

National Journal of Biological Sciences



Received: 18th February, 2026

Revised: 22nd April, 2026

Accepted: 29th May, 2026

Published: 29th June, 2026

DOI: <https://doi.org/10.37605/v7i1/1>

REVIEW ARTICLE

TITLE:

**IDENTIFICATION AND UNDERSTANDING OF NUTRITION
STAKEHOLDERS IN THE MULTISECTORAL GOVERNANCE FOR
CHILD AND MATERNAL NUTRITION DURING THE MDGs PERIOD – A
STAKEHOLDERS' NETWORK ANALYSIS OF KHYBER
PAKHTUNKHWA PROVINCE OF PAKISTAN**

Authors: Attaullah Jan^{1*}, Iftikhar alam², Rida Asif³, Amna ⁴, Shakeel Ahmad⁵

AFFILIATIONS

¹ National University of Medical Sciences (NUMS), Department of Nutrition & Dietetics, Islamabad; Bacha Khan University Charsadda, Department of Human Nutrition & Dietetics

² Bacha Khan University Charsadda, Department of Human Nutrition & Dietetics

³ Institute of Health Sciences Khyber Medical University Islamabad Campus

⁴ Women University Mardan, Department of Human Nutrition & Dietetics.

⁵ Hazar Univesity Manshehra KP

***Corresponding author:** Attaullah Jan

IDENTIFICATION AND UNDERSTANDING OF NUTRITION STAKEHOLDERS IN THE MULTISECTORAL GOVERNANCE FOR CHILD AND MATERNAL NUTRITION DURING THE MDGs PERIOD – A STAKEHOLDERS' NETWORK ANALYSIS OF KHYBER PAKHTUNKHWA PROVINCE OF PAKISTAN

Attaullah Jan^{1*}, Iftikhar alam², Rida Asif³, Amna ⁴, Shakeel Ahmad⁵

ABSTRACT

Background: Interest in multisectoral policies has increased, particularly in low-income and middle-income countries and efforts towards Sustainable Development Goals, with greater attention to understanding effective strategies for implementation and governance. This study had two objectives: 1) to identify the main stakeholders responsible for child and maternal nutrition during the MDGs period in Khyber Pakhtunkhwa (KP) province of Pakistan, and 2) to explore and map the composition and structure of the nutrition component of MDGs, identifying key actors engaged in nutrition policy implementation and their patterns of relationships at the provincial level in KP.

Methods: Stakeholder identification was conducted using the participatory NetMap tool. Social network analysis (SNA) was used to examine the structure of the actors' network relevant to child and maternal nutrition MDGs. The survey was administered to 108 respondents, producing three distinct network maps about interaction, information-seeking and decision-making patterns. The network measures of centrality, density, reciprocity and centralization were used to understand the network across the province.

Results: A total of 17 stakeholders were identified, including Provincial Government (P_Gov), Planning and Development Department (P&D), Ministry of Health (MoH), Board of Investment (BoI), Population Welfare Department (PWD), Agriculture Department (AgD), Ministry of Economic Affairs (MoE), Ministry of Science and Technology (MoST), Non-Governmental Organizations (NGOs), Media, Livestock, Charity Organizations, Elites, Parliament, Academia, and Political Parties. The network analysis results showed that members from MoH, P&D, NGOs, and Provincial Government were the most frequently consulted actors for interaction, information-seeking and decision-making, as they led provincial-level networks. The three networks as a whole displayed high centralization, with P&D and MoH exercising a central role with the highest in-degree centrality. The provincial network as a whole also exhibited greater density and reciprocity.

Conclusion: Collaboration and cooperation among sectors and departments are essential components of multisectoral policy. SNA provides a mechanism to uncover the nature of relationships and key actors in collaborative dynamics. It can be used as a visual learning tool for policy planners and

implementers to understand the structure of actual implementation and concentrate their efforts to improve and enhance collaboration.

Keywords: MDGs, nutrition, child nutrition, maternal nutrition, nutrition policy, stakeholders, Khyber Pakhtunkhwa

INTRODUCTION

Malnutrition is a common public health issue widespread in Pakistan (Asim and Nawaz, 2018). Despite national efforts across all health sectors, child and maternal nutrition still remains the main obstacle in achieving health targets established by international organizations (Asim and Nawaz, 2018). Over the last few decades, emerging socio-economic trends such as rapid population growth and economic shocks have negatively affected Pakistan's development potential, which in turn have led to stagnation in food security and nutrition trends, with Pakistan identified as one of 36 countries that account for 90% of the global burden of malnutrition (Bhutta et al., 2013).

There have been both challenges and opportunities in nutrition confronting Pakistan (Rizvi et al., 2015). In terms of opportunities, the MDGs era (2000-2015) was an excellent prospect for framing national nutrition policy in Pakistan (Rizvi et al., 2015; Bhutta et al., 2013). However, due to prevailing national and regional political situations, this opportunity was not fully exploited (Bhutta et al., 2013). Many researchers reported that Pakistan performed poorly on child and maternal nutrition during the MDGs era, despite the fact that it was a period of internationally driven collaboration directed at eradicating child and maternal malnutrition. The Government launched the

national maternal, neonatal and child health programs in 2007 to promote access to evidence-based cost-effective interventions; strengthen district health system capacities; empower communities; expand the community midwives' cadre; and promote utilization of essential services (Shadoul et al., 2010). Pakistan's national MDG report of 2004 charted a roadmap for enhancing maternal and child survival by placing greater emphasis on reducing maternal and neonatal mortality through a number of strategies, also including balanced diet and other related efforts for healthy nutrition. Factors that contributed to poor performance in Pakistan include gaps in legislation (Manzoor et al., 2016), low pace of women's empowerment (Shafiq et al., 2019), and nutrition-specific but not nutrition-sensitive approaches (Khan and Khalid, 2015). One of the global movements to address malnutrition in developing and underdeveloped countries is the "Scaling Up Nutrition" (SUN) movement, and Pakistan became a signatory in 2013, recognizing the extremely high figures of stunting and wasting (NNS 2011). The main purpose of the movement is to address malnutrition with global and national political commitment to adopt multisectoral approaches and policies from various sectors like business networks, academia and research networks, and civil society alliances. Through global advocacy movements, with the efforts of the World Health Organization and recommendations from the Lancet Series, Pakistan has realized the need for investing in nutrition of the nation with focus on children under 5 years, and integrated and standalone Planning Commission Documents (PC1) have been developed in all

provinces including Azad Jammu and Kashmir (AJK) and Gilgit-Baltistan (GB). The purpose of these PC1s is to integrate nutrition programming with health sectors of the provinces and provide life-saving nutrition-specific services and promote preventive measures to avoid malnutrition in the communities. Similarly, for the purpose of multisectoral approaches, the SUN secretariat has been established at the federal level within the Planning Commission of Pakistan, and under the SUN secretariat, other networks like business networks, civil society alliances, and Academia and Research networks are also in the process of establishment. The same process will be translated to provincial levels, and the process has been initiated under the leadership of the SUN secretariat. Malnutrition in Pakistan is a key concern, and provincial governments of AJK, Balochistan, GB, Khyber Pakhtunkhwa (KP), Punjab, and Sindh, under federal leadership, have started investing in malnutrition, and civil society organizations are piloting small-scale projects to provide life-saving nutrition-specific and nutrition-sensitive interventions for immediate assistance in flood-affected areas. For any successful national planning and implementation program, engagement of all related stakeholders is of great importance (Uddin et al., 2017; Klemm et al., 2022). Srivastava et al. (2016) reported that linkage between the public health system and NGOs, marked by frequent interaction and some reciprocity in information and resource flows, but weak participation in policy and planning, can be described as 'complementarity', entailing information and resource sharing but not joint action. Stronger

linkage is required for sustained and systematic collaboration, with joint planning, implementation and evaluation.

The nutrition landscape of any country is a complex network of diverse actors across different government departments, civil society institutions, development and research organizations, donors and associations (Acosta et al., 2012). In order to understand such landscapes, a stakeholder network analysis, which includes stakeholder identification, is essential. There is clearly a vigorous exchange of information related to research and advocacy, leading to a very complex nutrition landscape in a state under investigation. Some organizations may appear to be at the core of research and advocacy flow, but the presence of several other stakeholders in the network makes it a complicated setting to function in. While several government departments appear in the network, some may have low relative influence or have fewer links connecting them to the overall network. Even though the influence levels of stakeholders on the nutrition landscape may greatly vary, stakeholders supportive of nutrition programs must be explicitly identified.

There is a clear need to learn lessons from the experience of success or failure of the MDGs era. Retrospective analysis of past programs for future planning is not an unusual practice (Huang et al., 2020; Yang et al., 2020; Qiao et al., 2021; McGlashan et al., 2018). Such retrospective analysis is useful for effective planning of current or future nutrition programs. In the context of a renewed global commitment to end undernutrition, embodied by the Scaling Up Nutrition (SUN) movement, this report offers an array of

analytical tools, new knowledge and policy recommendations to understand how governance works to improve nutrition outcomes. The existing technical and scientific evidence is relatively clear to show 'what works' for reducing undernutrition. The challenge is ensuring these interventions are delivered through governance systems that make them cost-effective and sustainable. The six country case studies that accompany this comparison study provide detailed insights into how governance around nutrition issues within these high-burden countries has unfolded and where decisions have paid off. The analysis examines where there is a need for rethinking political motivations for intersectoral cooperation, how to make effective use of structures for effective service delivery, or how to minimize the fragmentation of funding sources. Nutrition is the bedrock of human development. It is a core indicator of progress on the MDGs, and will likely remain central with the new Sustainable Development Goals to be announced at Rio+20. While we acknowledge there is no single blueprint to achieve this solid foundation, the six countries highlighted in this report help us to identify the stakeholders, the mechanisms and the key entry points to inform ongoing work on priority countries and to support the political momentum generated by the Scaling Up Nutrition global movement. We hope the lessons shared here can thus help leverage nutrition status for a wider set of development goals towards and beyond 2015.

