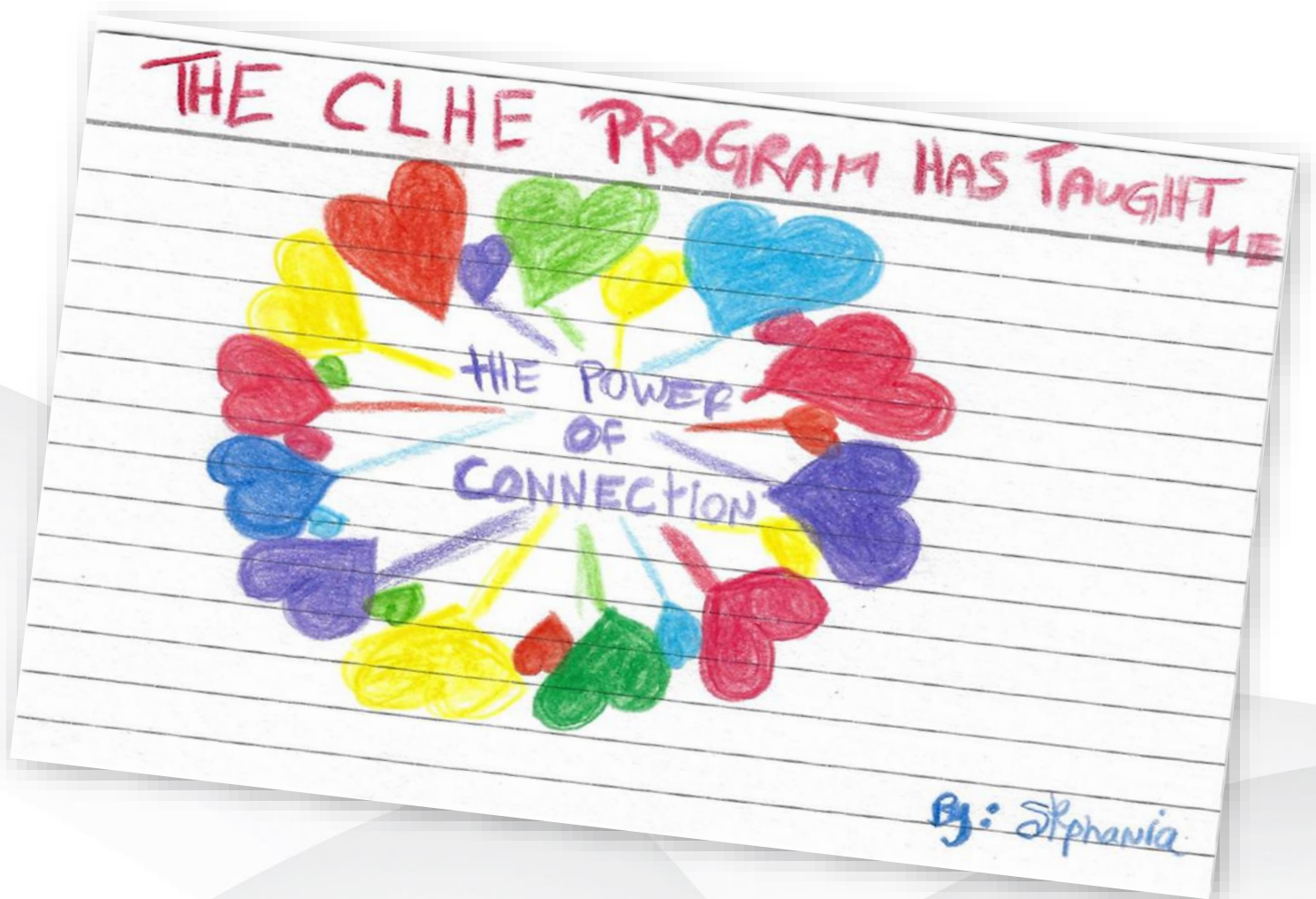# Community Leaders in Health Equity Evaluation

Appendix C: Social Network Analysis

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Exhibits

Appendix C: Community Leaders in Health Equity: Social Network Analysis

Introduction

This appendix presents the analysis of the social network data collected from the 2021 Cohort and Continuing Track Cohort of The Colorado Trust's Community Leaders in Health Equity program (CLHE). The evaluation was guided by the conceptual communities of practice (CoP) framework, an adult learning theory that emphasizes the social nature of learning through engagement in a shared practice, in this case social action toward equity. This study contributes to the field by demonstrating the efficacy of social network analysis as a descriptive method for evaluating the interactions of a bilingual and multicultural CoP focused on health equity. The full evaluation findings and recommendations, which triangulate data across data-collection methods, reside in Chapter 3.

Methods

Data Collection

AIR contracted with local consultants for onsite data collection, including for the administration of a paper social network survey to the 2021 Cohort and Continuing Track Cohort. The survey was available in English and Spanish and was administered twice. For the 2021 Cohort, administration occurred in November 2021 and November 2022, and for the Continuing Track Cohort, administration occurred in October 2021 and May 2022. For easy navigation, the survey included a roster detailing each member of the cohort by region. On the survey, we asked participants to identify who they knew prior to CLHE participation, the extent to which they interacted with each member while participating in CLHE, and whether they planned to stay connected when the program concluded (see Exhibit C1 for an example).

Exhibit C1. Social Network Survey Example

(1) Name Nombre	Region/ Location Región/ Ubicación	(2) Knew this person before CLHE (prior to April 2018)? (Circle Yes or No) ¿Ya conocía a esta persona antes de participar en CLHE? (Encierre sí o no en un círculo)	(3) No Interaction (I do not recognize this name or don't remember interacting with them) Ninguna interacción (No reconozco este nombre y/o no he interactuado con esta persona)	(3) Minimal Interaction (I know who this person is and have had minimal interaction with them) Interacción mínima (Sé quién es esta persona, pero solamente he interactuado muy poco con elle)	(3) Occasional Interaction (I know this person and we have shared information/ communicated with each other on occasion) Interacción ocasional (Sé quién es esta persona y hemos compartido información ǀ nos comunicamos de vez en cuando)	(3) Frequent Interaction (I know this person and we often share information/ work actively together/ have ongoing communication) Interacción frecuente (Conozco a esta persona y frecuentemente compartimos información ǀ trabajamos juntos ǀnos comunicamos constantemente)	(4) Future Interaction (I plan to stay connected with this person to share information/ work together after the program is over) (Circle Yes or No) Interacción en el futuro (Planeo mantenerme en contacto con esta persona para compartir información/trabajar juntos después de que termine el programa) (Encierre sí o no en un círculo)
Jane Doe	1 - Fort Morgan	Yes/Sí No/No					Yes/Sí No/No
John Doe	1 - Fort Morgan	Yes/Sí No/No					Yes/Sí No/No

Note. CLHE = Community Leaders in Health Equity program.

