Preprint – *the manuscript has not been peer-reviewed yet.*

Community-based System Dynamics Modeling of Sensitive Public Health Issues: Maximizing Diverse Representation of Individuals with Personal Experiences

Arielle R. Deutsch, PhD[1,2,*], Rebecca Lustfield, PhD[1], Mohammad S. Jalali, PhD[3,4]

[1]Sanford Research, Behavioral Sciences, Sioux Falls, SD
[2]University of South Dakota School of Medicine, Pediatrics Department, Vermillion, SD
[3]MGH Institute for Technology Assessment, Harvard Medical School, Boston, MA
[4]Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA

***Corresponding author:**
Arielle R. Deutsch, PhD
Assistant Professor, Arielle.deutsch@gmail.com
2301 East 60th St N, Sioux Falls, SD 57104 | (605) 312-6234

Acknowledgements: This study was funded by NIH grant (P20GM121341-03). The authors would like to first and foremost thank all of the wonderful women who shared their wisdom, time and strength with us. We would also like to thank the organizational leaders who graciously invited us to work with them, and of course, all of our other amazing community collaborators who have made this project possible.

Declarations of interest: None

Community-based System Dynamics Modeling of Sensitive Public Health Issues: Maximizing Diverse Representation of Individuals with Personal Experiences

Abstract: Community-based system dynamics (CBSD) models enhance our understanding of stigmatized public health issues and related health disparities. The accuracy and usefulness of these models depend upon the individuals who take part in group modeling sessions. Marginalized individuals that are personally impacted by these health issues are critical in the function and development of the models. However, the extent of inclusion varies between studies since such individuals are often hard to recruit. There is substantial diversity in how individuals experience a stigmatized public health issue and with the underrepresentation of individuals with personal experience, research may conclude in biased model development. The purpose of this study was to explore a method that would increase representation for individuals with personal experience of stigmatized issues in model development. We used a case study from a CBSD project on the association between alcohol misuse (AM) and intimate partner violence (IPV) within a Northern Plains American Indian community. Group model building sessions were held at three community organizations: a faith-based re-entry program, a substance use rehabilitation program for pregnant women and mothers, and a domestic violence shelter. Session participants (clients of these organizations) were quick to understand the systems method and were engaged in the modeling process. There were few similarities between the three CBSD models. Each model contributed unique system components, and a consolidated model provided a rich picture of the complex AM-IPV system, as well as the ways in which health disparities are maintained. Coupled with an emphasis on transparency and trust building between researchers and modelers, our approach illuminated the diversity of ways in which individuals with personal experience can perceive AM-IPV systems. Using similar strategies for model building can complement existing efforts to build representative models for stigmatized public health issues within communities.

Keywords: Community-based system dynamics, health disparities, intimate partner violence, alcohol misuse

1. Introduction

1.1 Background

System dynamics is an increasingly popular method within public and community health research (Carey et al., 2015; Hormer & Hirch, 2005) that accounts for complexity and provides translatable findings that inform and implement change (Lich et al., 2013). This method has been used for issues such as alcohol use (Apostolopouulous et al., 2017), mental health (Trani et al., 2016), community violence (Bridgewater et al., 2011), homelessness (Fowler et al., 2019), and community HIV viral load (Weeks et al., 2017). A feature of system dynamics is the way in which health disparities can be conceptualized holistically (Apostolopoulous et al., 2018; Frerichs et al., 2016) through community-based participatory approaches (Frerichs et al., 2016). Stakeholders (e.g., community members with a personal or professional interest in the issues, policymakers, and others who represent areas of the system) work alongside researchers to develop models that are representative of real-world systems (community-based system dynamics (CBSD); Hovmand, 2014).

CBSD is an optimal method to translate complex systems models into actionable efforts for community health (Freichs et al., 2016; Zimmerman et al., 2016). Models utilize real-world examples to simulate and test a series of causal hypotheses related to potential policy change (Hirsch et al., 2007). However, models are only as valid or as useful as their representativeness of a real-world system. Developing accurate models requires the integration of multiple

perspectives from diverse system areas. Qualitative model building approaches such as group model building (Hovmand, 2014; Hirsch et al., 2007; Vennix, 1999) can incorporate multiple perspectives required for model development. It can also enhance the buy-in process from diverse stakeholders, promoting an active adoption and participation in interventions related to the relevant public health issues. Through a series of group model building "scripts" (Hovmand et al., 2012), stakeholders draw out variables, generate graphs of variable behaviors over-time, and develop conceptual causal loop diagrams that illustrate the relationship between different variables.

Effective CBSD practices consider a diverse group of stakeholders who represent two different ideas: 1) unique aspects of the problem or issue of interest, and 2) the community that the model embodies (e.g., location, population), particularly when focusing on inequality and marginalization (Hovmand et al., 2012). The extent to which different types of stakeholders are represented in model building groups varies across studies. These groups typically include individuals such as organization directors, administrators, subject matter experts, front-line service providers, and those with personal experience related to the issues of interest. Participation for those with personal experience (e.g., individuals experiencing or at risk to experience the target issue) varies substantially among studies (Batchelder et al., 2015; Mahamoud et al, 2013; Reno 2018). Although there are some studies in which individuals with personal experiences may make up a substantial portion, or the entirety, of the modeling group, a common approach for representation is to include a small number of individuals who represent vulnerable populations as a whole. Marginalized and at-risk populations are difficult to access (Ellard-Gray et al., 2015), particularly in complex and time consuming research settings. Group model building sessions can span from 60 minutes to multiple days and project engagement can last multiple months. Potential participants from vulnerable groups may not have the necessary resources (time, financial, psychological, transportation) to participate in projects requiring more intensive commitment. Researchers also have to balance the potential time expenditure related to inclusion with internal research deadlines and progress milestones. Such barriers and constraints can lead to researchers having an unrepresentative group of individuals with personal experience within a larger group of other stakeholders. Underrepresentation may also inhibit group members with firsthand experience from actively participating in groups, as such participants may feel less empowered due to power dynamics such as differences in political, social, or cultural power (Gaventa & Cornwall, 2015). However, given the intricacies of many public health issues such as violence or substance use, the failure to fully include and analyze the input of individuals with "lived experiences" may result in the exclusion of important model structures (i.e., parameters and loops).