Based on reports and research articles published during and after the MDGs era (Asim and Nawaz, 2018; Rizvi et al., 2015;

Bhutta et al., 2013), we hypothesized that no comprehensive study has been conducted to identify the stakeholders that were responsible for child and maternal nutrition in the MDGs era. Therefore, this research question—"who were the child and maternal nutrition stakeholders during the MDGs era in Pakistan?"—remains unanswered. In addition, answers to other related questions ("what were the responsibilities, powers and approaches of different child and maternal nutrition stakeholders during the MDGs era in Pakistan?") are also important for successful conclusion of the unfinished agenda of child and maternal nutrition left over from MDGs to SDGs.

To answer these questions, stakeholder analysis is a systematic methodology usually employed. We know that multisectoral collaborations are essential in efforts to solve 'wicked' policy issues, as the solution lies beyond the remit and resources of a single sector. Effective multisectoral collaborations rely, in part, on efficient governance and implementation mechanisms. It is now well recognized that carrying out a detailed, accurate stakeholder analysis is a critical component in efforts to mount successful and sustainable intervention programs. Such analysis will identify potential synergies and obstacles from different stakeholder group perspectives, identify opportunities and potential threats of alternative intervention actions, and mechanisms to gain stakeholder interest and support. The objective of the stakeholder analysis study is to capture a snapshot of the stakeholders and develop an understanding of how they interact with each other to achieve nutrition outcomes. The results of the analysis are meant to inform

which stakeholders were engaged and how they could have facilitated interaction between these stakeholders in Pakistan during the MDGs era. In order to develop such an understanding and enable strengthening of the stakeholder network of nutrition policies in Pakistan, there is a dire need to conduct stakeholder identification and their network analysis—a method that has been used for stakeholder network analyses. The results of the analysis are meant to assist in efforts towards understanding who were, or could be, influential in tackling undernutrition in Pakistan. This study provides a map of implementation structures, identifying key actors and relationships among them.

What do the new findings imply? The mapping of key actors and their connectedness offers a better understanding of implementation structure and the interaction patterns that have implications for governance practices. The identification of key actors (leaders and brokers) and their role in these structures can provide valuable insights on how to best deliver and monitor interventions. Social network analysis can be a useful tool to analyze the structure of implementation and help improve intervention in multisectoral settings.

METHODOLOGY

The Case: The Millennium Development Goals (MDGs-2000-2015)

In September 2000, the United Nations General Assembly adopted a number of resolutions aimed at alleviating poverty and promoting equitable and sustainable development in developing countries. One of

these resolutions identified eight areas for concrete action with measurable results to be achieved by the year 2015. All 189 member-states of the United Nations endorsed these Millennium Development Goals (MDGs) and vowed to make concerted efforts in achieving them. In subsequent summit-level meetings in Monterrey, Mexico (2001), Doha, Qatar (2002), and Kananaskis, Canada (2002), the Development Assistance Committee (DAC) of the industrialized world adopted a number of complementary measures to help developing countries achieve the MDGs. Increasing development assistance, gradual untying of aid, and providing greater access for developing country goods to the markets of the industrialized world constitute some of these complementary measures.

Three of the eight MDGs are explicitly health-related—Goal 4 (reduce under-5 child mortality), Goal 5 (improve maternal health), and Goal 6 (combat HIV/AIDS, malaria, and other diseases). Goals 4 and 5 call for the reduction of under-five child mortality rate by two-thirds and the maternal mortality ratio by three-quarters within the next fifteen years (taking 1990 as the base year). Similarly, by 2015, the goal (6) is to "halt and begin to reverse the spread of HIV/AIDS and the incidence of malaria and other major diseases." Another three Millennium Development Goals are intricately related to health—eradication of extreme poverty and hunger (Goal 1), achieving universal primary education (Goal 2), and promoting gender equality and empowerment of women (Goal 3). The relevance and importance of these three goals in achieving the directly health-related ones can hardly be overemphasized.

Since their adoption, the MDGs have received wide endorsement from civil society organizations in both developed and developing countries. Various development agencies expressed their commitment to work with developing countries in achieving the MDGs. Following the Johannesburg World Summit for Sustainable Development (WSSD) in September 2002, the United Nations has urged member states to redouble their efforts to achieve the MDGs. It has been stressed that "meeting these goals is feasible but far from automatic. Indeed, on our current trajectory, those goals will not be met for a significant proportion of the world's poor. Success in achieving the MDGs will require a seriousness of purpose, a political resolve and an adequate flow of resources from high-income to low-income countries on a sustained and well-targeted basis."

For Pakistan, two health-related Millennium Development Goals—4 and 5—have been of particular relevance. One calls for the reduction by two-thirds the under-5 mortality rate, while the other demands a reduction of the maternal mortality ratio by three-quarters by the year 2015. Goal 6 is also relevant insofar as malaria and other major communicable diseases (such as tuberculosis) are concerned. The base-year for these targets is 1990. In other words, countries are committed to reduce their under-5 mortality rate by two-thirds and their maternal mortality ratio by three-quarters between 1990 and 2015—a span of twenty-five years.

Study Design

This survey developed in the study was part of a more extensive mixed methods research project conducted in the Khyber

Pakhtunkhwa province of Pakistan. Data were collected from subjects mainly in Peshawar, the capital of KP province, selected based on their involvement in MDGs-related nutrition activities.

Stakeholder Identification

The literature describes a number of approaches for stakeholder identification and subsequent classification and analysis; however, this study adopted a top-down or analytical categorization approach and Mitchell et al.'s (1997) stakeholder classification system. The top-down or analytical categorization approach was adopted because it was not within the scope of this study to involve a large number of stakeholders, which is one of the preconditions in a bottom-up or reconstructive approach. In the present study, our interest was to firstly identify the stakeholders who were the main actors for child and maternal nutrition during the MDGs era. We were interested in stakeholders who were responsible for all nutrition-related activities—at planning, financing, implementation, and monitoring levels—during the MDGs era (2000-2015). The target population for the study included policy makers and their groups, relevant national and provincial government officials, other technical service producers, and non-governmental organizations. Data was collected through a participatory tool known as NetMap, which was developed by the International Food Policy Research Institute (IFPRI) for examining actors and their roles, linkages, influences and goals. The NetMap tool was chosen for this study as it is an interview-based mapping approach that lets people understand, visualize, discuss and

improve conditions in which various different players with diverse influence levels have the ability to influence outcomes (Puri et al., 2017). Representatives of various stakeholders in the Nutrition MDGs landscape were identified and engaged in identifying and mapping actors and institutions involved in 'child and maternal nutrition', their roles, influence in decision making, and interactions regarding flow and provision of training and technical information on child and maternal nutrition, as well as funding and lines of authority. Data was collected in the form of group interviews guided by these four questions: (i) which stakeholders are involved in child and maternal nutrition in the KP province of Pakistan? (ii) What roles do they play in child and maternal nutrition practices? (iii) How do they interact? (iv) How do they influence decision making in relation to these practices? A list of potential participants, groups of people or organizations presumed to be knowledgeable or experienced in child and maternal nutrition was developed.

The research team contacted those identified as knowledgeable, and a list of potential participants for group discussion was developed through snowballing. The final list of 49 potential participants was reviewed to ensure that participants were representatives of all important sectors. These identified participants were contacted through email or telephone call and officially invited for the stakeholder mapping workshops. An actor who had an effect on allocation of resources was defined as "an actor influential in 'shaping' decisions," and this was related to the lines of authority. Flow of information and linkages were defined as a formal

exchange of technical support (training, technical guides, equipment, information, research evidence, routine data or field experience/case studies). Review of literature was done to gather information on child and maternal nutrition practices in Pakistan during the MDGs era. These were obtained from published peer-reviewed papers, research and development reports, donor reports about various aspects of child and maternal nutrition in Pakistan, institutional reports (research and development, including NGOs), academic theses, government (national and provincial) reports, web-based data sources, and national census publications, among others.

Firstly, discussion was held with the groups regarding the stakeholders that may influence the child and maternal nutrition landscape. Subsequently, a list of likely actors was developed and placed into a blank NetMap sheet. Then, discussion was held about what roles each of these stakeholders had played in the child and maternal nutrition chain, how they interact with each other in relation to provision of training and flow of technical information, funding and lines of authority, including direction of interaction (who to whom). A blank NetMap sheet was used to draw the interaction and direction using different colours for flow of information, funding and lines of authority. Next was to visualize the level of influence of each stakeholder against another, which was done through pairwise analysis where each stakeholder was compared to each other by asking who is more important than the other in relation to research and training, market and input information, as well as provision of funding as key important aspects of child and

maternal nutrition. Key challenges of group interview as data collection methodology include making sense of massive amounts of data, reducing the volume to valuable information, identifying significant patterns and constructing a framework to communicate the essence of what the data reveals. Certain biases arose throughout the process including consistency, error and reference biases. Such biases were avoided by devising the interview guide neutrally with clear definitions of terminologies used to address the research questions. Sampling bias was addressed by including respondents from all segments of stakeholders including researchers, development partners, and government bodies.

A workshop ('Stakeholders and the MDGs Period') was held in March 2022. The main objective of the workshop was to elaborate on the nutrition policy status in Pakistan. The proceedings of the workshop have been published elsewhere. The experts given in Table 1 were invited to attend the workshop. A brief presentation was given by one of the co-authors (IA) elaborating on the MDGs era in general and child and maternal nutrition in particular. The presentation elicited discussion that was used for further elaboration on stakeholder identification. After the presentation, an open discussion was initiated encouraging the attendees to elaborate on the MDGs era with regard to child and maternal nutrition. The attendees of the workshop were asked to identify departments, sections, organizations and units as well as individual stakeholders. A questionnaire was distributed asking about various attributes of the stakeholders. These experts were asked to identify various

stakeholders with details on their designations and departments, who were the main players of nutrition activities during the MDGs era. "In your opinion, who were stakeholders of child and maternal nutrition during the MDGs era?"