Our data-collection strategy included two components at baseline and three at endline. First, we asked participants to identify who they knew prior to participation in the program. Then we asked them to rate their level of interaction with each participant. At endline, we asked them to indicate whether they intended to stay in touch with each of their fellow participants. Response rates for the surveys ranged from 45% to 78% (see Exhibit C2). Given the response rates, results should be interpreted with caution and cannot be generalized to each cohort's whole network.

Exhibit C2. Social Network Survey Response Rates

CLHE track	Baseline respondents	Endline respondents
2021 Cohort	61/93 (66%)	27/60 (45%)
Continuing Track	17/23 (74%)	18/23 (78%)

Note. CLHE = Community Leaders in Health Equity program.

Data Analysis

We entered survey responses into an Excel matrix whereby each row corresponded to responses that the respondents gave regarding each of the participants listed on the roster. We imported the social network data into Gephi,[1] a social network analysis software, to construct social network maps and calculate social network measures. In social network maps, individual participants are represented by

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[1] Bastian, M., Heymann, S., & Jacomy, M. (2009). Gephi: An open source software for exploring and manipulating networks. *International AAAI Conference on Weblogs and Social Media, 3*(1), 361−362.

Community Leaders in Health Equity Evaluation Final Report

circles, or *nodes*, and interactions between individuals are represented by lines, or *ties*, which connect the two nodes. In our maps, ties are undirected, meaning we considered two participants connected if at least one of them reported an interaction. We mapped three different networks for each cohort:

- First, we mapped ties prior to CLHE based on respondents' reporting of who they knew before joining CLHE.

- Second, we mapped ties at the end of CLHE based on respondents' reporting of their level of interaction with other participants at the time of the survey.

- Third, we mapped ties of planned interactions based on respondents' reporting of their intended future interactions beyond CLHE.

We also imported participants' demographic information provided to us by Transformative Alliances into Gephi, including preferred language(s). This allowed us to display the network data by linguistic and regional characteristics.

DATA ENTRY CONSIDERATIONS

Missing and/or conflicting responses were addressed as follows:

- When participants marked responses for people in their region but skipped responses for people outside it, the missing data (those rows left blank) were coded as "no interaction," "not known prior to CLHE," and "no intended future interaction."

- When participants marked responses for some people on the roster but not all, skipped individuals were coded as "not known prior to CLHE," "no interaction," and "no intended future interaction."

- When participants responded to at least one question for an individual but not all, the missing responses were coded as "not known prior to CLHE," "no interaction," and/or "no intended future interaction."

- When participants marked multiple options for the level of interaction with a single person, the response was coded as the lowest level of interaction indicated.

- Regarding ties, if one participant had missing data or was a nonrespondent, we used the data from the participant who responded to determine whether two participants were connected.

To characterize each network, we documented the total number of participants, total number of ties, how many ties each participant had with other participants (also known as their degree), the average number of ties per participant across language and regional groups, and range of ties.

To complement the maps, we also analyzed the responses to the social network survey in Stata, a general-purpose statistical software, to determine the portion of ties in each network that occurred within a region versus across regions and the portion that occurred within the same language group.
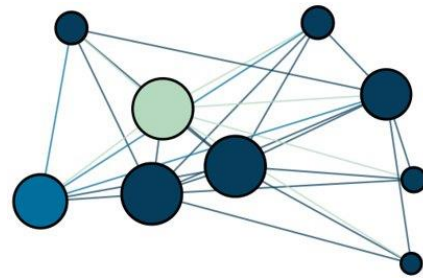
Additionally, we calculated the average degree of participants within each region and linguistic group and the portion of reported interactions that were rated as minimal, occasional, or frequent.

To construct the social network maps (see Exhibit C3 for an example), we used responses from the second administration of the survey. We constructed three maps for both the 2021 Cohort and the Continuing Track: one of ties prior to CLHE, one of ties at the end of CLHE, and one of ties based on intended future interactions. In the maps, nodes vary by size; larger nodes correspond to participants with a greater number of ties to other participants, while smaller nodes correspond to participants with fewer ties.

Exhibit C3. Example Social Network Map

Evaluation Advisory Group

Once the initial social network analysis was complete, a summary of 2021 Cohort findings was presented to 2021 Cohort participants who chose to participate in that cohort's evaluation advisory group (EAG). The evaluation team held a series of feedback sessions during which evaluation findings were presented to the EAG participants on a virtual call, and they were asked to reflect on whether the findings resonated with their experiences, whether they had additional interpretations of the analyses, and whether anything seemed inaccurate. The EAG was also asked about the data visualizations to ensure they were accessible to them and with whomever they may share the results. Thirteen 2021 Cohort participants formed the EAG, and each member received a $50 gift card for their participation. The evaluation team engaged the Continuing Track in a similar process to develop a series of report briefs but did not engage that EAG in a review of the full evaluation analysis, as too much time had passed since the Continuing Track programming was completed. The Continuing Track feedback from the EAG discussion that centered on the social network report brief is included here, and it mirrors what was discussed among the 2021 Cohort.

How to Interpret an SNA Map

Circles represent participants (nodes).

Lines represent connections (ties).

= Connected

= Not connected

Larger circles correspond to participants with a greater number of lines, or ties, leading to other participants.