The current article explores a strategy to improve the representation of vulnerable individuals when constructing a model related to intimate partner violence (IPV) and alcohol misuse (AM), with a focus on inequities experienced by American Indian/Alaskan Native (AIAN) women. These are both two highly sensitive and stigmatized topics. We discuss how conducting multiple short modeling sessions with different "target population" groups provides a more detailed picture of the knowledge related to these topics, rather than involving a single "personal experience" representative group. Additionally, we show that the incorporation of more than one modeling session can reduce participant burden and maximize input.

1.2 Case Study: Disparities in the association between alcohol misuse and intimate partner violence within American Indian women

Project SYNCH (SYstems of Native Community Health) is an ongoing CBSD model project based in a Northern Plains small metro area with a substantial AIAN population. It is a community-based partnership between researchers and stakeholders representing community

interests (e.g., institutions related to Native cultural resources, intimate partner violence (IPV), substance use prevention and intervention, and services related to mental health, prenatal and maternal health, housing and homelessness, child welfare, and justice and law).The project focuses on the role of IPV in developing strategies to address alcohol-exposed pregnancy health disparities within these communities. Community engagement involves both advisory board meetings and continual outreach/networking to build the capacity for developing and refining an alcohol-exposed pregnancy CBSD model.

Below, we focus exclusively on model development pertaining to the association between alcohol misuse (AM) and IPV, which is a core component of the syndemic association between AM, IPV, and risky sexual behavior that can underlie alcohol-exposed pregnancies (Deutsch, 2019; Gilbert et al., 2015; Eaton et al., 2012).

1.2.1. The relationship between alcohol misuse and intimate partner violence

The association between IPV and AM is well established. IPV is a precedent and antecedent of AM (Cafferky et al., 2018; Capaldi et al., 2012). IPV events are more likely to occur on alcohol-using days compared to non-alcohol using days (Stuart et al., 2013; Shorey et al., 2011), and within alcohol-using couples (Lipsky et al., 2005; Cunradi et al., 2015). In turn, AM is a coping mechanism that is often associated with trauma and stress-related events. These behaviors can be brought upon by individual IPV events (Dibello et al., 2017; Flanagan et al., 2014) and long-term relationship conflicts that accumulate over time due to IPV-related events (Eckhardt et al., 2015). Repeated increases of AM and IPV can lead to a habitual pattern of partner interaction in which these behaviors become part of a continual cycle of interpersonal conflict (Katerndahl et al., 2014). Individuals may also carry these patterns over to new romantic relationships (Testa et al., 2003).

There are additional far-reaching influences on proximal and distal matters of AM and IPV. Intrapersonal AM and IPV factors include: mood disorders such as depression and anxiety, (Capaldi et al., 2012; Devries et al., 2007), coping skills (Flanagan et al., 2014), and adverse childhood experiences (Strine et al., 2012; Steel et al., 2017). Interpersonal social/familial environments such as partner AM (Golinelli et al., 2009; Leadley et al., 2000), family conflict (Eckhardt et al., 2015), and low social support (Wenzel et al., 2004; Moak & Agrawal, 2009) also contribute to this association. Community factors that also have an impact are enhanced personal involvement with justice and social service systems (Marsh & Smith, 2011; Macy & Goodbourn, 2012; Stone, 2015) as well as residence in areas with limited resources (e.g., hospitals, clinics, community centers). Overburdened infrastructure, increased social disorganization (e.g., low social cohesion) and violence (Cunradi, 2007; Goodman et al., 2009) also have an impact on AM and IPV. These social factors can enable increased rates of re-victimization and perpetrator recidivism (Cateno & Goodman, 2005; Humphresy et al., 2005).

1.2.2. Health disparities within American Indian communities

In the US, it is reported that American Indian/Alaskan Native (AIAN) populations have AM rates (e.g., alcohol use disorder) that are disproportionately higher than the general population (Grant et al., 2015; Vaeth et al., 2017). Similarly, AIAN individuals experience higher rates of violent victimization (Sapra et al., 2014; Stockman et al., 2014). AM and violence rates are often sustained within AIAN communities intergenerationally. Like many health disparities experienced by AIAN communities, AM and IPV are exacerbated by historical trauma such as cumulative psychological distress from mass community trauma across generations. The subjugation of tribes through violence, forced relocation to reservations or cities, familial disruption via mandatory child enrollment in boarding schools, and suppression of cultural practices, language, and identity (Evans-Campbell, 2008; Wilmon-Hague & Bigfoot, 2008) are

all components of the historical anguish. These factors have affected AIAN communities since their colonization (Yellow Horse Brave Heart, 2011). Such experiences have cultivated mistrust of non-Indigenous, colonialist institutions (South Dakota Advisory Committee, 2000). Despite the efforts to pay reparation to the AIAN communities, discrimination and marginalization have persisted, further increasing stress and maintaining rates of AM and IPV (Burnett & Figley, 2016; Walters et al., 2002).

The systems that define and sustain AM and IPV are deeply interconnected to mechanisms underlying AIAN health disparities. This includes higher poverty rates, community violence, neighborhood disorganization, and less access to health and wellness services (Sarche & Spicer, 2008). Heightened mistrust of and mistreatment by the government and colonialist-based institutions additionally facilitate AIAN's low engagement in health services (Oetzel et al., 2007). Although many culture-based substance use and violence prevention programs have proven more effective for AIAN communities compared to traditional evidence-based practices (Gone & Looking, 2011; Lowe et al., 2012), there is still limited access to such culturally based services even in areas with high AIAN representation.

2. Methods

2.1. Participants

Participants who contributed to the models discussed below were clients from three organizations within our target community. Group 1: a faith-based reentry program for women who were previously incarcerated. Group 2: a substance use treatment program for pregnant women and mothers, and Group 3: a domestic violence shelter. The modelers/group facilitators, (consisting of the Principal Investigator and lab staff from Project SYNCH), received permission from organization leaders prior to participant recruitment to conduct the group model sessions. These sessions were open to all clients of the specific organization who were available to participate. There was one modeling session held within each organization. Group 1 consisted of five women, Group 2 consisted of twenty women, and Group 3 consisted of four women.

To increase anonymity and comfort while discussing sensitive issues, we did not collect any identifying information from participants. However, we learned during the sessions that the majority of participants in each group self-identified as AIAN (although this was never asked explicitly by the session facilitators). All research activities were approved by the research institution's Institutional Review Board.