Instrument and Data Collection

The second step was to define the relationships between actors using a survey instrument, which included both socio demographic information and network information. For this purpose, different stakeholders identified in the workshop were contacted through email, phone and in person, and a simple list of stakeholders identified in the workshop by the experts was shared with them. They were asked to make suggestions for other actors who had a stake in child and maternal nutrition during the MDGs era. In this way, applying the snowball method, the stakeholder list was continuously extended by new stakeholders. The process was repeated until a comprehensive list of stakeholders was identified and no new stakeholder was added. After a preliminary discussion and identification process as mentioned above, a list of the potential stakeholders was prepared and presented to these experts for further ranking. The experts were asked the next question: "In the given list of stakeholders, please rank the stakeholders according to their importance for child and maternal nutrition during the MDGs era." The questionnaire also provided separate space for any additional comments.

The survey covered demographic and socioeconomic information for each respondent, including age, sex, highest academic degree, organization, years in the

organization, administrative position, and years in position and association with MDGs. Second, for the network information, the survey instrument required the interviewees to identify the individuals from the actor list whom they interact with (for program sensitization), and who they go to for information (implementation assistance) and decision-making support (programmatic or financial approvals). The tool was piloted with respondents from three different departments, and the survey tool was adjusted accordingly to capture the different engaged departments in the child and maternal nutrition program. The three specific network interests (program sensitization, information-seeking and decision-making) evolved during the tool piloting, as they were defined as three broad categories of interaction defined by the implementers. Interaction relates to general sensitization about the program, whereas information-seeking and decision-making denote specific purpose or reason behind the interactions with respect to the child and maternal nutrition program.

The survey was administered to all the actors across different departments, including the departmental heads with higher administrative ranks. In order to increase the response rate and minimize missing data, we administered the survey ourselves in person. The actor list was presented to each participant, and they were asked to identify individuals with whom they interacted one-to-one, via face-to-face or telephonic conversation, while working on the MDGs. The participants could also name other actors not on the list but with whom they had

discussed the implementation of child and maternal nutrition MDGs.

Data Analysis

Data was analyzed using different approaches according to the objectives of the study. Data was triangulated and collated by cross-referencing both qualitative and quantitative data. Quantitative data was entered into Excel for analysis. NetMaps were subjected to quantitative analysis using Organizational Risk Analysis (ORA) in Social Network Analysis (SNA) to map, as well as measure relationships and influences of stakeholders and examine relative positions. The ORA tool was used to develop the map of stakeholders and direction of their influences.

In this study, we employed social network analysis (SNA) to explore stakeholders' relationships and importance. The respondents were asked to list other related organizations or actors they interacted with, and to rate the level of interaction with the actors they had listed. The score from 1-5 of the ties indicates their relationships between individuals, groups, and institutions. A higher value would indicate that a node has a closer relationship with other nodes. It is not practical and usually not necessary to engage with all stakeholder groups with the same level of intensity all the time. Therefore, calculating stakeholders' weights according to their relevance could promote stakeholder engagement. In social network analysis (SNA), the concept of centrality indicates the central position of the individual who has higher power, status and popularity. The centrality of a point can be determined by reference to three different structural attributes: 'degree', 'betweenness' and

'closeness'. Degree centrality measures only the number of nodes that are directly connected to others without considering indirect connection between nodes. Likewise, 'betweenness' centrality only measures the degree of 'intermediary' effect. 'Closeness centrality', which refers to the distance between nodes, primarily represents the capacity of stakeholders to access resources, information and methods within the network (Freeman 1978). Sabidussi (1966) defined the most central point in a network as the one with the minimum cost or time for communicating with all other points. Therefore, this paper uses the concept of closeness centrality to rank stakeholder importance and the weight of them. The absolute value is the sum of the shortest distance between one node and the other nodes in the diagram over the network size minus one (Sun et al. 2015).

Once the list of stakeholders was identified, further investigations were carried out to better understand characteristics and perspectives of these stakeholders. Stakeholder Analysis or Stakeholder Mapping has evolved in recent years as a technique for analyzing the likely interests and actions of stakeholders (Johnson et al. 2008). The method of stakeholder mapping was applied in this study as a visual analysis for investigating stakeholders' perspectives and characteristics related to Pakistan

nutrition in the perspective of MDGs. The network analysis was performed using the ORA software, which calculated standard social network metrics including in-degree, out-degree, weighted degree, betweenness centrality, authority, hub, PageRank, and eigenvector centrality. These metrics are standard outputs for stakeholder network analysis and are appropriate for examining the structure and flow of interactions, information, and decision-making among stakeholders.

RESULTS

Expert Panel for Stakeholder Identification

As a first step for identification of stakeholders, we needed experts in the field of nutrition who could help in identifying and later on help in the analysis of nutrition stakeholders in the MDGs era. For this purpose, an initial list of nutrition experts and practitioners was developed using five criteria: (a) an individual working in community or clinical nutrition; (b) at least a master's degree in nutrition, food sciences, public health and nutrition or related fields; (c) work experience of >10 years; (d) attendees of the NEAT 'Stakeholders and the MDGs Period' workshop series; and (e) affiliation to national professional nutrition networks. The details of these nutrition experts (n=49) are provided in Table 1

Table 1: Experts' Categories and Designations

Categories	Designation
Academic (n=22)	Professor/Associate Professor
International Organizations (n=14)	Managers/Community Workers
Government Officials (n=8)	Secretaries/Deputy Secretaries
Researchers (n=2)	PI/Co-PI

Identification and Ranking of Stakeholders – NetMap of Stakeholders

In an effort to ascertain who were the stakeholders for child and maternal nutrition during the MDGs era, respondents were offered a list of stakeholders and asked to indicate their level of agreement based on Freeman's definition of a stakeholder, which is "any group or individual who can affect or is affected by the achievement of the organization's objectives" (2010, p.46). The responses are recorded by category with number of selections made (Table 2). The average Likert score is calculated in the right-hand column and colour coded to correspond

with where the score places them on the 5-point Likert scale.

The representative stakeholders in Pakistan included departments from government, academia and research, and NGOs. Stakeholders were grouped into four main categories: (1) Government: Provincial Government (P_Gov), Planning and Development Department (P&D), Ministry of Health (MoH), Board of Investment (BoI), Population Welfare Department (PWD), Agriculture Department (AgD), Ministry of Economic Affairs (MoE), Ministry of Science and Technology (MoST); (2) Non-Governmental Organizations (NGOs); (3) Media; (4) Livestock; (5) Charity Organizations; (6) Elites; (7) Parliament; (8) Political Parties; and (9) Academia.

Table 2: Responses to the Question of 'Who is a Stakeholder?'

Stakeholder	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Average Likert Score
P_Gov	45	3	1	0	0	4.9
MoH	36	12	0	0	0	4.7
BoI	33	12	2	1	0	4.6
P&D	19	19	5	1	2	4.1
PWD	13	14	13	3	4	3.5
AgD	16	19	6	4	2	3.9
MoE	12	19	7	6	3	3.6
NGOs	30	10	2	6	1	4.3
Acad	21	14	3	4	5	3.9
MoST	11	26	4	5	2	3.8
Med	13	18	6	8	3	3.6
Livestock	10	6	30	2	1	3.45
Charity	10	5	29	2	3	3.35

Stakeholder	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Average Likert Score
Elites	12	7	23	3	4	3.41
Parliament	43	5	1	0	0	4.86
Political Parties	22	10	10	4	3	3.90

Stakeholders' Network Analysis

Once the list of stakeholders was identified, further investigations were carried out to better understand their characteristics and perspectives. For this purpose, a total of 302 questionnaires were sent out and 139 were returned, of which 108 were valid. This represents a response rate of 46% (139/302) for returned questionnaires and 36% (108/302) for valid responses, which is within the typical range for a self-administered mail survey (Bhattacharjee 2012). Furthermore, in similar studies where expert opinions were surveyed through questionnaires, a small number of responses were also used: Bragagnolo et al. (2012) surveyed a total of 12 experts; Polido et al. (2016) collected 16 filled questionnaires; and Peterson (2004) obtained 26 responses.

Provincial-level General Interaction for Nutrition

"With whom did you have interaction for the general purposes regarding

nutrition in the province?" This question was asked from stakeholders. Respondents were also encouraged to list other actors who have a stake in maternal and child nutrition (e.g., authorities, companies, groups, organizations) they had contact with, and their level of interaction with them. Respondents introduced a wide range of actors and acknowledged interaction with them (Figure 1). Most stakeholders have extensive relationships with others as shown by the thickness of the lines (edges) connecting them. The interactions were concentrated with P&D and MoH. P&D is central in the network of information and contact exchange, with close ties to all other stakeholder groups of government, academia, enterprise and NGOs. MoH is also central given its strong ties to other groups and P&D. It acts as health services provider and monitor in the process of health and nutritional care in Pakistan. As shown in Figure 1, the thickness of the line shows the density of the relationship between the stakeholders; the

blue lines show the positive relationship between the stakeholders, and the red lines

show the negative relationship between the stakeholders.

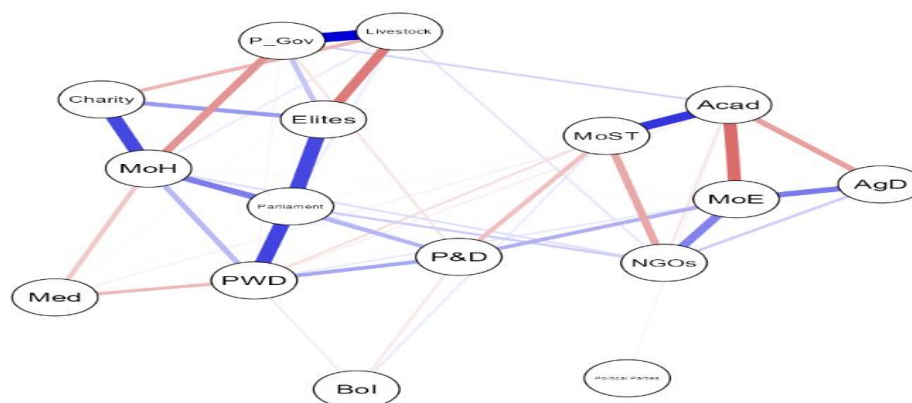


Figure 1: Network of Stakeholders

(Figure 1: Gaussian graphical model showing stakeholder relationships, with nodes representing stakeholders and edges representing connections)

"Blue edges indicate positive relationships, red edges indicate negative relationships; edge thickness reflects relationship strength."