= Node with many ties

= Node with few ties

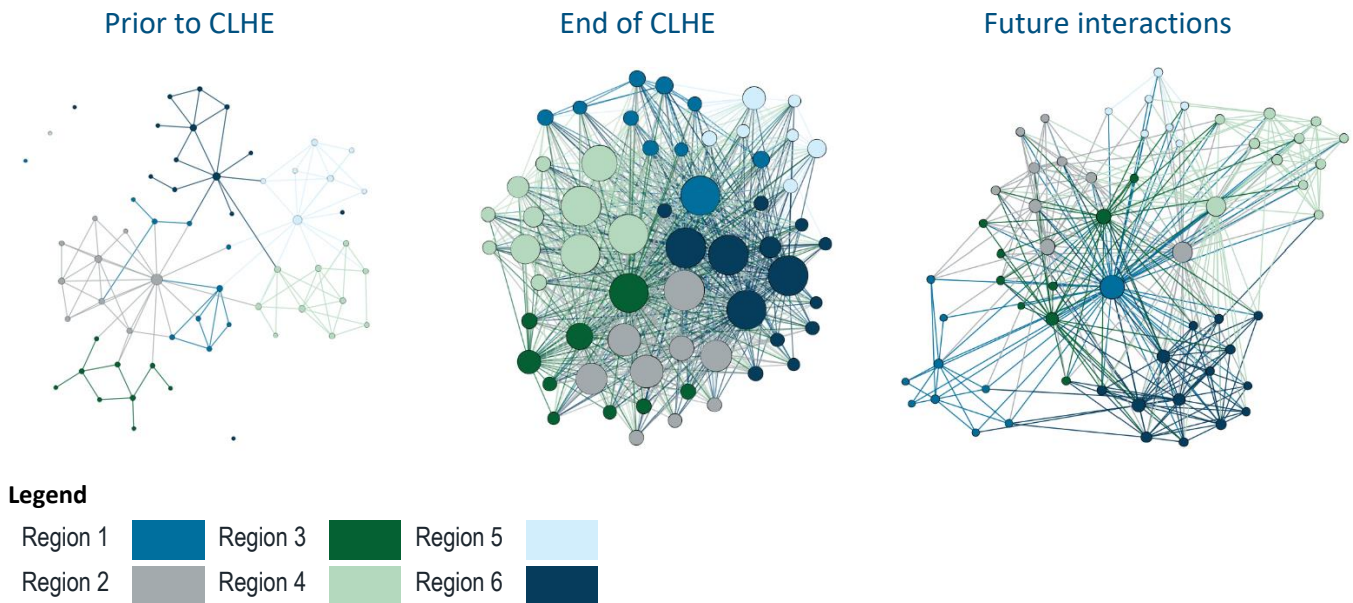Community Leaders in Health Equity Evaluation Final Report
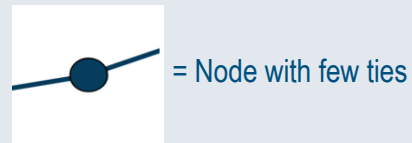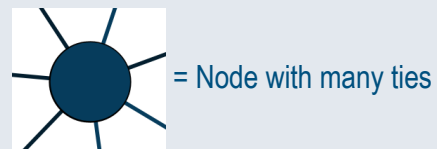
Analysis: 2021 Cohort

This section presents results for the 2021 Cohort, including a description of the maps and analysis of the interactions within and across language groups. In Exhibit C4, the color of the node corresponds to the participant's region, and in Exhibit C5, the color corresponds to their linguistic group. Because only two participants identified as monolingual Spanish speakers in this cohort, they were combined into a group with bilingual speakers to protect their anonymity.

Prior to CLHE, the network of participants was sparse with few ties between them. Overall, there were 112 ties among the 60 participants. On average, participants had 3.8 ties to other CLHE participants, and a little more than half (33 participants) had ties to between zero and three people. By the end of CLHE, the network grew to include 881 ties. All participants had at least 14 ties to other people, and 20 participants had more than 30 ties. At the end of CLHE, participants were asked about their intentions to continue collaborating with each other. This network of intended future interactions included 375 ties, or 43% of the number reported at the end of CLHE. On average, participants in this future network had 12.6 ties, and notably, all participants had at least three ties. Thus, while the network of intended future interactions had fewer ties than the network of interactions achieved by the end of CLHE, it had more ties than what was in place prior to CLHE.

Exhibit C4. 2021 Cohort Network Graphs by Region

Prior to CLHE   End of CLHE   Future interactions

Legend

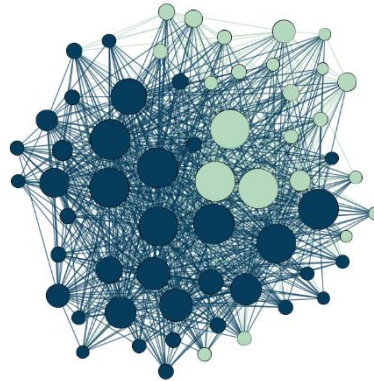|					
Region 1	■	Region 3	■	Region 5	■
Region 2	■	Region 4	■	Region 6	■

Note. CLHE = Community Leaders in Health Equity program. For a larger version of this graphic, click here.

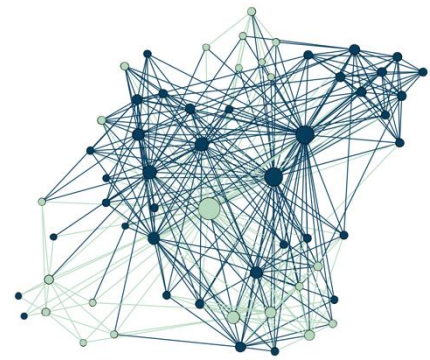## Exhibit C5. 2021 Cohort Network Graphs by Language Group

Prior to CLHE	End of CLHE	Future interactions

Legend

Monolingual English ▮   Monolingual Spanish and bilingual ▮

Note. CLHE = Community Leaders in Health Equity program. Monolingual Spanish and bilingual speakers were combined to preserve the anonymity of the two monolingual Spanish speakers in the 2021 cohort. For a larger version of this graphic, click here.