2.2. Procedure

In preparation for the three sessions, we aimed to create a script (e.g., a facilitation guide which outlined how to conduct the group model activities) that provided: 1) sufficient time to develop a causal loop diagram model while accommodating busy schedules and external demands of participants, and 2) accounting for potential emotional or psychological distress brought upon when discussing highly personal issues. After consulting with our community partners, including our contacts at the participating organizations, we decided to modify the scripts to fit a 1 ½ hour timeframe. To shorten the session, we did not include behavior-over-time graphs—which is an initial activity within a group modeling session (Hovmand et al., 2012). We initially planned for participants to build their own models without facilitator guidance (e.g., session facilitators would not be drawing diagrams, leading or prompting discussions, or selecting variables). Instead, we opted for an informal "talking circle" (e.g., Hodge et al., 1996) style structure by prompting discussion with a question or variable, which allowed for conversation to progress

naturally and respectfully, and encourage new insights, ideas, and themes to progress naturally, with a facilitator serving as the model illustrator.

Prior to each session, organization leaders informed clients of an opportunity to participate in a research focus group for which they would be compensated $50. Organization leaders made sure to emphasize that participation was optional. The research team then met with any interested potential participants prior to the session to explain the project and discuss how CBSD can help achieve project goals (e.g., reducing AM, IPV, and alcohol-exposed pregnancy). We also disclosed our own personal/professional experiences and interests in these subjects to facilitate an environment of openness and trust. Finally, we discussed group modeling procedures and the value of participants' stories, highlighting the opportunity to be a co-owner of the model through participation.

Consent forms were read and discussed by all participants prior to participation in group modeling sessions. The operational definitions of both AM and IPV (presented in Table 1) were also explained. Participants wrote down three causes and three effects for IPV and AM. These variables were then placed on a wall and grouped thematically by the facilitators (e.g., variables related to mental health such as depression, anger, low self-esteem). Participants then voted for the most important causes and effects by placing stickers on their top three choices.

Using a large whiteboard visible to the group, the modeling facilitator drew a small causal loop diagram between IPV and AM to provide an example of positive and negative associations between variables. Participants first discussed if AM caused IPV and vice versa. They were then asked if these relationships were positive (if one variable changes, the other also changes in the same direction) or negative (both variables change in opposite directions). The facilitator then selected the variable with the most votes and asked about causal connections to both IPV and AM, and if relationships were positive or negative. The conversation then proceeded organically, as participants discussed and were encouraged to contribute additional variables and connections. The modeling facilitator asked for group consensus for each variable and connection added.

During times in which the group seemed stuck regarding how to proceed, the facilitator would encourage the group to think about the next popular idea generated during the variable elicitation. This process would continue until the allotted hour and a half concluded, after which the participants received their compensation. After the session, the facilitators thanked participants, emphasized the importance of their contribution to these models, and discussed ways in which they could stay informed about the activities of Project SYNCH.

3. Results

Table 1 presents all the variables used in the models presented in this study (Figure 1 and Supplemental Figures 1-3). Except for IPV and AM, which were pre-defined, all variables were defined in three main ways. First, variables were defined through the modeling process when discussing how to translate thematic ideas from the variable elicitation activity to the modeling activity. For example, mental health was characterized by determining a reasonable neutral variable (not inherently positive or negatively valenced) that would capture many of the aspects that had been suggested as both cause and effects during the elicitation process (e.g., self-esteem, depression, and insecurities). Similar processes were conducted for variables such as social support (isolation, abandonment, lack of support system) and relationship functioning (cheating, partner fighting, jealousy). Variables were also defined through the discussion and development of the model. For example, a discussion that reported IPV to the police was an essential link between IPV and justice system intervention. Also, other variables were standardizations of terms that had similar definitions but different names. This was done to increase our ability to compare models. "Legal troubles" (Group 2) and "jail" (Group 1 and 3) became "justice system intervention." "Negative partners (broken person)" (Group 1) and "relationship functioning"

(Group 3) changed to "relationship functioning" (this shows links between negative partners and other variables from Group 1). "Family and emotional health" (Group 1) and "family functioning" (Group 3) became "family functioning", and "<Name of Mental Health Resource>" (Group 1) and "mental health resources" (Group 2) became "mental health resources."

"Cop/police skills," "personal strength," "stressful events," and "death" were removed as they were external variables not connected to a specific loop. "Drugs" was also removed to focus exclusively on alcohol use.

Table 1: Operational Definitions for all variables presented in Figure1 and Supplemental Figures 1-4

Variable Name	**Definition**	**Groups**
Accountability	An obligation or willingness to accept responsibility	1,2
Alcohol Misuse	A pattern of drinking that impacts one's life negatively, potentially harming health and relationships; an individual that continues to drink even after experiencing consequences, needing alcohol to cope with life or deal with daily functions, or sacrificing other aspects of life (activities, relationships) to drink	1,2,3
American Indian Cultural Identity	Identifying as AIAN; incorporating tribal and cultural knowledge, history, and/or practices as a part of one's identity.	2
Child Removed from Home	Legal/institutional intervention (e.g., Child Welfare, Department of Social Services) removing a child from the home and care of his parent or guardian.	1, 3
Children Witness IPV in House	Children witnessing IPV within their family (typically parents/adults/caregivers)	3
Childhood Home Functioning	The quality of the overall relations within a family as determined between social, emotional, and behavioral interactions with family members. Also incorporates quality of care/support received by a child (e.g., meeting their physical, emotional, and mental needs)	2
Community Acceptance of Alcohol Misuse	Acceptance of AM within a community; perceived norms related to the level of acceptance	3
Community Acceptance of Intimate Partner Violence	Acceptance of IPV within a community; perceived norms related to the level of acceptance	3
Community Alcohol Misuse Rate	The rate of AM within a community	3
Community Intimate Partner Violence Rate	The rate of IPV within a community	3
Coping	Skills and abilities related to managing feelings and thoughts in a productive, healthy manner	1,2
Court Order to Mental Health Resources	Legal mandate for receiving and engaging in mental health resources.	3
Desire to stop the family cycle	Understanding an intergenerational history of violence and/or AM in one's family, wanting to stop transmission to children within a family unit.	3
Dire Situations	Experiences in which one's life is in danger through either an added threat or the removal of basic survival needs.	1
Experienced Caseworker Mistreatment	Experiencing mistreatment (e.g., stigma, shaming, hostility, bias, marginalization) from assigned child welfare caseworkers	3
Family Functioning	The quality of the overall relations within a family as determined between social, emotional, and behavioral interactions	1,2,3
Fear of Partner	To be afraid of a partner's negative or violent behavior – especially as directed towards others	2
Healing	Emotional/mental recovery from prior trauma or disorder	1
Higher Power	Belief of and faith in a higher power (e.g., power greater than ourselves) – can be reference to a specific religion or spirituality	1
Historical Trauma	Collective trauma (e.g., genocide, targeted oppression, and violence) experienced by a community or group related to long-term social, mental, and physical harm	2
Intimate Partner Violence (IPV)	The deliberate mental, physical, social, emotional, financial, or spiritual harm of a romantic or sexual partner in order to exert power/control	1,2,3
IPV Reporting	Contacting the police to report a case of IPV	2
Justice System Intervention	Contact with policing or legal institutions leading to the enforcement of corrective orders	1, 3
Mental Health	Absence of negative cognitions, feelings or mental disorders (e.g., depression, fear, anxiety) that impede daily life	1,2,3
Mental Health Resource	Resources related to the improvement of mental health	1,3