The graph shown in Figure 1 consists of nodes (vertices) and edges (arcs, connections) connecting the nodes. The results of the analysis show that there are more connections between the variables indicating positive relationships. As can be seen in Figure 1, the total number of connections between the variables is 95. The maximum number of connections for this network is 171. Accordingly, the degree of sparsity is 0.44. This value indicates a low degree of sparsity and shows that there is a high level of density in the network. For a network with 16 nodes, this sparsity rate is

sufficient. Based on this finding regarding the general structure of the network, it can be said that there is a relationship between the variables and that the variables interact with each other. In the study, four types of measures were used to determine the centrality levels of the stakeholders. They were degree, closeness, betweenness, and expected influence centrality measures. Table 3 presents the network metrics for examining stakeholders' relationships and importance within the scope of the study. Based on the findings given in Table 3, the general structure of the network shows that there exists a relationship among various stakeholders. In addition, the stakeholders interacted with each other. Four measures were used to determine the centrality levels of the stakeholders: degree centrality, closeness centrality, betweenness centrality, and expected influence.

Table 3: Centrality Values of the Network

Nodes	Betweenness	Closeness	Strength	Expected Influence
P_Gov	0.094	0.334	0.481	0.332
MoH	1.797	1.729	1.514	1.22
BoI	0.898	0.605	1.174	2.629
P&D	2.002	0.97	0.006	0.147
PWD	0.395	0.67	0.468	0.5
AgD	-1.011	-0.139	-0.623	-0.427
MoE	1.4	0.496	0.572	0.332
NGOs	-0.207	0.223	-0.085	0.026
Acad	1.199	0.296	0.738	-1.013
MoST	-0.709	0.311	0.036	-0.698
Med	-1.011	-0.51	-1.305	-1.625
Livestock	-0.408	0.192	0.642	-0.328
Charity	-1.011	0.204	-0.212	0.312

Nodes	Betweenness	Closeness	Strength	Expected Influence
Elites	-0.408	0.303	0.403	0.309
Parliament	-1.011	-1.75	-1.776	-0.844
Political Parties	-1.011	-2.934	-2.034	-0.873

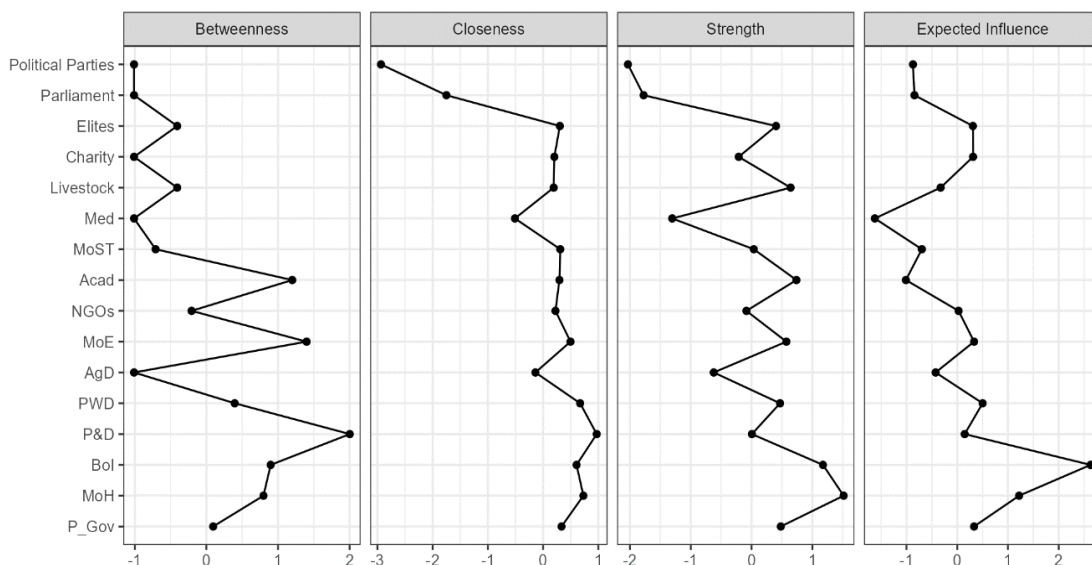


Figure 2: Centrality Graph showing Centrality Values of the Network

(Figure 2: Centrality plots depicting betweenness, closeness, strength, and expected influence of each stakeholder node) Nodes with a high degree of betweenness have a relatively more important position. Accordingly, among the variables, P&D, MoH, MoE, and Academia are the key variables that are highly active in the network (Table 3) and act as a bridge between other

unconnected variables (Figure 2). As a result, the overall network consists of highly correlated variables. Accordingly, the variables with the highest degree of closeness are MoH and P&D. Since these variables can be reached most easily, reaching these variables is more important than reaching other variables, and when these variables are

reached, other variables can be reached as well.

Table 4: Clustering Coefficients for the Variables

Variable	Barrat	Onnela	WS	Zhang
P_Gov	-0.455	-0.147	-0.485	-0.112
MoH	-0.831	-0.678	-0.704	-0.665
Med	0.894	-0.892	0.315	0.57
Livestock	-0.469	0.113	-0.028	0.357
Charity	0.65	0.28	1.115	-0.241
Elites	0.18	1.915	0.115	0.173
Parliament	1.182	-0.374	1.115	0.499
Political Parties	-2.75	-1.889	-2.885	-1.57
BoI	-0.212	-0.166	-0.1	-0.501
P&D	0.533	0.121	0.257	-0.052
PWD	0.518	0.098	0.329	0.192
AgD	1.468	0.472	1.315	3.121

Variable	Barrat	Onnela	WS	Zhang
MoE	0.468	0.452	0.715	-0.169
NGOs	-0.118	-0.215	-0.028	-0.157
Acad	-0.781	-0.644	-0.957	-0.439
MoST	-0.277	-0.447	-0.085	-1.006

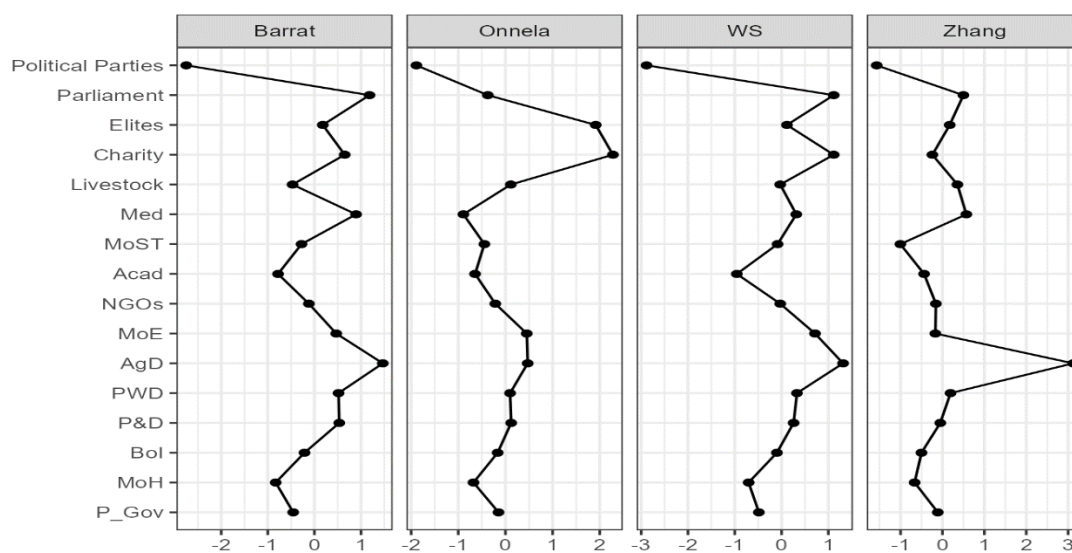


Figure 3: Clustering Coefficients for the Variables

(Figure 3: Graphical representation of clustering coefficients for each stakeholder variable)

The clustering coefficient measures local cohesiveness and is defined as the fraction of connected neighbours for any vertex. These coefficients reveal how strongly the variables are connected with their neighbours.

Clustering coefficients for the variables are given in Table 4. Figure 3 shows the graphs of clustering coefficients for the variables given in Table 4. Clustering coefficients, which are used to measure the clustering tendency of the parameters in the network, are used to measure the frequency of the parameters in groups, that is, their tendency

to form cliques. This coefficient, which gives the frequency of connecting the parameters with which they are connected, also shows the importance of the parameter for the groups. So, a high clustering coefficient indicates a high correlation of the variables, and a low one indicates less frequent connections.

The distance from one node to another indicates the degree of the relationship

between the stakeholders. The clustering coefficients reveal the strength of the link between the stakeholders. Table 4 presents the clustering coefficients for the stakeholders. The highest clustering coefficient values were for AgD (Barrat = 1.468), whereas the lowest was for Political Parties (Onnela = -1.889).