Interaction by Region

CLHE included participants from six regions in Colorado (see Exhibit C6 for the total number of participants per region). As shown in Exhibit C7, the average number of ties among participants in a particular region ranged from 2.4 to 6.1 prior to CLHE**.** Ties increased substantially within each region, and by the end of CLHE, the average number ranged from 19.9 to 37.6**.** Average ties in the intended future interactions network were lower than at the end of CLHE in all regions but higher than those prior to CLHE except in one region, ranging from 5.3 to 18.2.

Exhibit C6. Participants by Region

Region	Number of participants
Region 1	10 (17%)
Region 2	9 (15%)
Region 3	9 (15%)
Region 4	11 (18%)
Region 5	7 (12%)
Region 6	14 (23%)
Total	60 (100%)

Exhibit C7. Average Number of Ties per Participant in Each Region
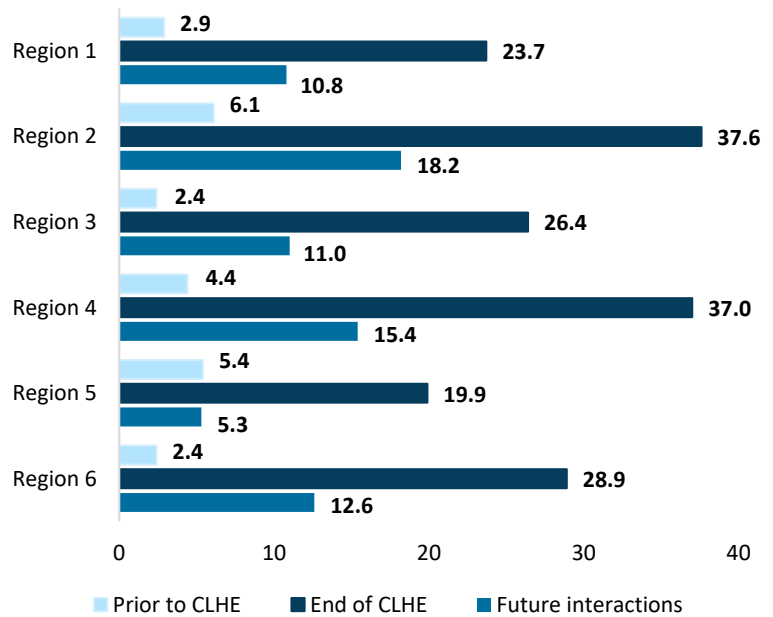
Region 1: Prior to CLHE 2.9, End of CLHE 23.7, Future interactions 10.8
Region 2: Prior to CLHE 6.1, End of CLHE 37.6, Future interactions 18.2
Region 3: Prior to CLHE 2.4, End of CLHE 26.4, Future interactions 11.0
Region 4: Prior to CLHE 4.4, End of CLHE 37.0, Future interactions 15.4
Region 5: Prior to CLHE 5.4, End of CLHE 19.9, Future interactions 5.3
Region 6: Prior to CLHE 2.4, End of CLHE 28.9, Future interactions 12.6

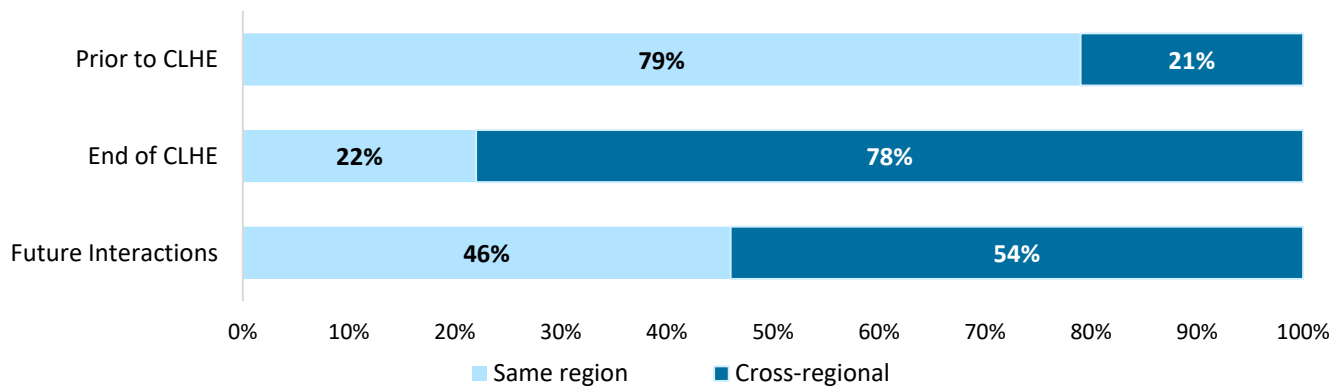■ Prior to CLHE   ■ End of CLHE   ■ Future interactions

Note. CLHE = Community Leaders in Health Equity program.

Interaction Across Regions

By the end of CLHE, interaction across regions increased substantially (see Exhibit C8), and a large portion of cross-regional ties were reflected in the network of intended future interactions. Prior to CLHE, only 21% of ties were between people from different regions; that is, there were 23 cross-regional ties and 89 same-region ties. By the end of CLHE, 78% of ties were between participants from different regions, meaning that 690 of the 881 ties were cross-regional, whereas 191 ties were within the same region. In the network of intended future interactions, 54% of the ties were between people from different regions, whereas there were 202 intended cross-regional ties and 173 same-region ties.

Exhibit C8. Percentage of Ties Within and Across Regions

Prior to CLHE: Same region 79%, Cross-regional 21%
End of CLHE: Same region 22%, Cross-regional 78%
Future Interactions: Same region 46%, Cross-regional 54%

■ Same region   ■ Cross-regional

Note. CLHE = Community Leaders in Health Equity.