Variable Name	Definition	Groups
Learning about [your] American Indian Culture	Understanding of traditional tribal beliefs, norms, customs, and practices associated with one's affiliated tribe and familial history	2
Leaving Abusive Partner	Dissolving the romantic relationship (e.g., breaking up, leaving the house)	3
Pursuing Couples Therapy	Utilizing couple's therapy to improve the relationship between romantically involved individuals	3
Partner Dependence	Relying on your partner for social, financial, and mental needs – in IPV relationships, a partner forcing or coercing dependence upon them is a form of control.	2
Partner Willingness to Change	Partner's receptiveness to modifying their behavior (e.g., violent/abusive behavior), to improve the romantic relationship	3
Relationship Functioning	The quality of a romantic relationship determined by social, emotional, and behavioral interactions between partners	1,2
Social Support	Healthy, supportive relationships that provide external support and care for individuals	1,2
Stress from Child Welfare Intervention	Stressors that arise trying to fulfill and comply with the regulations and obligations necessary for reunification with one's child through child welfare and legal institutions	3
Structured and Caring Environment	An environment in which there is structure regarding activities, duties, interactions, and meeting needs framed by a culture of support and encouragement of others	1

3.1 Group 1

The Group 1 model was developed with participants from a faith-based reentry facility—see Supplementary Figure 1 for the variables and loops that we discuss below. There are 15 variables pertaining to the AM-IPV system. Given the organizational emphasis on mental health and well-being, many of the variables relate to therapeutic and mental care such as accountability and coping. There are multiple reinforcing loops relating to sustaining AM and IPV. Both AM and IPV increase the removal of children from home, which cause a decreased mental health. In turn, decline in mental health facilitate increases in IPV and AM and declines in multiple variables that improve mental health. Some examples of those variables are social support, healing, accountability, and endorsement of a higher power.

Mental health resources and endorsement of a higher power are central linchpins for balance. AM and IPV increase justice system intervention in dire situations, leading to increases in mental health resources and endorsements in a higher power. These variables are catalysts for increasing multiple aspects of mental health and related variables, leading to decreases in both IPV and AM. Higher mental health resources increase caring and structured environments, which in turn increase accountability and healing. These both result in lower rates of IPV.

3.2 Group 2

The Group 2 model was developed with participants at a substance-use rehabilitation facility for pregnant women and mothers (displayed in Supplementary Figure 2). For this model, the key mechanism relates to the maintenance of AM and IPV was support systems. Higher IPV related to lower support systems. Declines in these support systems increase IPV (directly and through lower relationship functioning), as well as AM (through decreased mental health). Although this model does not feature balancing loops, there are two sub-areas that have potential for becoming part of a balancing loop. The first sub-area focuses on IPV reporting. Although increases in IPV expectedly lead to increases for the justice system, Group 2 spent time discussing potential barriers and key intermediaries between IPV and jail, particularly IPV reporting. At the end of the discussion, it was decided that although increases in IPV would lead to increases in IPV reporting (rather than directly to justice system intervention), increases in fear of partner and dependence on partner lead to declines in IPV reporting. Conversely, increasing both accountability and support systems lead to increases in IPV reporting.

The second sub-area that was discussed was the role of AIAN identity and culture, and its impact on childhood home functioning. Although childhood home functioning was an external

variable in the Group 2 model, its impact on support systems and AM/IPV, indicates that it may be a highly influential variable. The importance of the role of AIAN culture is the cultivation of identity for improving childhood home functioning, as well as the role that continual historical trauma has had in decreasing AIAN cultural exposure and on childhood home functioning itself. This topic was discussed and evaluated in depth by the group.

3.3 Group 3

The Group 3 model was developed with participants at a domestic violence shelter (see Supplementary Figure 3). Similar to the model from Group 1, mental health plays a reinforcing role for both IPV and AM. Unique to the Group 3 model was the role of child welfare services, which was shown as an additional way to reinforce AM. AM increases children being removed from the home, which decreases mental health, increasing AM. Child removal from homes also leads to further child welfare intervention. This increases AM directly, as well as increasing case worker mistreatment, which subsequently decreases mental health. A second area for reinforcement that was unique to the Group 3 model was community norms and behavior. Participants discussed the cycle of individual-level AM and IPV influencing community rates, which reinforce community-level acceptance. Normative acceptance of AM and IPV would subsequently facilitate individual-level AM and IPV.

Similar to Group 1, balancing loops in the Group 3 model centered on mental health resources. Both AM and IPV increase justice system intervention, which increase court orders for mental health resources, obtaining mental health resources, and subsequently, increase overall mental health and decrease AM and IPV. However, Group 3 participants also discussed the way in which the desire to stop family (intergenerational) cycles of AM and IPV can become a potential turning point for change. Children witnessing IPV in the house increased the desire to stop the family cycle. This is related to increases in engagement with mental health resources. Wanting to stop the family cycle also increases both pursuing couples' therapy and leaving abusive partners. Participants agreed that this was contingent upon the partners' willingness to change. An escalation in both couples therapy and leaving the abusive partner result in decreased IPV statistics as well.