Table 5: Correlation Analysis

	Network															
Variable	P_Gov	MoH	BoI	P&D	PWD	AgD	MoE	NGOs	Acad	MoST	Med	Livestock	Charity	Elites	Parliament	Political Parties
P_Gov	0	-0.193	0	-0.044	-0.012	0	0	0	0.072	0	0	0.459	0	0.104	0	0
MoH	-0.193	0	0.233	0.134	0.125	0.004	0.006	0.057	0	0	-0.097	0.034	0.332	0	0.027	0
BoI	0	0.233	0	0.092	0.338	0	0	0.087	0	-0.007	-0.005	0.028	0	0.334	0	0
P&D	-0.044	0.134	0.092	0	0.156	0	0.143	0	0	-0.111	0	0	0	0	-0.04	0
PWD	-0.012	0.125	0.338	0.156	0	0	0.041	0	-0.027	-0.056	-0.126	0	0	0	0	0
AgD	0	0.004	0	0	0	0	0.239	0.084	-0.17	0	-0.006	0	0	0	0	0
MoE	0	0.006	0	0.143	0.041	0.239	0	0.223	-0.265	0	0	0	0	0	0	0
NGOs	0	0.057	0.087	0	0	0.084	0.223	0	-0.041	-0.157	0	0.039	0	0	0	0

Variable	P_Gov	MoH	BoI	P&D	PWD	AgD	MoE	NGOs	Acad	MoST	Med	Livestock	Charity	Elites	Parliament	Political Parties
MoST	0	0	-0.007	-0.111	-0.056	0	0	-0.157	0.364	0	0	0	0	0	0.035	0
Med	0	-0.097	-0.005	0	-0.126	-0.006	0	0	0.023	0	0	-0.008	0	0	0	0
Livestock	0.459	0.034	0.028	0	0	0	0	0.039	0	0	-0.008	0	-0.132	-0.239	0	0
Charity	0	0.332	0	0	0	0	0	0	0	0	0	-0.132	0	0.181	0	0
Elites	0.104	0	0.334	0	0	0	0	0	0	0	0	-0.239	0.181	0	0	0
Parliament	0	0.027	0	-0.04	0	0	0	0	0	0.035	0	0	0	0	0	0
Political Parties	0	0	0	0	0	0	0	0	0.013	0	0	0	0	0	0	0

Provincial-level Interaction Network

"With whom did you have interactions regarding child and maternal nutrition activities during the MDGs period?" This question was asked to develop a provincial-level interaction network. The interaction network mapped in Figure 4 shows nodes (actors) as circles, and ties between them are

represented as lines (edges). We used the in-degree centrality measure, where the size of the node indicates in-degree centrality, while the thickness of edges (ties) represents how frequently they interact. The frequencies of interaction were used as weights. The key actors across the network were the P&D, Parliament members, MoH, and NGOs. Structurally, the network was more centralized with a few main nodes (actors)

with higher betweenness centrality; these nodes can be referred to as broker nodes as they connect other nodes to the network. The

interaction network was the largest of the three networks.

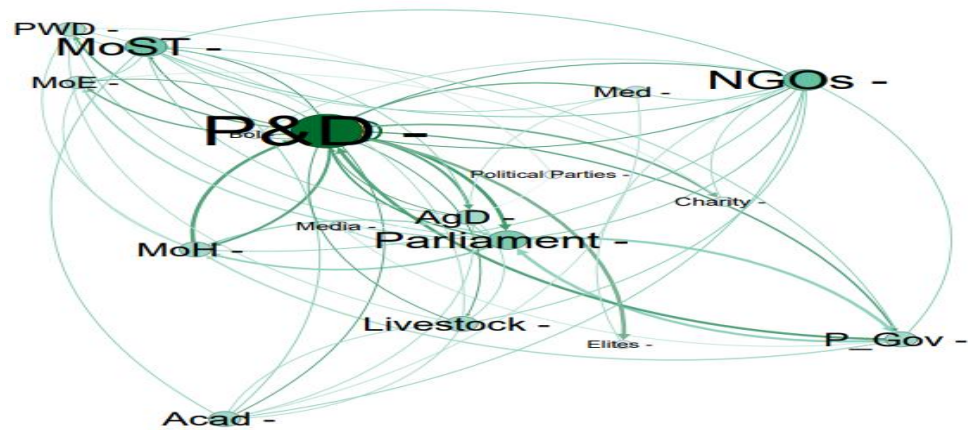


Figure 4: Interaction Network at Provincial Level

(Figure 4: Nodes (actors) as circles, ties between them as lines (edges); node size indicates in-degree centrality; edge thickness represents interaction frequency)

ID	In-Degree	Out-Degree	Degree	Weighted In-degree	Weighted Out-Degree	Weighted	Eccentricity	Closeness Centrality	Harmonic Closeness Centrality
P_Gov	4	4	8	10	15	25	3	0.5517	0.6146
Media	3	0	3	6	0	6	0	0.0000	0.0000
MoH				12	12	24	2	0.5714	0.6250
Parliament				14	21	35	2	0.6400	0.7188
P&D				22	47	69	2	0.8889	0.9375
PWD				9	2	11	3	0.3902	0.4479
MoE				9	2	11	3	0.5000	0.5417
AgD	3	5	8	6	5	11	3	0.5517	0.6354
NGOs	5	8	13	6	8	14	3	0.6400	0.7396
Acad	6	2	8	6	4	4	8	0.4211	0.4792
MoST	5	7	12	6	4	7	11	0.6400	0.7188
Med	3	2	5	5	9	15	24	0.4324	0.4896
Livestock	5	3	8	6	5	2	7	0.5333	0.5833
Charity	2	1	3	5	4	2	6	0.4103	0.4531
Elites	1	1	2	5	1	6	4	0.4103	0.4531
Bol	1	1	2	2	1	3	4	0.4103	0.4531
Political Parties	1	1	2	1	1	2	1	1.0000	1.0000

Table 6: Statistics for Interaction Network

ID	BetweennessCentrality	Authority	Hub	PageRank	Module	InferredClass	Cluster	EigenvectorCentrality
P_Gov	88333	03102	01805	00438	00000	00000	05000	04993
Media	00000	00966	00000	00632	00000	00000	03333	02216
MoH	36000	02762	02181	00428	00000	00000	05000	04837
Parliament	111000	02547	03377	00462	00000	00000	03086	04837
P&D	898000	03727	05943	01089	10000	00000	02857	10000
PWD	153667	03075	00479	00720	00000	00000	03333	06289
MoE	23333	02740	00895	00432	00000	00000	04500	05060
AgD	26167	02346	02669	00341	10000	00000	04667	04086
NGOs	476167	01925	04186	00905	10000	00000	02455	04505
Acad	22000	03511	00947	00870	10000	00000	06000	06817
MoST	298500	02681	03685	00850	10000	00000	03086	05780
Med	00000	02309	01117	00336	10000	00000	07500	03690
Livestock	188500	02566	01861	01014	10000	00000	04000	06280
Charity	05000	01234	00347	00366	10000	00000	06667	02973
Elites	00000	01072	00347	00182	10000	00000	10000	01973
Bol	00000	01072	00347	00182	10000	00000	10000	01973
PoliticalParties	13333	00086	00174	00427	00000	00000	00000	01239

Provincial-level Information-Seeking Network

Figure 5 shows the information-seeking network. Actors were asked to identify resources for implementation within the network, including clarification of guidelines, advice around planning nutrition MDGs enforcement drives and training activities. During the survey, several participants mentioned that they focused on their specific assignment and did not seek

information about program implementation. This information was mostly sought by mid-level managerial staff responsible for providing guidance to the field-level implementers.

The information-seeking map reveals a similar pattern. The actors from NGOs, P&D, Provincial Government and MoH remain central in terms of providing information on the program. The most central nodes in the information-seeking map were almost the same as in the interaction map.

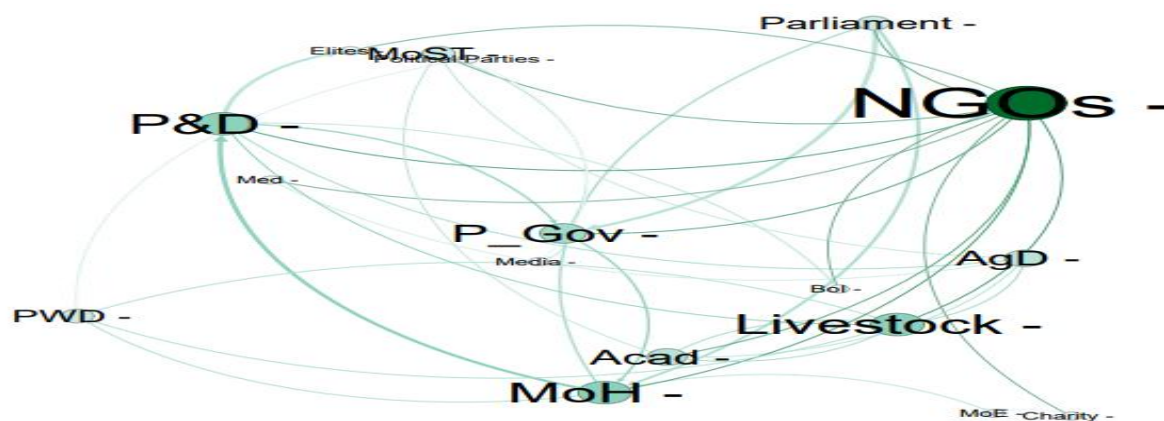


Figure 5: Information-Seeking Network at Provincial Level

(Figure 5: Nodes (actors) as circles, ties between them as lines (edges))

ID	In-Degree	Out-Degree	Degree	Weighted In-degree	Weighted Out-Degree	Weighted	Eccentricity	Closeness Centrality
P_Gov	4	2	6	10	5	15	5	0.3488
Media	2	0	2	3	0	3	0	0.0000
MoH	3	4	7	8	12	20	4	0.4545
Parliament	2	2	4	4	9	13	5	0.3488
P&D	4	3	7	8	10	18	4	0.3947
PWD	2	2	4	3	2	5	6	0.3061
MoE	1	1	2	2	1	3	5	0.3125
Elites	1	1	2	5	1	6	4	0.4054
Bol	1	1	2	2	1	3	4	0.4054
Political Parties	1	1	2	1	1	2	1	1.0000
Livestock	4	3	7	4	3	7	5	0.3846
AgD	0	5	5	0	5	5	5	0.4211
Acad	3	2	5	3	2	5	5	0.3333
MoST	3	1	4	3	1	4	6	0.2830
Med	2	0	2	2	0	2	0	0.0000
Charity	1	1	2	1	1	2	4	0.4167
NGOs	3	8	11	3	8	11	3	0.6250