Interaction by Language Group

CLHE was inclusive of both English and Spanish speakers. Thirty-eight participants identified as monolingual English speakers, two as monolingual Spanish speakers, and 20 as bilingual or with some ability to speak both languages. To protect the anonymity of the two monolingual Spanish speakers, we grouped them with bilingual speakers for our analysis.[2] The EAG understood and approved of this approach. As shown in Exhibit C9, the average number of ties among monolingual English and among monolingual Spanish and bilingual speakers was similar prior to CLHE (3.6 and 4, respectively). However, although the average number of ties increased for both groups by the end of CLHE, monolingual English speakers had a higher number than Spanish speakers. This difference also appeared in the network of intended future interactions.

**Exhibit C9. Average Number of Ties per Participant in Each Language Group**
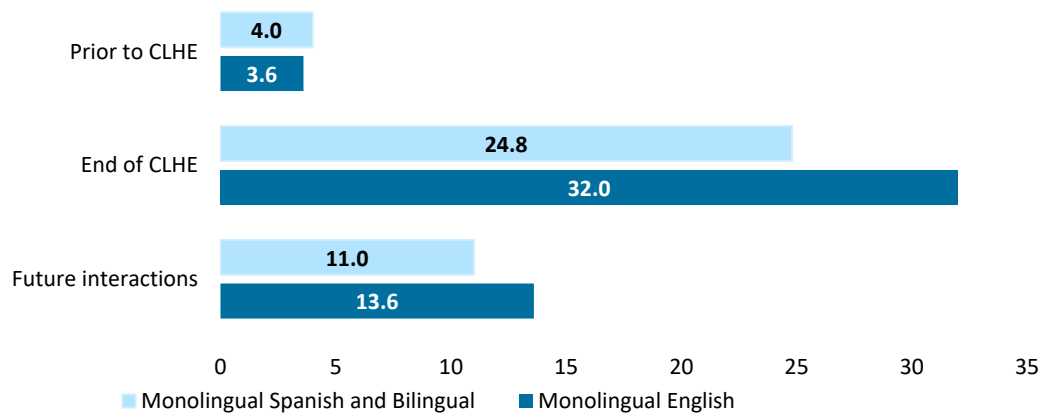
Note. CLHE = Community Leaders in Health Equity program.

Interaction Across Language Groups

By the end of CLHE, interaction across linguistic boundaries increased (see Exhibit C10), and much of these gains were preserved in the network of intended future interactions**.** Prior to CLHE, only 27% of ties were between people with different linguistic backgrounds; that is, 82 ties were between participants who spoke the same language and 30 were between participants who spoke different languages. This included ties between monolingual English speakers and monolingual Spanish or bilingual participants. By the end of CLHE, 40% of ties were among participants in different language groups, where 354 of the 881 ties were between those who spoke different languages, and 527 were between those who spoke the same language. In the network of intended future interactions, 36% of the ties were among people from different language groups, meaning there were 136 intended cross-language ties and 239 same language ties.

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[2] The term "bilingual speakers" refers to participants who identified as speaking both English and Spanish.

Exhibit C10. Percentage of Ties Within and Across Language Groups
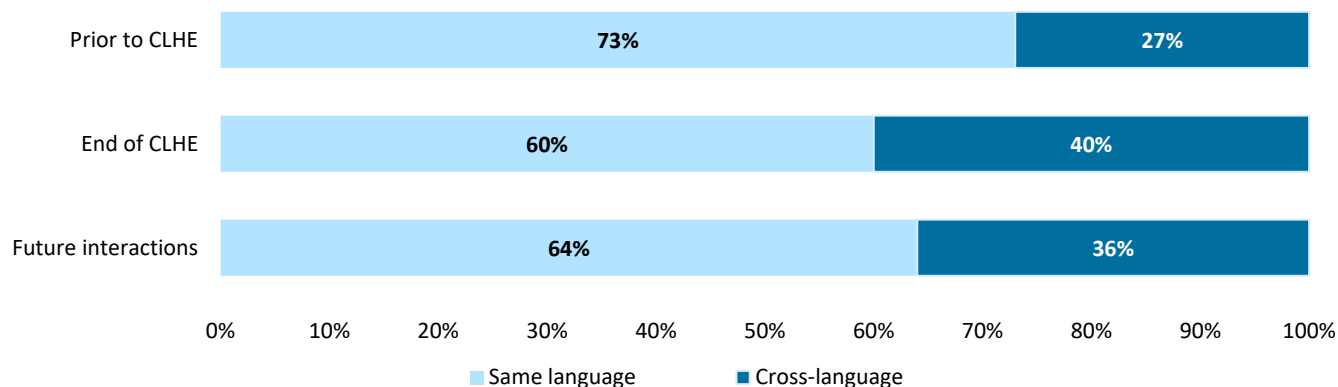
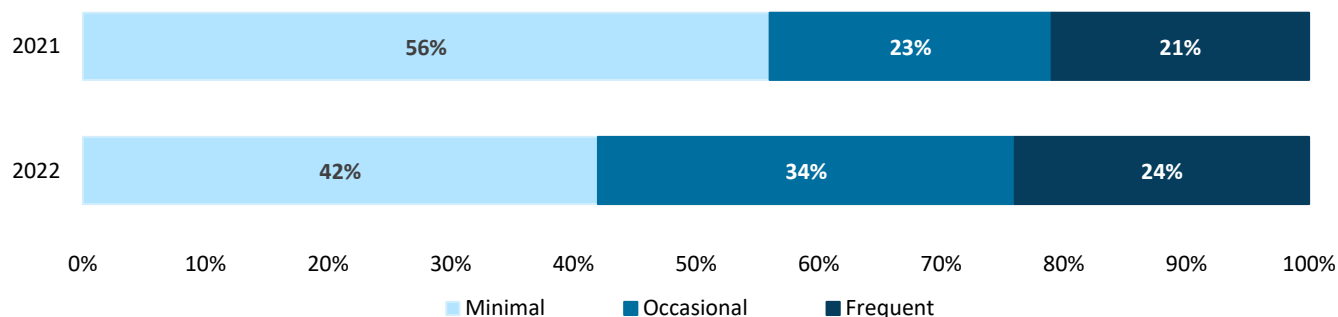|	Same language	Cross-language
Prior to CLHE	73%	27%
End of CLHE	60%	40%
Future interactions	64%	36%

Note. CLHE = Community Leaders in Health Equity program.