3.1. Conceptual Thematic Model

In total, there were 35 variables generated from the three groups. Out of the 35 variables, 23 of them were only mentioned in one of the three groups. This indicated the broad array of perspectives, viewpoints, and experiences expressed by individuals considered part of the population of interest. Figure 1, referred to as our "conceptual" model, provides the main thematic constructs that combine all three individual organizational models. Colors for the model indicate the individual contributions of each group. Group 1 (the faith-based reentry facility; blue), Group 2 (the substance use rehabilitation for pregnant women or mothers; red), Group 3 (the domestic violence shelter; green), and the consensus contributions (black). For efficiency, not every variable or link is presented in the conceptual model depicted in Figure 1. We present the individual organization models (Supplementary Figures 1–3). Below, we focus on discussing the differences in thematic contributions, rather than detailed descriptions of the content of each model.

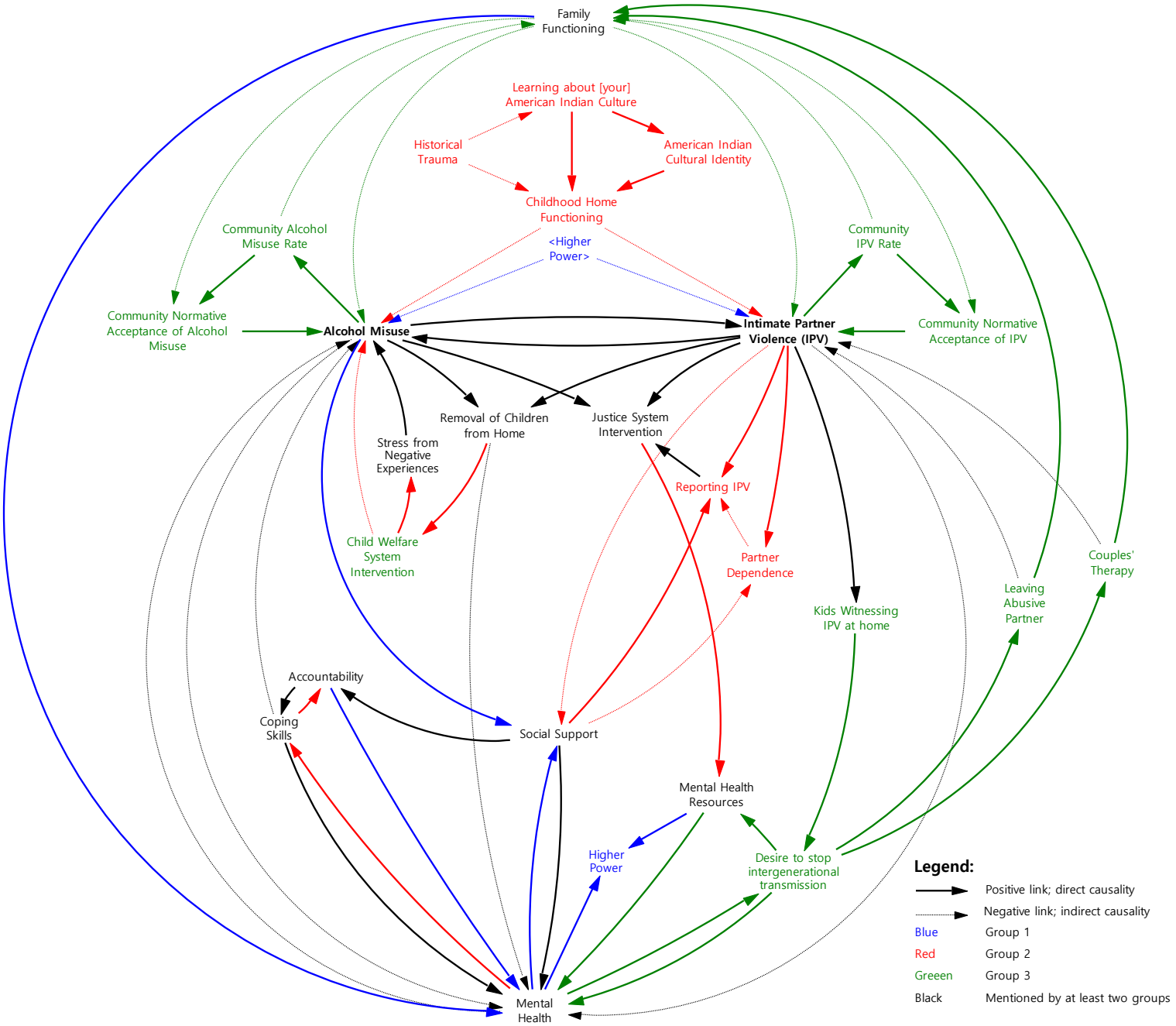


Figure 1: Conceptual thematic causal loop diagram model representing the consolidation of all three individual organization group models

As seen in Figure 1, there was little overlap in what was discussed between all three groups. All three groups discussed the bidirectional reinforcing loops between heightened rates of AM and IPV, as well as decreased rates of mental health. Some variables that were mentioned in two of the three groups were: legal removal of children from the home, (current) family functioning, coping skills, accountability, justice system intervention, (intimate partner) relationship functioning, mental health resources, and social support. Taking these factors into consideration, the conceptual model is a rich depiction of the way that individual, intrapersonal, and community level constructs contribute to the maintenance of both IPV and AM within a complex system. Critical subthemes, such as the mental health process, engagement in child welfare and justice institutions, community norms, and the importance of AIAN culture and identity to childhood family wellbeing, were unique contributions from the individual groups. There were also key factors that were important for multiple subthemes. For example, social support connects to both mental wellbeing (mental health subtheme) and the justice subtheme through partner dependence. New and potentially important system areas were also created when combining models. Family functioning, although having relatively minor systemic influence in individual models, was an important connector between "community norms" and "individual mental health" in the conceptual model.

4. Discussion

The purpose of this study was to explore a way in which CBSD models can increase diverse perspectives of individuals with personal experience of stigmatized public health issues. There are more barriers for equitable representation of participants with personal experience, compared to professional, political, or academic expertise in the modeling development process. However, such inclusion is not only good CSBD practice but also essential to the development of models that represent the real-world system. The current study demonstrates that it is feasible to build inclusive models with a variety of participants through the partnership with collaborative organizations. In addition, differences between group models demonstrate the need and strength of diversity in regards to the ways that modeling issues of interest are experienced by individuals.

4.1 Lessons learned from the group modeling process

One strength of system dynamics is its accessibility to a wide variety of laymen and professionals (Frerichs et al., 2016). The visual language of systems models can translate complicated experiences and situations into a coherent story that is easy to follow. The organization leaders who we partnered with, all of whom were tasked with providing services to vulnerable populations, were acutely aware of the need for a systems perspective to address public health issues. In the group model sessions, participants were quick to understand how AM and IPV could be conceptualized as part of a broader system. For some of the women who participated in our groups, discussions elicited personal memories of trauma or distress. However, the modeling process also elicited a sense of empowerment among the groups. System dynamics models translated the intricate interaction of IPV and AM into a more tangible representation.