Table 7: Statistics for Information-Seeking Network

ID		Harmonic Closeness Centrality	Betweenness Centrality	Authority	Hub	Page Rank	Module	Inferred Class	Cluster	Eigenvector Centrality
P_Gov		0.4378	43.6667	0.2641	0.0691	0.1108	0.0000	3.0000	0.0000	0.0000
Media		0.0000	0.0000	0.0196	0.0000	0.0954	0.0000	0.0000	0.0000	0.0000
MoH		0.5667	63.5000	0.2427	0.2376	0.0942	0.0000	3.0000	1.0000	0.0000
Parliament		0.4378	0.8333	0.2519	0.1335	0.0471	0.0000	3.0000	0.0000	0.0000
P&D		0.4889	52.4167	0.4567	0.0808	0.0710	0.0000	3.0000	1.0000	0.0000
PWD		0.4067	22.5833	0.1307	0.1165	0.0664	0.0000	3.0000	1.0000	0.0000
MoE		0.3578	15.4167	0.0626	0.0000	0.0351	0.0000	3.0000	1.0000	0.0000
Elites		0.4556	10.6667	0.0213	0.0000	0.0352	0.0000	3.0000	1.0000	0.0000
Bol		0.4556	10.6667	0.0213	0.0000	0.0352	0.0000	3.0000	1.0000	0.0000
Political Parties		1.0000	1.8333	0.0307	0.0052	0.0391	0.0000	1.0000	0.0000	0.0000
Livestock		0.4967	30.7500	0.4117	0.2585	0.0753	0.0000	3.0000	2.0000	0.0000
AgD		0.5646	0.0000	0.0000	0.5188	0.0151	0.0000	4.0000	2.0000	0.0000
Acad		0.4211	2.7500	0.3941	0.2088	0.0510	0.0000	3.0000	2.0000	0.0000
MoST		0.3433	8.7500	0.3810	0.0696	0.0513	0.0000	3.0000	2.0000	0.0000
Med		0.0000	0.0000	0.3260	0.0000	0.0297	0.0000	2.0000	2.0000	0.0000
Charity		0.4611	17.4167	0.0000	0.0000	0.0449	0.0000	3.0000	2.0000	0.0000
NGOs		0.7444	70.7500	0.0000	0.7186	0.1131	0.0000	3.0000	2.0000	0.0000

Provincial-level Decision-Making Network

Figure 6 shows the decision-making network. The respondents required inputs and approvals to make decisions regarding financial and program planning. Very few actors were identified as having such a decision-making role. We observed a similar

centralization pattern for decision-making, which corresponds to higher network centralization, where the Provincial Government, P&D, MoH, and Parliament were the key in providing decision-making support to the network such as disbursing funds.

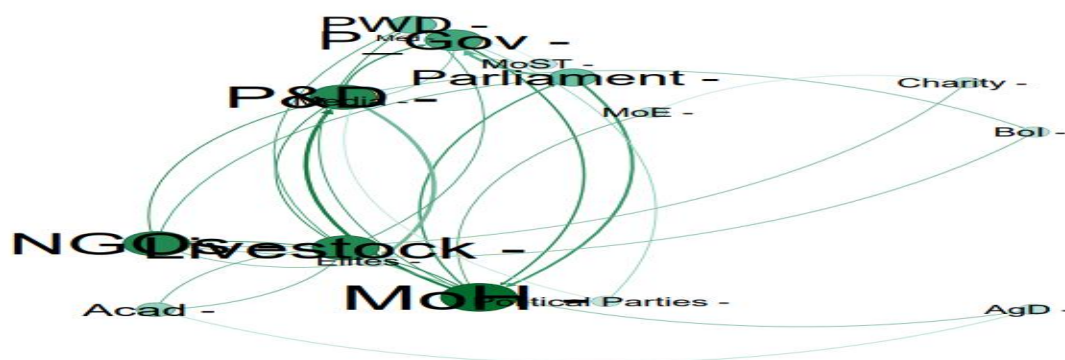


Figure 6: Decision-Making Network at Provincial Level

(Figure 6: Nodes (actors) as circles, ties between them as lines (edges))

Table 8: Statistics for Decision-Making Network

ID	In-Degree	Out-Degree	Degree	WeightedIn-degree	WeightedOut-Degree	Weighted Degree	Eccentricity	ClosenessCentrality
Med	0	1	1	0	1	1	6	0.2419
AgD	0	2	2	0	2	2	6	0.3043
Pol Parties	1	1	2	1	1	2	1	1.0000
Charity	1	1	2	1	1	2	5	0.3333
MoST	1	1	2	1	1	2	5	0.2979
MoE	1	1	2	2	1	3	6	0.2653
BoI	1	1	2	2	1	3	5	0.3250
Acad	2	1	3	2	1	3	6	0.2889
Media	2	0	2	3	0	3	0	0.0000
PWD	2	2	4	3	2	5	6	0.3171
Livestock	3	3	6	3	3	6	5	0.3939
NGOs	3	3	6	3	3	6	4	0.4483
Parliament	2	2	4	4	9	13	4	0.3939
Elites	1	1	2	5	1	6	5	0.3250
P&D	3	3	6	7	10	17	5	0.3714
MoH	3	4	7	8	12	20	3	0.5200
P_Gov	3	2	5	9	5	14	4	0.3939

D	HarmonClosenessCentrality	BetweenCentrality	Authority	Hb	PageRank	Metric	Influence	Clust	EigenvalueCentrality
Med	0.3000	0.0000	0.0000	0.0000	0.0130	0.0000	5.0000	3	0
AgD	0.4036	0.0000	0.0000	0.1057	0.0130	0.0000	3.0000	2	0
Political Parties	1.0000	2.8333	0.0096	0.0227	0.0384	0.0000	1.0000	0	0
Charity	0.3936	13.6667	0.0000	0.0000	0.0448	0.0000	2.0000	0	0

MoST	03560	140000	00000	00314	00241	00000	40000	3	0
MoE	03282	146667	02501	00000	00374	00000	20000	0	0
BoI	03872	58333	00166	00000	00394	00000	20000	1	0
Acad	03577	00000	02226	00217	00409	00000	20000	2	0
Media	00000	00000	00602	00000	00839	00000	00000	0	0
PWD	04282	378333	04329	00253	00598	00000	20000	0	0
Livestock	05154	450000	00576	04845	00786	00000	20000	2	0
NGOs	05449	503333	00000	05196	01181	00000	20000	1	0
Parliament	04744	58333	04461	01455	00709	00000	20000	0	0
Elites	03872	58333	00166	00000	00394	00000	20000	1	0
P&D	04062	606667	06289	00439	00932	00000	20000	1	0
MoH	06154	856667	03025	06631	01149	00000	20000	0	0
P_Gov	04744	558333	00833	01368	00900	00000	20000	0	0

DISCUSSION

This study was designed to identify the major groups in KP, Pakistan that have an interest in the proposed activities of the Millennium Development Goals (MDGs) that related to child and maternal nutrition, in order to determine their reaction to proposed activities, the roles that each group could have played to help ensure its support for project activities, and indicators to monitor the support over time of key stakeholders. This application of stakeholder analysis is one of the first systematic attempts to apply this approach in the context of nutrition policy in Pakistan. Although the MDGs, in general, and those related to child and maternal nutrition, in particular, were not fully successful in the eradication of child and maternal malnutrition problems, the documentation of the approach undertaken in this study may provide guidance to others interested in using stakeholder analysis in the design of new approaches to health care delivery and financing. It is hoped that the

SDGs and other partners in Pakistan will use this methodology in other health and development work. Health ministries, in turn, will apply this experience to other activities of this nature in other provinces. We hope that the overall result of this chain of experience will benefit the people of Pakistan and other parts of the developing world, through improved design of new approaches to the delivery of health services to underserved populations.

Network Structure and Stakeholder Characteristics: Cues about Program Compliance

We mapped, illustrated and studied the implementation network of child and maternal nutrition programs across KP province of Pakistan. The actors most frequently engaged in the program were from the departments of health, P&D, and provincial government. Government organizations (MoH, P&D etc.) remained the lead organizations, with high centralization and key actors, in all three interaction,

information-seeking and decision-making networks. Provincial-level health department leads relied on state teams for information support. Across the three network maps encompassing interaction, information and decision-making, a similar pattern emerged: the dominant and more centralized role of the key government organizations. The more centralized network had the potential for rapid diffusion of information, characterized by high reachability to people in the network who can act as broadcasters. The centralized networks also share more power and influence with the central actors (Valente, 2010). Thus, in such a case, if the central actors are active and embrace the idea of networking and working across departments, diffusion and coordination can be more effective. This indicates that the identified person or node plays a significant part in allowing information to pass from one part of the network to the other. We found they acted as bridges or brokers to the main network as they facilitate the flow of information and resources within the groups of people separated from the main network (Long et al., 2013). These actors can maximize a network's benefits by reaching actors and people who are difficult to reach (Valente et al., 2010). Engagement and participation from these brokered nodes can facilitate or inhibit joint action of the actors within the network. A more engaged participation or allocating designated implementation roles to these managers may lead to increased cooperation and coordination among the participating actors.

Previous studies have shown that actors in a highly centralized network, where most of the interaction is with one or two key actors,

completed tasks more easily and effectively (Shaw 1971). This may be related to the explanation that, in a dispersed network, establishing chains of communication require more intensive efforts to involve, establish and maintain the links (Nardi et al., 2002). A dense and reciprocal communication network can lead to higher rapport, cohesion and trust (Hinds and McGrath, 2006) and, hence, facilitate coordination to improve performance. This can be beneficial in a complex multisectoral policy environment, where the dynamic setting needs effective, frequent and open channels of communication between members of the network. As the central tenet of multisectoral collaboration is relationship building, these dense and open information channels can facilitate the mutual understanding, trust and accountability needed to achieve shared goals and opens up mechanisms to provide feedback on processes, and potentially the adaptation required to identify and achieve emergent needs (Kuruville et al., 2018; de Leeuw 2017). Such observed patterns of centralization, density and reciprocity can help us understand the structural differences we observed, enabling the identification of key nodes or actors that can be effective and robust channels of communication to provide scope for better coordination.