Changes in Level of Interaction

In addition to the formation of new ties, the level of interaction among participants increased during CLHE. In November 2021, we administered the first wave of the social network survey, and participants reported their level of interactions with other participants at the time. As shown in Exhibit C11, 56% of interactions were rated as minimal, while 44% were rated as occasional or frequent. When we administered the second wave of the survey at the end of CLHE in November 2022, 58% of interactions were rated as occasional or frequent. Through participation in the program, participants who responded to the survey confirmed they were engaging with each other more and thus forming a stronger CoP.

Exhibit C11. Level of Interaction Reported in 2021 and 2022

|	Minimal	Occasional	Frequent
2021	56%	23%	21%
2022	42%	34%	24%

Analysis: Continuing Track

This section contains the results for the Continuing Track, consisting of 23 participants, including the maps and further analyses of the levels of interaction within and across language groups. In Exhibit C12, we present the three maps for the Continuing Track, with the color indicating the participants'

language. Maps with participants' regions are not presented for the Continuing Track, as some regions had a very low number of participants, feedback from the evaluation advisory group sessions indicated that displaying the maps by region might have been too identifying and looking at the maps by language was more informative.

Prior to CLHE, the network of Continuing Track participants was sparse, with several isolated individuals and relatively few ties. As depicted in Exhibit C12, there were 23 ties among the 23 participants. On average, participants had ties to two other people in the network, and nearly one-third (seven participants) had no ties to anyone in the network. By the end of CLHE, the network grew to include 205 ties, and participants had an average of 17.8 ties (out of a possible 22). All participants had ties to at least 10 other people, and seven had ties with every other member of the Continuing Track. The network of intended future interactions included 145 ties, or 70% of the number of ties reported at the end of CLHE. On average, participants in this future network had 12.6 ties, and notably, all participants have at least four ties. Moreover, 15 participants (65%) had more than 10 ties. This suggests a majority of participants had an interest in maintaining their CLHE connections.

The Continuing Track included four monolingual Spanish speakers, five bilingual speakers, and 14 monolingual English speakers. Because there was a greater number and percentage of monolingual Spanish speakers in the Continuing Track network than in the 2021 Cohort, the results were disaggregated across three language groups. The results also focused on language groups rather than region because some regions only had one or two participants and because feedback from the EAG sessions suggested that analysis by language group was more relevant to participants' experience.

Exhibit C12. Continuing Track Network Graphs by Language Group
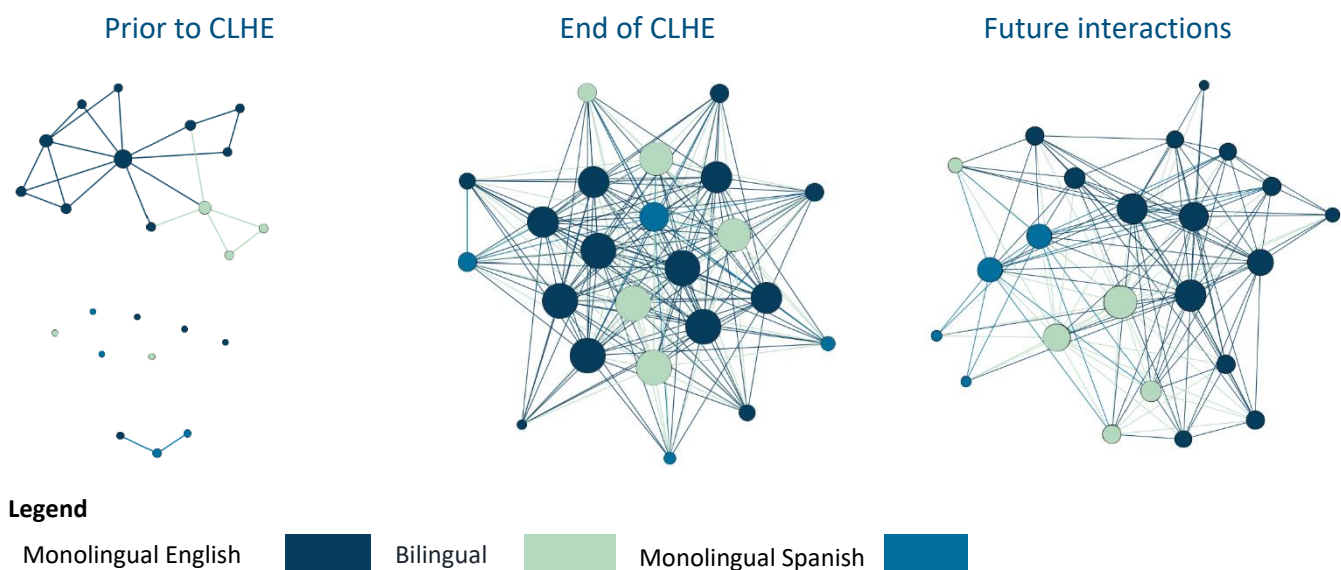
Prior to CLHE   End of CLHE   Future interactions

Legend

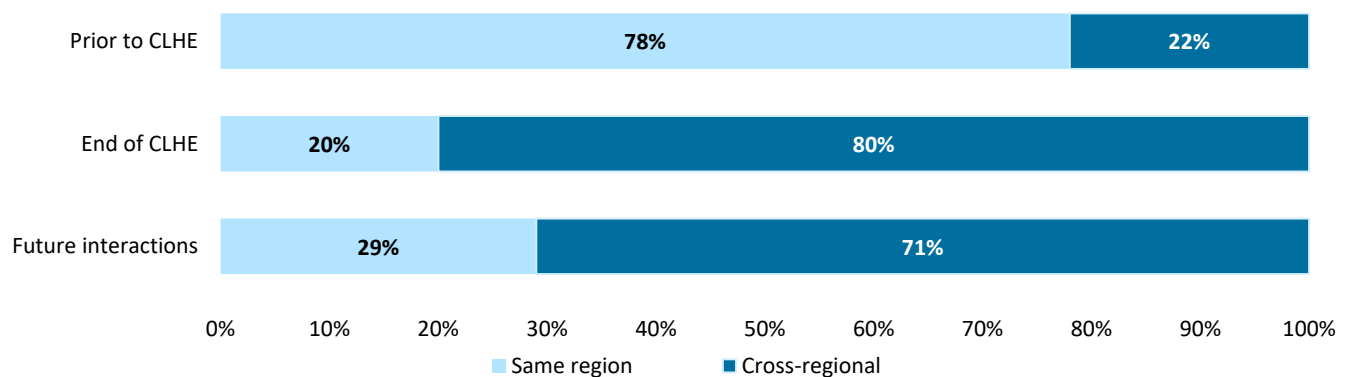Monolingual English ▪   Bilingual ▪   Monolingual Spanish ▪

Note. CLHE = Community Leaders in Health Equity program. For a larger version of this graphic, click here.