Community-based projects are dependent upon buy-in and trust (Wallerstien & Duran, 2010). The project mission must be relevant to community interests, and community members must trust the research partners enough to contribute both time and effort to the project. Both the organization leaders and participants were excited about discussing the relation between

IPV and AM, particularly as it relates to health disparities within AIAN communities. As the public and scientific communities have increasingly recognized the ongoing violence and victimization taking place in Indian Country (e.g., Missing and Murdered Indigenous Women; Rosay, 2016; Whitebear 2019) and the role of intergenerational and historical trauma on current day health disparities (Gone & Trimble, 2012), this project was timely and relevant to the community.

An open, transparent dialogue with the participants prior to the modeling session encouraged enthusiastic participation in the group modeling sessions. This included: 1) a discussion of the intended outcomes of the project in regards to direct benefits and contributions to the community; 2) talking about our personal backgrounds, including personal experience with the subjects of interest or related subjects; and 3) acknowledging our outsider status, and emphasizing our need for the participants' guidance to ensure project success. We also answered any questions about our personal interests in this project. Wariness towards researchers/research is common in marginalized communities that have experienced "helicopter research" (e.g., research that provides no actual benefit to the community, only to the research team (Mosavel & Simon, 2010)), and therefore open discussion about research motives is often necessary.

Partnering with organizations that serve vulnerable and marginalized individuals was a powerful way to reach out to a variety of potential participants. Project SYNCH allowed for a time and space to share a meal and information with women as a group, reducing the general organization's burden to recruit participants, as well as the burdens of participation for the clients (who did not need to reach out personally to the researchers or re-arrange schedules to accommodate for participating in the session). Taken together, striving to remove practical barriers for participating and build genuine researcher-participant relationships helped ensure session success.

4.2 Lessons learned from the group models

Many variables and loops that participants discussed have been broadly explored in empirical and applied research from a variety of disciplines (e.g., mental health: Capaldi et al., 2012; Flanagan et al., 2014, social support: Wenzel et al., 2004, relationship health: Eckhardt et al., 2015, community influences: Goodman et al., 2009). Importantly, participants were able to collaboratively develop complex dynamics that extended beyond any individual area of research, policy, or practice. While this model incorporates the well known links between mental health, trauma, and both AM and IPV, it also includes an understanding of reciprocal influence between individual, familial, and community contexts (e.g., socioecological models; Bronfenbrenner, 1986). A practical understanding of barriers for seeking help within IPV-relationships marked by power inequity (e.g., partner dependence via power and control; Ali, Dhinga & McGarry, 2016) also aided in further understanding this relationship. However, a comprehensive understanding of the ways in which these variables relate to each other was only made possible by the inclusion of a variety of participants with different perspectives. Although other types of stakeholders – practitioners, policymakers, administrators, or academics – would be likely to come up with similar contributions to a model, the breadth of the perspectives provided in the three groups was important for developing a modeling framework that can further be developed and refined with additional groups.

The current model demonstrates several important systems relevant to those with personal experiences with AM/IPV that are particularly relevant for AIAN communities. A

clear finding is the perceived negative impact of child welfare systems on personal and familial wellbeing. AIAN families are disproportionately represented in child welfare systems (Lawler et al., 2012) and out-of-home placements (Donald et al., 2003). Childrearing and caregiving have a strong significance in many AIAN cultures. Separation from children, particularly given the legacy of familial disruption (e.g., forced placement in boarding school, Indian Welfare Act (Crofoot & Haris, 2012; Halverson, Puig, & Byers, 2002), current cultural conflict, and perceived prejudice experienced through engagement with the child welfare system, may substantially increase stressors for AIAN mothers. Another key, but often under looked, variable is the importance of recognizing the cycles of intergenerational transmission of both violence (Evans-Cambell, 2008) and AM (Myhra & Wieling, 2014), and how the desire to stop this transmission can be a catalyst for change (Myhra, 2011). As more prevention and intervention programs for AIAN youth focus on teaching culture and developing identity as a strategy to improve psychological wellbeing (Gone & Looking, 2011), a desire to stop the cycle can also relate to the AIAN identity-child home functioning subsystem discussed by participants.

Although the modeling team did not explicitly discuss the ways in which specific areas may relate to AIAN health disparities, it allowed for participants to explore areas that were salient to them. Using this model as a starting point for continued discussion and exploration of these areas in future sessions will help elucidate system structures that maintain health disparities and aid the search to eliminate them.

Limitations

Although we were able to work with three groups of qualitatively distinct participants, a common thread was their affiliation with an organization or resource. For the current study, our effort to include a diverse group of individual was more successful through organization-based recruitment compared to community-wide participant recruitment. However, the main limitation of this approach is that it isolates participants to a "personal experience" or an organization-affiliated group which limits generalization. The models presented here are part of a larger body of modeling sessions, all of which are eventually incorporated into a single, holistic, and/or representative model. However, this method has a considerable drawback in its inability to facilitate inclusive groups of stakeholders from a wide variety of backgrounds. More inclusive groups may provide opportunities for the community and the participants themselves to discuss, discover, and negotiate how systems should be modeled. Such groups are ideal for CBSD (Kirlay & Misclolzi, 2019), and healthy conflicts that arise within these groups often lead to not only a richer model (Metcalf 2008), but also a more informed community. Unfortunately, there are multiple barriers to including a proportional number of marginalized, stigmatized, or vulnerable individuals in such groups. These barriers include the long-term time commitments and issues with power balances, and fear of stigmatization or the potential for increased psychological distress. For individuals who are in the process of experiencing the issue at hand in particular (those in a violent relationship, those who are recovering from substance abuse), open participation in a group model session may only be possible in more insular groups.

Given the limited time that we had, we were not able to explore or develop some model areas that require further discussion. Although a 1 ½ hour time frame was a reasonable amount of time to have a discussion and develop the start of a model, there were obvious areas in the models that could be elaborated upon. For example, the reciprocal relationship between mental health and social support networks: the better your mental health, the more you can develop

meaningful and supportive relationships. And the more meaningful and supportive relationships you have, the better your mental health. The way in which mental health associates with social support network formation, maintenance, and dissolution (as well as the characteristics of the individuals who make up the support network) would likely provide more meaningful insight into potential areas for interventions compared to a broad "social support" variable. We suggest that it may benefit researchers to visit with participants multiple times, if feasible, such that "under-developed" loops can be further explored.