Lead Organization Governance— Network Management and Steering

In describing network governance, Kenis and Provan (2008) identify three governance forms: participant governed, lead organization governed and governance by network administrative organizations. The governance practices we observed in

nutrition programming align with lead organization governance. The department of health leads the network governance, either through a central role by the nodal officer for nutrition or through a brokered role. The lead organization guides the governance practices in part, by providing administrative costs, resources to enable coordination, and the network's goals are best aligned with their own goals (Provan and Kenis, 2008). In Pakistan, nutrition programs at national and provincial levels primarily nest within the department of health. Both levels contribute to the program's financial and human resources. However, to promote coordination across all departments, the head of provincial administration known as the Chief Minister (CM) chairs the provincial-level coordination committee and serves as chair for the overall program to provide guidance, ensure monitoring and conduct performance review. Hence, in the decision-making network, we observe that the health department does rely on the P&D department to take programmatic and planning decisions. Thus, in practice, the health department leads and coordinates the program and takes all operational decisions (Graddy and Chen, 2006), but there is a need for cooperation and coordination from other network members to reach their mutual goals. The measure of in-degree centrality is the most frequently used network measure of opinion leadership (Valente and Davis, 1999). At the provincial level, P&D demonstrates the highest in-degree centrality (Tables 6, 7, 8) and influence in providing guidance for implementation. These leaders or central actors need to coordinate network-level activities through network management, which broadly refers to efforts

and activities employed to bring in relevant actors, implement joint efforts and enable problem-solving (Kickert et al., 1997, Agranoff and McGuire, 2001) in order to fulfil network functioning. The importance of network management (Klijn et al., 2010) and the network manager role (Edelenbos et al., 2011) becomes essential for realizing network goals and actions. The importance of network management and steering is pronounced in Pakistan's bureaucratic setup, which remains very hierarchical and segmented, with departments working in silos with limited avenues for integration. As the ownership of the program remains with the health sector, these central actors can act as significant information resources for implementation. This finding is concurrent with the literature revealing how network managers play significant roles in exploring innovative ideas (Koppenjan and Klijn, 2004) and in guiding interactions. Enhancing network efficiency would require supporting and building capacities of network managers, both central actors and brokers, to steer and guide the network. In addition to technical knowledge, several authors have indicated a variety of necessary skills for such managers. These include network diagnostic skills, to reduce and manage uncertainties in complex relationships (Koppenjan and Klijn, 2004), and skills that enable better comprehension of how to implement appropriate network activities (Agranoff and McGuire, 2001). Hence, further building such leadership skills and supporting these leaders can enhance network coordination and efficiency.

Comparison with Existing Nutrition SNA Studies

Our finding that P&D and MoH dominate centrality is consistent with Uddin et al.'s (2017) findings in South Asian countries where government planning departments and health ministries typically occupy central positions in nutrition governance networks. Similar to Srivastava et al. (2016) who found complementarity between public health systems and NGOs in Uttar Pradesh, India, our study also identified NGOs as important actors bridging government departments and communities. However, unlike Klemm et al. (2022) who found that nutrition officers in Tanzania fostered effective collaborative strategies through designated coordination roles, our study revealed that in Pakistan, such coordination roles were less formalized, with P&D and MoH acting as *de facto* coordinators rather than having explicitly designated network management functions.

Implications for Research, Practice, and Policy

As a means of mapping and exploring implementation of multisectoral coordination, SNA provides a visual structural map of provincial-level implementation networks. A diagnosis in the form of a network map can inform discussions about how different networks can be strengthened. The results of SNA provide more explicit descriptions or 'mapping' of key actors, relationships and decision-making, offering insights into health system leaders regarding effective implementation. In this study, the network relied on key central players for the diffusion of innovation, knowledge and network interventions

(Sikkema et al., 2000). We identified actors who act as brokers and play a crucial role in coordination and building linkages between different groups in the system (Burt, 2002; Newman and Dale, 2005). Strengthening these managers' roles in network support and cohesion can enhance participation of stakeholders that do not rely on central mediation.

The SNA approach can also provide a pragmatic network diagnosis to facilitate the 'rewiring' of networks, where decision-makers might consider intervening to optimize relationships or connections; for instance, to 'activate' key actors who could engage with a greater role in decision-making to enhance the potential of the network (Blanchet et al., 2012). Network metrics can provide insights into the relationships, positions, structure and strength of a network, so as to diagnose weaker relations/ties which have not been fully utilized. Moreover, SNA can be used as a learning instrument by provincial and district stakeholders to study these districts as 'learning sites' for formalized, continuous research and partnerships to promote continuous learning and create an overlap between policy development and implementation. Simultaneously, this can also provide the scope for the improvement of everyday practices at local level and to promote cooperation and coordination for the program by sharing the visual network diagrams that build awareness and invite different departmental partnerships.

SNA can be of value during pilot or developmental, implementation and evaluation phases. During the early phases of intervention, it can enable understanding of

complex implementation, by deciphering the networks of multiple professionals and associated sectors. Using the mapping exercise, it can help design strategies considering the social context of program members, its delivery, determining the appropriate methods and channels of communication needs, and identify particular change agents and opinion leaders to widen the outreach of the network. During the implementation and evaluation phases, when coupled with a mixed methods design, SNA can help analyze the network as a whole system and at individual organizational level. Thus, enabling identification of points of influence to create and improve selected strategies for a group or organization. Therefore, SNA as a tool can be adopted to diagnose, map, monitor and intervene in complex multisectoral health programs.

SNA is context sensitive (Borgatti et al., 2009), hence contextual knowledge in designing the tool is crucial. It was time intensive to seek appointments from various departments, especially from the high-ranking officers of each department. The provincial nutrition teams facilitated this survey by providing permission and making introductions to other departments. Thus, an SNA that has multisectoral outreach will require a deep understanding of context, programs and facilitation in the collection and interpretation of the data. The emerging findings were also shared with the provincial nutrition teams, to help interpret the preliminary findings and situate the research in context.

The findings of this study showed that the identified stakeholders have a different spectrum of interest, position, power and

influence on child and maternal nutrition policies and practices in Pakistan. Retrospective identification of these stakeholders is an important factor for succeeding in developing and implementing effective interventions and mobilizing all necessary resources and facilities. Regarding child and maternal nutrition policy in Pakistan, the identified stakeholders directly and indirectly influence the formulation and implementation of policies. According to participants' viewpoints, P&D is the most important stakeholder identified. Disagreements and different standpoints concerning the development and implementation of healthcare policies can be a challenge, despite negotiations being able to mitigate such contrasts and contribute to finding an optimal compromise. In the case of child and maternal nutrition-related policies in Pakistan, a lack of cooperation might have hindered proper implementation of the plans. Based on the ranks and metrics properties of the stakeholders, one of the noticeable findings of the present investigation is that, despite the fact that child and maternal nutrition has been properly identified as a challenge for Pakistan's health sector, many stakeholders believe that they could not do much. Indeed, many stakeholders tend to consider child and maternal nutrition merely as a priority of the MoH. The identified stakeholders showed different degrees of interest towards child and maternal nutrition policy. Their differing motivation can explain this; for example, interest by Charity Organizations and Political Parties was found to be low despite being important stakeholders. On the other hand, stakeholders rated high for position can

have a high impact on other stakeholders. The political, economic, social and cultural status of each stakeholder indeed plays an important role in the process of policy-making. The power of stakeholders is one of the main factors and components of the development and implementation of health-related policies. However, regarding child and maternal nutrition-related policies, participation and involvement in political discussions for policy-making are generally low, and this is a challenge that can affect policy implementation by causing delays or resulting in failures. Experts believe that, in order to improve policy and implementation, both top-down and bottom-up approaches should be used to allow continuous implementation of policies. Specifically regarding child and maternal nutrition policies in Pakistan, most of the decisions are taken by the MoH, with low participation of other stakeholders and a lack of appropriate dialogue with the bottom-up beneficiaries. Through a more intense political dialogue, these weaknesses could be somewhat reduced.

Stakeholders can influence policies based on their own characteristics and their effects can be positive or negative. Regarding the prevention dimension, media, social media, news websites and religious leaders can have a great influence on society. Unfortunately, despite this high potential, because of certain cultural problems associated with child and maternal nutrition, such as stigma, they have not been successful in fulfilling the mission of raising awareness. However, in recent years, the MoH has tried to reduce child and maternal nutrition-related stigma, and stakeholders are working with the MoH to

raise awareness among the general population. The findings of the present study showed that network density was generally moderate. Collaboration and interactions among all involved stakeholders at all levels should be extensively adopted to address important issues such as child and maternal nutrition. They should have a comprehensive understanding of the magnitude and impact of their collaboration. Cultural factors and community views can affect health policies. In the Pakistani society, stigma is still high and, therefore, SNA findings showed that those who are responsible for spreading information and raising awareness should have a more active participation and a greater role in preventive policies. Finally, the findings of this study showed that ongoing dialogue between stakeholders favours more sensitivity and empowerment, potentially resulting in integration of some programs. Consultation with all involved stakeholders can help in the design and implementation of adequate policies.

Why is Multi-Stakeholder Engagement Important for Nutrition?

When different groups combine their skills and resources, they can achieve much more than if they work alone. Uniting the efforts of multiple sectors and stakeholders is fundamental to the SUN Movement and one of seven principles to which all those within the SUN Movement commit. The importance of involving multiple sectors to address malnutrition is well recognized. The causes of malnutrition are complex and interconnected. Sustainable solutions therefore rely on different sectors of government—

together with the stakeholders that support them—working together in a coherent and coordinated fashion. The health, agricultural and social protection sectors are important service delivery providers; planning and finance provide the systems and investment for nutrition; local government is critical for scaling up nutrition in districts and communities; while the offices of prime ministers and presidents give political leadership and commitment to improving nutrition. There are other sectors that impact on nutrition in different ways depending upon the context of the country. Multi-sectoral collaboration requires the engagement of multiple stakeholders from across government and outside government. A range of government ministries representing different sectors need to work in a coherent way supported by external organizations that are strengthening government-led endeavors to improve nutrition. These include United Nations (UN) agencies that provide technical support to governments, donors who are investing in national development, civil society organizations who work closely with communities ensuring that marginalized groups are reached, businesses with their potential resources for improving nutrition, academic and science institutions that are involved in training and research related to nutrition, and Members of Parliament who can use their positions of authority to maintain and spread commitment to nutrition.

