30565-X](https://doi.org/10.1016/S1473-3099(20)30565-X)
- [51] Tworek, H.J.R., colleagues: Public health and communication in the covid-19 infodemic: Lessons from global responses **11**(4), 503–513 (2020) <https://doi.org/10.1111/1758-5899.12852>
- [52] Lambert, S.: Time back! a research manifesto for indigenous urgencies. In: — (ed.) A Research Agenda for COVID-19 and Society, pp. 61–84. Edward Elgar Publishing, Cheltenham, UK (2022)
- [53] Hendl, T., Roxanne, T.: Digital surveillance in pandemic response **36**(3), 305–312 (2022)
- [54] Ministerio de Salud del Perú: Geo-Indicadores: Establecimientos de Salud. <https://geo.minsa.gob.pe/Views/mapas/EESS-maps/eess-map.aspx>. Accessed: 2026-05-21 (n.d.)
- [55] Gobierno del Perú, Ministerio de Salud del Perú: Servicios y categorías del primer nivel de atención de salud. <https://www.gob.pe/16728-servicios-y-categorias-del-primer-nivel-de-atencion-de-salud>. Accessed: 2026-05-21 (n.d.)
- [56] Espinal, M.A.: The pan american health organization: 120 years in the americas hemisphere. The Lancet Regional Health–Americas **21** (2023)
- [57] Gracey, M., King, M.: Indigenous health part 1: determinants and disease patterns. The Lancet **374**(9683), 65–75 (2009)
- [58]
- [59] Taylor, L.: Covid-19: How the brazil variant took hold of south america. *bmj* **373** (2021)
- [60] Fraser, B.: Covid-19 strains remote regions of peru. *Lancet* (London, England) **395**(10238), 1684 (2020)
- [61] Carrillo-Larco, R.M., Guzman-Vilca, W.C., Leon-Velarde, F., Bernabe-Ortiz, A., Jimenez, M.M., Penny, M.E., Gianella, C., Leguía, M., Tsukayama, P., Hartinger, S.M., et al.: Peru–progress in health and sciences in 200 years of independence.

- [62] Ashida, M., Kim, J.D., Lee, S.: Covid-19 mythbusters in world languages. In: Proceedings of the Thirteenth Language Resources and Evaluation Conference, pp. 3048–3055 (2022)
- [63] Cargo, M., Mercer, S.L.: Participatory research **29**, 325–350 (2008) <https://doi.org/10.1146/annurev.publhealth.29.091307.083824>
- [64] Wild, A., et al.: Communicating covid-19 **31** (2021)
- [65] Israel, B.A., Eng, E., Schulz, A., Parker, E.: Methods for Community-based Participatory Research. Wiley, ??? (2012)
- [66] Bürkner, P.-C.: brms: An r package for bayesian multilevel models using stan **80**(1), 1–28 (2017) <https://doi.org/10.18637/jss.v080.i01>
- [67] R Core Team: R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria (2021). R Foundation for Statistical Computing. <https://www.R-project.org/>
- [68] Sanders, C.K., Scanlon, E.: Digital divide **6** (2021)
- [69] Baumkötter, R., Yilmaz, S., Zahn, D., Fenzl, K., Prochaska, J.H., Rossmann, H., Schmidtmann, I., Schuster, A.K., Beutel, M.E., Lackner, K.J., *et al.*: Protective behavior and sars-cov-2 infection risk in the population—results from the gutenbergs covid-19 study. BMC Public Health **22**(1), 1993 (2022)
- [70] Hovey, R., Delormier, T., McComber, A.M.: Social-relational understandings of health and well-being from an indigenous perspective. International Journal of Indigenous Health **10**(1), 35–54 (2014)
- [71] Montag, D., Barboza, M., Cauper, L., Brehaut, I., Alva, I., Bennett, A., Sanchez-Choy, J., Barletti, J.P.S., Valenzuela, P., Manuyama, J., *et al.*: Healthcare of Indigenous Amazonian Peoples in response to COVID-19: marginality, discrimination and revaluation of ancestral knowledge in Ucayali, Peru. BMJ Publishing Group Ltd (2021)
- [72] Montag, D., Barboza, M., Cauper, L., Brehaut, I., Alva, I., Bennett, A., Sanchez-Choy, J., Sarmiento Barletti, J.P., Valenzuela, P., Manuyama, J., García Murayari, I., Guimaraes Vásquez, M., Aguirre Panduro, C., Giattino, A., Palomino Cadenas, E.J., Lazo, R., Delgado, C.A., Nino, A., Flores, E.C., Pesantes, M.A., Murillo, J.P., Belaunde, L.E., Recuenco, S., Chuquimbalqui, R., Zavaleta-Cortijo, C.: Healthcare of indigenous amazonian peoples in response to covid-19: marginality, discrimination and revaluation of ancestral knowledge in ucayali, peru. BMJ Global Health **6**(1), 004479 (2021) <https://doi.org/10.1136/bmjgh-2020-004479>

- [73] Pesantes, M.A., Cardenas Palacios, C., Hewlett, C., Maake, C.: Primary health care in the peruvian amazon during covid-19: perspectives from indigenous nurse technicians. *Frontiers in Tropical Diseases* **4**, 1119499 (2023) <https://doi.org/10.3389/ftd.2023.1119499>
- [74] Lossio, J.: Social responses to covid-19 in peru **30** (2023)
- [75] United Nations Permanent Forum on Indigenous Issues: Restoring Indigenous Health by Connecting Systems through the Indigenous Determinants of Health: Local to Global Evidence. Technical Report E/C.19/2026/5, United Nations Economic and Social Council (2026). 25th Session of the United Nations Permanent Forum on Indigenous Issues. <https://docs.un.org/en/E/C.19/2026/5>