Implications and Future Directions

Building models of stigmatized public health issues, particularly those that have substantial health disparities among marginalized groups, requires an equitable representation of diverse individuals. As shown in this study by the diverse perspectives of individuals with personal experience, equity is not only about equal numbers of individuals. Is it also about accounting for the diversity of expertise in different areas of the system as it proves important to those with personal experience, compared to those with professional experience. It is important to note that we suggest this method be used to complement other group model sessions and strategies, rather than as a substitution for all other forms of CBSD model development. A core modeling group that is able to refine a cohesive model is essential for the iterative process necessary for model development, and ideally this group would include participants from the prior personal experience groups.

Understanding the diversity of contributors does not have to be exclusive to those with personal experience. Rather than having a few representatives of different subsystem components, group modeling sessions with individuals who represent separate components of a subsystem may also provide diverse, otherwise ignored perspectives critical for model accuracy. Sessions with individuals who provide a specific social service from public, private, and non-profit sectors may have more useful and comprehensive information compared to a broader model session in which only one or two social service representatives would participate.

Declarations of interest: None

References:

Ali PA, Khingra K & McGarry J (2016). A literature review of intimate partner violence and its classifications. Aggression Violent Behavior, 31, 16 – 25. Doi: 10.1016/j.avb.2016.06.008

Allard, S. W. (2008). Accessibility and stability of nonprofit service providers: Faith-based and community-based organizations in urban and rural America. In Joshi, P., Hawkins, S., Novey, J. (Eds.), Faith-based and community initiatives: Conference on research, outcomes, and evaluation (pp. 79-102). Washington, DC: U.S. Department of Health and Human Services.

Apostolopoulos Y, Lemke MK, Barry AE & Hassmiller Lich K. (2018). Moving college drinking prevention research forward–Part I: Introducing a complex systems paradigm. Addiction, 113, 353–362. , doi:10.1111/add.13955.

Batchelder AW, Gonzalez, JS, Palma A, Schonenbaum E, & Lounsbury DW. (2015). A socioecological model of syndemic risk affecting women with and at–risk for HIV in

impoverished urban communities. Amer J Community Psychol, 56, 229–240. 10.1007/s10464-015-9750-y.
Bridgewater K, Peterson S, McDevitt J, Hemenway D, Bass J, Bothwell PL & Everdell, R. (2011). A community-based systems learning approach to understanding youth violence in Boston. Progress Community Health Partnerships, 5, 67–75. doi: 10.1353/cpr.2011.0011.
Bronfenbrenner U. (1986). Ecology of the family as a context for human development: research perspectives. Developmental Psychol. 22:723–742. doi:10.1037/0012-1649.22.6.723.
Burnette CE & Figley CR. (2016). Risk and protective factors related to wellness of American Indian and Alaska Native youth: A systematic review. Int Public Health J, 8, 137–154.
Carey G, Malbon E, Carey N, Joyce A, Crammond B & Carey A. (2015). Systems science and systems thinking for public health: A systematic review of the field. BMJ Open, 5, e009002
Cafferky BM, Mendez M, Anderson JR & Sith SM. (2018). Substance use and intimate partner violence: A meta-analytic review. Psychol Violence, 8, 110–131. doi: 10.1037/vio0000074
Capaldi, DM, Knoble NB., Shortt JW & Kim HK (2012). A systematic review of risk factors for intimate partner violence. Partner Abuse, 3, 231–280. doi: 10.1891/1946-6560.3.2.231
Catteneo LB & Goodman LA (2005). Risk factors for reabuse in intimate partner violence. A cross-disciplinary critical review. Trauma Violence Abuse, 6, 141–175. doi: 10.1177/1524838005275088
Crofoot TL & Harris MS (2012). An Indian Child Welfare perspective on disproportionality in child welfare. Child Youth Serv Rev, 34, 1667 – 1674.
Cunradi CB (2007). Drinking level, neighborhood social disorder, and mutual intimate partner violence. Alcoholism: Clin Exp Res, 31, 1012–1019. doi: 10.1111/j.1530-0277.2007.00382.x
Cunradi CB, Todd M & Mair C. (2015). Discrepant patterns of heavy drinking, marijuana use, and smoking and intimate partner violence: Results from the California Community Health Study of Couples. J Drug Educ, 45, 73–95. doi:10.1177/0047237915609450
Deutsch AR (2019). The importance of intimate partner violence in within–relationship and between-person risk for alcohol-exposed pregnancy. Alcoholism: Clin Exp Res, 43, 679–689.
Devries KM, Child JC, Bacchus LJ, Mak J, Falder G, Grahm K, …& Heise L (2014). Intimate partner violence victimization and alcohol consumption in women: A systematic review and meta-analysis. Addiction, 109, 379–391. doi: 10.1111/add.12393.
Dibello AM, Preddy TM, Overup CS & Neighbors C. (2017). Understanding the context of romantic partner relational victimization: Links between relationship satisfaction, depressive symptoms, and alcohol-related problems. Psychol Violence, 7, 543–522. doi: 10.1037/vio0000064
Donald KL, Bradley LK, Day D, Critchley R & Nuccio KE (2003). Comparison between American Indian and non-Indian out-of-home placements. Families Society: J Contemporary Soc Services, 84, 267–274.
Eaton LA, Kalichman SC, Sikkema KJ, Skinner D, Watt MH, Pieterese D & Pipitan E (2012). Pregnancy, alcohol intake, and intimate partner violence among men and women attending drinking establishments in a Cape Town, South Africa Township. J Community Health, 37, 208–216.
Eckhardt CI, Parrott DJ & Sprunger JG (2015). Mechanisms of alcohol-facilitated intimate partner violence. Violence Against Women, 21, 939–957. doi: 10.1177/1077801215589376

Ellard–Gray A, Jefferey NK, Choubak M & Crann SE (2015). Finding the hidden participant: Solutions for recruiting hidden, hard-to-reach, and vulnerable populations. Int J Qual Methods, 14, 1 – 10. doi: 10.1177/1609406915621420

Evans-Campbell T (2008). Historical trauma in American Indian/Native Alaska communities: A multilevel framework for exploring impacts on individuals, families, and communities. J Interpersonal Violence, 23, 316–338. doi: 10.1177/0886260507312290.