One of the important questions that needs to be asked when considering how to and who will assist to develop solutions to address the identified public health nutrition (PHN) issue

is 'who are the main stakeholders involved in this issue'? There is increasing recognition of the central role of stakeholders—individuals, groups and organizations—who have an interest (or stake) and the potential to influence the actions and aims of a project or policy direction. By collecting and analyzing data on stakeholders, an understanding of who will be affected or concerned by the identified PHN issue, as well as their level of interest and influence in developing solutions to the issue, can be achieved. Stakeholder analysis and engagement builds upon the work already achieved from community engagement and uses these relationships with community stakeholders to identify additional internal and external stakeholders of relevance to the identified PHN issue. Stakeholder analysis is the process of identifying and generating knowledge about the key stakeholders around an intervention. Understanding the behaviour, interests, inter-relations and intentions can be used to assess the influence, resources and affect these stakeholders can have on the viability of the intervention. Stakeholder analysis includes both the winners and losers, and those involved or excluded from the decision-making processes. It even involves identifying stakeholders who may be barriers to change, so that they can be managed or neutralized. A stakeholder analysis can be used to inform intervention planning, implementation and evaluation. Once the key PHN issues have been identified, stakeholder analysis is used to recognize who is or will be affected by these issues, their level of interest and influence. Identifying stakeholders and their interests in the issues can assist with managing current or potential conflict of

interest, or assist with the development of stakeholder 'coalitions' of intervention sponsorship, ownership or cooperation.

Limitations

The study has several limitations. Due to resource constraints, we mapped the networks at a single point in time. While such a snapshot is useful, networks are indeed dynamic and studying them over time is important to understand how networks evolve and what shapes these networks. Similarly, while the quantitative approach to SNA that depicts positions and transactions across actors is useful, it falls short of capturing the qualitative nature of these relationships. We explored these qualitative aspects in a larger study, the findings from which are reported in a separate paper. We had a comparable response rate in our study. Yet, we did miss out on some actors whose positions we depicted in the networks but had no data on how they relate to others in the network. The non-response in our study was mainly due to logistical reasons, and the missing data were not concentrated in any specific cadre of officers. While such data could have enhanced our understanding of the networks, it is unlikely that it would have changed our findings substantially. The cross-sectional single-time-point NetMap snapshot limits our ability to capture the evolution of stakeholder relationships over time. There is also potential for self-report bias, as participants reported their perceptions of interactions rather than verified ties. The Peshawar-centered sampling may not fully represent the entire provincial network, as stakeholders from other districts may have different interaction patterns. Future research could potentially

explore how network features could explain program implementation scenarios over time and across different districts. The study makes a valuable contribution to understanding multisectoral nutrition governance in Pakistan, with practical implications for SNA methodology in health policy research.

REFERENCES

1. Asim M, Nawaz Y. Child malnutrition in Pakistan: evidence from literature. *Children*. 2018 May 4; 5(5):60.
2. Bhutta ZA, Hafeez A, Rizvi A, Ali N, Khan A, Ahmad F, Bhutta S, Hazir T, Zaidi A, Jafarey SN. Reproductive, maternal, newborn, and child health in Pakistan: challenges and opportunities. *The Lancet*. 2013 Jun 22;381(9884):2207-18.
3. Rizvi A, Bhatti Z, Das JK, Bhutta ZA. Pakistan and the millennium development goals for maternal and child health: progress and the way forward. *Paediatrics and International Child Health*. 2015 Oct 2;35(4):287-97.
4. Shadoul AF, Akhtar F, Bile KM. Maternal, neonatal and child health in Pakistan: towards the MDGs by moving from desire to reality. *EMHJ-Eastern Mediterranean Health Journal*. 2010;16(Supp):39-46.
5. Manzoor R, Toru SK, Ahmed V. Legislative Gaps in Implementation of Health-related Millennium Development Goals: a case study

- from Pakistan. *Journal of the Pakistan Medical Association*. 2016 Jun 1;66(6).
6. Shafiq A, Hussain A, Asif M, Hwang J, Jameel A, Kanwel S. The effect of "women's empowerment" on child nutritional status in Pakistan. *International Journal of Environmental Research and Public Health*. 2019 Nov;16(22):4499.
 7. Uddin S, Mahmood H, Senarath U, Zahiruddin Q, Karn S, Rasheed S, Dibley M. Analysis of stakeholders networks of infant and young child nutrition programmes in Sri Lanka, India, Nepal, Bangladesh and Pakistan. *BMC Public Health*. 2017 Jun;17(2):15-25.
 8. Klemm GC, Kayanda R, Kazoba A, McCann J, Nnally LP, Dickin KL. Translating multisectoral nutrition policy into community practice: Participation of Nutrition Officers in Tanzania fosters effective collaborative strategies to improve child nutrition. *Current Developments in Nutrition*. 2022 Apr;6(4):nzac030.
 9. Srivastava A, Bhattacharyya S, Gautham M, Schellenberg J, Avan BI. Linkages between public and non-government sectors in healthcare: a case study from Uttar Pradesh, India. *Global Public Health*. 2016 Nov 25;11(10):1216-30
 10. Huang X, Yang B, Liu Q, Zhang R, Tang S, Story M. Improving maternal and child nutrition in China: an analysis of nutrition policies and programs initiated during the 2000-2015 Millennium Development Goals era and implications for achieving the Sustainable Development Goals. *Journal of Health, Population and Nutrition*. 2020 Dec;39:1-3.
 11. Yang B, Huang X, Liu Q, Tang S, Story M, Chen Y, Zhou M. Child nutrition trends over the past two decades and challenges for achieving nutrition SDGs and national targets in China. *International Journal of Environmental Research and Public Health*. 2020 Feb;17(4):1129
 12. Qiao J, Wang Y, Li X, Jiang F, Zhang Y, Ma J, Song Y, Ma J, Fu W, Pang R, Zhu Z. A Lancet Commission on 70 years of women's reproductive, maternal, newborn, child, and adolescent health in China. *The Lancet*. 2021 Jun 26;397(10293):2497-536.
 13. McGlashan J, Nichols M, Korn A, Millar L, Marks J, Sanigorski A, Pachucki M, Swinburn B, Allender S, Economos C. Social network analysis of stakeholder networks from two community-based obesity prevention interventions. *PLoS One*. 2018 Apr 27;13(4):e 0196211.

14. Freeman, L. C. (1978). Centrality in social networks conceptual clarification. *Social networks*, 1(3), 215-239.
15. Sun, M., Gadad, S. S., Kim, D. S., & Kraus, W. L. (2015). Discovery, annotation, and functional analysis of long noncoding RNAs controlling cell-cycle gene expression and proliferation in breast cancer cells. *Molecular cell*, 59(4), 698-711.
16. Bhattacharjee, A. (2012). *Social science research: Principles, methods, and practices*. University of South Florida.
17. Polido, A., João, E., & Ramos, T. B. (2016). Exploring experts' views and perspectives on the enhancement of Strategic Environmental Assessment in European small islands. *Environmental Impact Assessment Review*, 58, 25-33.
18. Long JC, Cunningham FC, Braithwaite J. Bridges, brokers and boundary spanners in collaborative networks: a systematic review. *BMC Health Serv Res*. 2013;13:158.
19. Valente TW. *Social networks and health: models, methods, and applications*. Vol. 1. New York: Oxford University Press, 2010.
20. Shaw ME. *Group dynamics*. New York: McGraw-Hill, 1971
21. Nardi BA, Whittaker S. The place of face-to-face communication in distributed work. In: *Distributed work*. Vol. 83. Cambridge, MA: MIT Press, 2002: 112 p.
22. Kuruvilla S, Hinton R, Boerma T, et al. Business not as usual: how multisectoral collaboration can promote transformative change for health and sustainable development. *BMJ*. 2018;363 :k4771-10.
23. Leeuw E. Engagement of sectors other than health in integrated health governance, policy, and action. *Annu Rev Public Health*. 2017;38:329-49.
24. Provan KG, Kenis P. Modes of network governance: structure, management, and effectiveness. *Journal of Public Administration Research and Theory*. 2008;18:229-52.
25. Graddy EA, Chen B. Influences on the size and scope of networks for social service delivery. *Journal of Public Administration Research and Theory*. 2006;16:533-52.
26. Valente TW, Davis RL. Accelerating the diffusion of innovations using opinion leaders. *Ann Am Acad Pol Soc Sci*. 1999;566:55-67.
27. Kickert WJM, Klijn E-H, Koppenjan J. *Managing complex networks: strategies for the public sector*. SAGE Publications Ltd, 1997.
28. Agranoff R, McGuire M. Big questions in public network management research.

- Journal of Public Administration Research and Theory. 2001;11:295-326.
29. Klijn EH, Steijn B, Edelenbos J. The impact of network management on outcomes in governance networks. *Public Adm.* 2010;88:1063-82.
 30. Edelenbos J, Klijn E-H, Steijn B. Managers in governance networks: how to reach good outcomes? *International Public Management Journal.* 2011;14:420-44.
 31. Koppenjan J, Klijn E-H. Managing uncertainties in networks: public private controversies. Vol. 1. 1st edn. Routledge, 2004
 32. Agranoff R, McGuire M. Big questions in public network management research. *Journal of Public Administration Research and Theory.* 2001;11:295-326
 33. Klemm GC, Kayanda R, Kazoba A, McCann J, Nally LP, Dickin KL. Translating multisectoral nutrition policy into community practice: Participation of Nutrition Officers in Tanzania fosters effective collaborative strategies to improve child nutrition. *Current Developments in Nutrition.* 2022 Apr;6(4):nzac030.
 34. Sikkema KJ, Kelly JA, Winett RA, et al. Outcomes of a randomized community-level HIV prevention intervention for women living in 18 low-income housing developments. *Am J Public Health.* 2000;90:57
 35. Blanchet K, James P, do Hto. How to do (or not to do) a social network analysis in health systems research. *Health Policy Plan.* 2012; 27:438-46.
 36. Borgatti SP, Mehra A, Brass DJ, et al. Network analysis in the social sciences. *Science.* 2009;323:892-6.
 37. Peterson, N. A., & Zimmerman, M. A. (2004). Beyond the individual: Toward a nomological network of organizational empowerment. *American Journal of Community Psychology*, 34(1-2), 129-145.
 38. Khan MI, Khalid R. Comparison of Multisectoral approaches with standalone Nutrition Specific Interventions to Address Malnutrition in Sanghar, Sindh. *J Nutr Health Sci.* 2015;2(4):402.