Interaction Across Regions

By the end of CLHE, interaction across regions increased substantially (see Exhibit C13), and a large portion of cross-regional ties were reflected in the network of intended future interactions. Prior to CLHE, only 22% of ties were between participants from different regions, meaning that five of the 23 ties were cross-regional and 18 were within the same region. By the end of CLHE, 80% of ties were across regions; in other words, 164 of the 205 ties were cross-regional, whereas 41 ties were within the same region. In the network of intended future interactions, more than two-thirds (71%) of ties were among people from different regions, so 103 ties are intended to occur across regions, and 42 ties are intended to occur within region.

Exhibit C13. Percentage of Ties Across Regions

Note. CLHE = Community Leaders in Health Equity program.

Interaction by Language Group

Within the Continuing Track, 14 participants identified as monolingual English speakers, four as monolingual Spanish speakers, and five as bilingual. As shown in Exhibit C14, the average number of ties among all linguistic groups was low prior to CLHE, but monolingual English speakers had an average of 2.4 ties compared to 1.8 among bilingual speakers and 0.8 among monolingual Spanish speakers. By the end of CLHE, the average number of ties noticeably increased across language groups, though monolingual Spanish speakers continued to have fewer ties on average than the other two groups, while bilingual speakers had the most. Specifically, monolingual Spanish speakers (four participants) had an average of 14.0 ties while monolingual English speakers (14 participants) had an average of 18.1 ties and bilingual speakers (five participants) had an average of 20.0. In the network of intended future interactions, the average number of ties was less than at the end of CLHE in each linguistic group, and monolingual Spanish speakers continued to have fewer average ties. However, the gap between monolingual Spanish speakers and the other two groups decreased.

## Exhibit C14. Average Number of Ties per Participant in Each Language Group
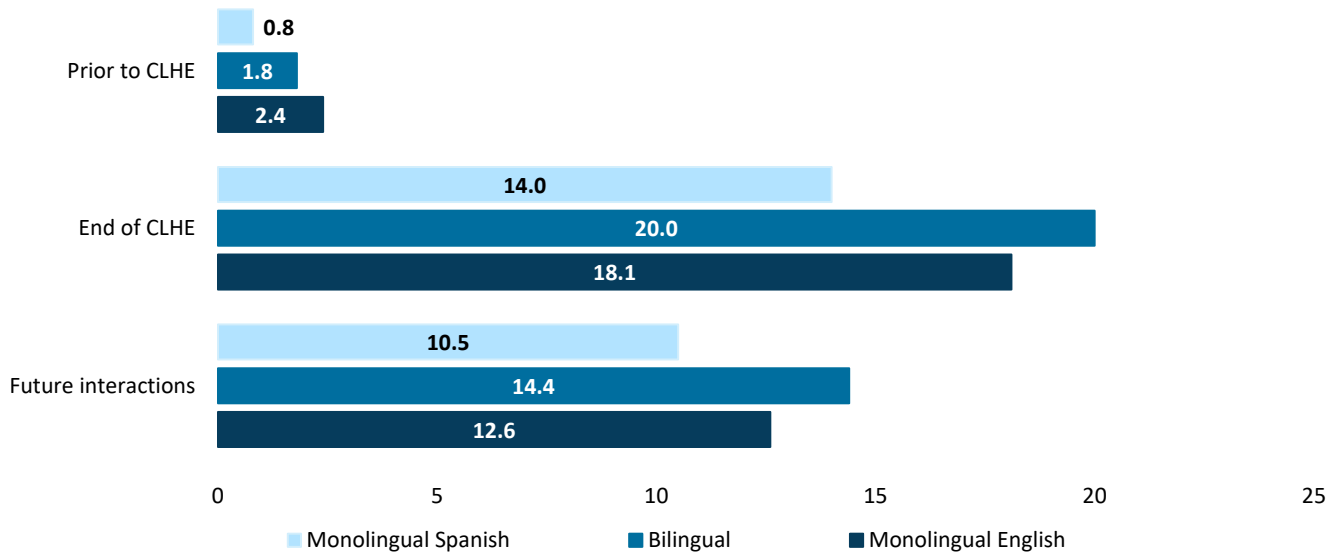
Note. CLHE = Community Leaders in Health Equity program.

Interaction Within and Across Language Groups

By the end of CLHE, interactions across linguistic boundaries increased (see Exhibit C15), and this trend was generally maintained in the network of intended future interactions. Prior to CLHE, only 22% of ties between participants were between people in different linguistic groups; that is, five of the 23 connections were across language groups, and 18 were within language groups. This included ties between monolingual Spanish and monolingual English speakers, monolingual Spanish and bilingual speakers, or monolingual English and bilingual speakers. By the end of CLHE, 55% of ties were among participants in different language groups, meaning that 113 of the 205 connections were between participants who spoke different languages from one another, and 92 connections were between participants who spoke the same language. In the network of intended future interactions, 51% of the ties were among people in different language groups, where 74 of the 145 intended future ties were among participants who spoke different languages, and 71 were among those who spoke the same language.

Community Leaders in Health Equity Evaluation Final Report

Exhibit C15. Percentage of Ties within and across Language Groups
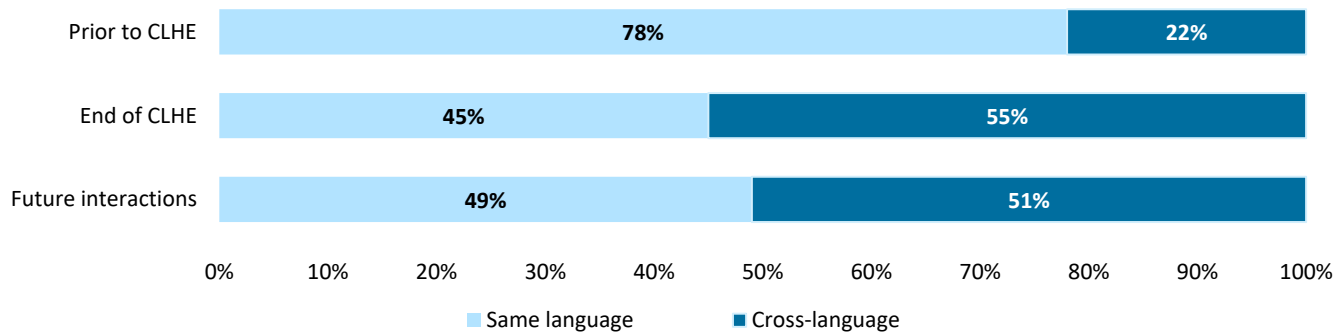
|	Same language	Cross-language
Prior to CLHE	78%	22%
End of CLHE	45%	55%
Future interactions	49%	51%

Note. CLHE = Community Leaders in Health Equity program.

Changes in Level of Interaction

In addition to the number of ties increasing, the reported level of interaction deepened among participants between the first administration of the social network survey in October 2021 and the second administration in May 2022. As shown in Exhibit C16, the percentage of interactions rated as minimal decreased from 47% to 19%. The percentage of interactions rated as frequent also correspondingly increased from 20% to 38%.

Exhibit C16. Level of Interaction Reported in 2021 and 2022

	Minimal	Occasional	Frequent
2021	47%	33%	20%
2022	19%	43%	38%
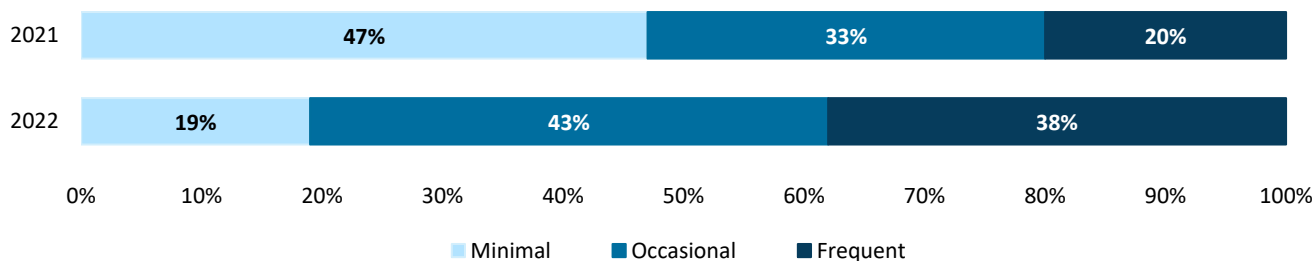
Discussion

EAG members reported that the results of the social network analysis largely aligned with their experiences, though responses might have been different, (e.g., ties likely higher), if participants' photos were placed next to their names on the rosters. The EAG confirmed that CLHE supported the creation of social connections through the convenings and program activities and that participants got to know more people and deepen relationships as the program progressed. The Continuing Track had fewer people which further facilitated the CoP acting as a safe space for participants to share, learn, and engage with one another. The logistical and financial support for attending activities was particularly crucial. EAG participants felt that most interactions occurred within their region but that CLHE's statewide focus allowed them to learn about other regions in Colorado and to interact with participants from other regions during the convenings. Participants also credited the translation

services and inclusive programming offered through CLHE with supporting interactions between monolingual English, monolingual Spanish, and bilingual speakers. Because the bilingual participants did not have language barriers, they could continue connecting during off-program times when interpretation services were not available. However, monolingual participants were observed by the EAG as trying to make cross-language connections during these times. Finally, though participants expressed a desire to stay in contact and collaborate with other participants, they were concerned that without the support of CLHE, connections would be hard to maintain.

Social network analysis was used in the CLHE evaluation to investigate and describe the ways that bilingual and multicultural CoP participants interacted throughout the program. In looking at the number of connections developed and the intensity of interactions over time across both geographic and language groups, we were able to conclude that highly interactive networks were established in each CLHE cohort. Below, we summarize our primary findings from this analysis.

CLHE promoted network development. During CLHE, there was a nearly eightfold increase in ties among the 2021 Cohort and a nearly ninefold increase in ties among the Continuing Track, suggesting that the initiative brought together previously disconnected individuals to form a CoP.

CLHE supported cross-regional interaction. The average number of ties among participants in each region in the 2021 Cohort varied but increased across all regions. The proportion of ties between participants from different regions versus the same region also increased substantially in both cohorts and was even more pronounced in the Continuing Track.

CLHE engaged diverse language groups in network development and supported cross-language interaction. During CLHE, the proportion of ties among participants from different linguistic groups increased, again more so in the Continuing Track. Ties also increased within each linguistic group by the end of CLHE.

However, greater integration of Spanish speakers would have strengthened network development. Average ties were lower among monolingual Spanish and bilingual speakers in the 2021 Cohort and among monolingual Spanish speakers in the Continuing Track.

CLHE has garnered interest from participants in continuing interactions. All participants were included in the maps of intended future interactions. Interest in future interactions was particularly evident in the Continuing Track, as the network of intended future interactions was 71% of the network in place at the end of CLHE.

Ties among participants will likely decrease after the program. The number of ties based on intended future interactions was lower than that achieved at the end of CLHE. This attrition was present in all regional and linguistic subgroups. Without continued support for meaningful interaction across regional and linguistic barriers, the social networks developed through CLHE will likely weaken over time.

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