Flanagan JC, Jaquier V, Overstreet N & Swan SC (2014). The mediating role of avoidance coping between intimate partner violence (IPV) victimization, mental health, and substance use among women experiencing bidirectional IPV. Psychiatry Res, 220, 391–396. doi: 10.1016/j.psychres.2014.07.065.

Fowler PJ, Hovmand PS, Marcal KE & Das S (2019). Solving homelessness from a complex systems perspective: Insights for prevention responses. Annu Rev Public Health, 40, 465–486. doi: 10.1146/annurev-publhealth-040617-013553

Frerichs, L., Lich, K. H., Dave, G. & Corbie–Smith, G. (2016). Integrating systems science and community-based participatory research to achieve health equity. Am J Public Health 106, 215–222. doi:10.2105/AJPH.2015.302944

Frerichs L, Lich KH, Funchess M, Burrell M, Cerulli C, Bedell P & White AM (2016). Applying critical race theory to group model building methods to address community violence. Progress Community Health Partnership, 10, 443–459. doi:10.1353/cpr.2016.0051.

Gaventa J & Cornwall, A (2015). Power and knowledge. In H. Bradbury (Ed.) The Sage handbook of action research: Participative inquiry and practice (3rd ed.) Thousand Oaks, CA: Sage.

Gilbert L, Raj A, Hien D, Stockman J, Terlikbayeva A & Wyatt G (2015). Targeting the SAVA (Substance Abuse, Violence and AIDS) syndemic among women and girls: A global review of epidemiology and integrated interventions. J Acquired Immune Deficiency Syndrome, 69, S118–S127.

Goodman LA, Smyth, KF, Borges, AM & Singer, R (2009). When crises collide. How intimate partner violence and poverty intersect to shape women's' mental health and coping? Trauma Violence Abuse, 10, 306–329 doi: 10.1177/1524838009339754

Gone JP & Looking PE (2011). American Indian culture as substance abuse treatment: Pursuing evidence for a local intervention. J Psychoactive Drugs, 43, 291–296.

Gone JP & Trimble JE (2012). American Indian and Alaska Native mental health: Diverse perspectives on enduring disparities. Ann Rev Clin Psych, 8, 131–160. doi: 10.1146/annurev-clinpsy-032511-143127

Golinelli D, Longshore D & Wenzel SL (2009). Substance use and intimate partner violence: Clarifying the relevance of women's use and partners' use. J Behavioral Health Service Resources, 36, 199–211. doi: 10.1007/s11414-008-9114-6

Halverson K, Puig ME, Byers SR (2002). Culture loss: American Indian family disruption, urbanization, and the Indian Child Welfare Act. Child Welfare, 81, 319–36.

Hirsch GB, Levine R & Miller RL (2007). Using system dynamics modeling to understand the impact of social change initiatives. Am J Community Psychology, 39, 239–253. doi: 10.1007/s10464-007-9114-3

Hodge FS, Fredericks L & Rodriguez B (1996). American Indian women's talking circle. A cervical cancer screening and prevention project. Cancer, 78, 1592–1597.

Hormer JB & Hirsch GB (2005). System dynamics modeling for public health: Background and opportunities. Am J Public Health, 96, 452–458. doi: 10.2105/AJPH.2005.062059

Hovmand PS, Nelson A, Carson K. 2012. Understanding social determinants from the ground up. In Proceedings of the 2012 International System Dynamics Conference, St Gallen, Switzerland. System Dynamics Society.
Hovmand, PS (2014). Community Based System Dynamics. New York: Springer
Hovmand PS, Andersen DF, Rouwette E, Richardson GP & Rux K (2012). Group model building 'scripts' as a collaborative planning tool. Systems Res Behavioral Sci, 29, 179–193. doi: 10.1002/sres.2015
Humphreys CC, Regan L, River D & Thiara RK (2005). Domestic violence and substance use: Tackling complexity. Br J Soc Work, 35, 1303–1320. doi: 10.1093/bjsw/bch212
Kaysen D, Dillworth TM, Simpson T, Waldrop A, Larimer ME & Resick PA (2007). Domestic violence and alcohol use: Trauma–related symptoms and motives for drinking. Addictive Behaviors, 32, 1272–1283. doi: 10.1016/j.addbeh.2006.09.007
Katerndahl D, Burge S, Ferrer R, Becho J & Wood R (2014). Multi-day recurrences of intimate partner violence and alcohol intake across dynamic patterns of violence. J Eval Clin Prac 20, 711–718. doi: 10.1111/jep.12218
Lawler MJ, LaPlante KD, Giger JT, & Norris DS (2012). Overrepresentation of Native American children in foster care: An independent construct? J Ethnic Cultural Diversity Social Work, 21, 95–110.
Leadley K, Clark CL & Cateano R (2000) Couples' drinking patterns, intimate partner violence, and alcohol-related partnership problems. J Substance Abuse, 11, 253–263. doi: 10.1016/S0899-3289-3289(00)00025-0
Lich KH, Ginexi EM, Osgood ND & Mabry PL (2013). A call to address complexity in prevention science research. Prevention Science, 14, 279–289. doi: 10.1007/s11121-012-0285-2.
Lipsky S, Caetano R, Field CA & Larkin GL (2005). Is there a relationship between victim and partner alcohol use during an intimate partner violence event? Findings from an urban emergency department study of abused women. J Stud Alcohol, 66, 407–412.
Lowe J, Liang H, Riggs C, Henson J. & Elder T. (2012). Community partnership to affect substance abuse among Native American adolescents. Amer J Drug Alcohol Abuse, 38, 450–455. doi: 10.3109/00952990.2012.694534
Marsh JC & Smith BD (2011). Integrated substance abuse and child welfare services for women: A progress review. Child Youth Services Rev, 33, 466–472. doi: 10.1016/j.childyouth.2010.06.017
Macy RJ & Goodbourn M (2012). Promoting successful collaborations between domestic violence and substance abuse treatment service sectors: A review of the literature. Trauma Violence Abuse 13, 234–251. doi: 10.1177/1524838012455874.
Moak ZB & Agrawal A (2009). The association between perceived interpersonal social support and physical and mental health: Results from the National Epidemiological Survey on Alcohol and Related Conditions. J Public Health, 32, 191–201. doi: 10.1093/pubmed/fdb093
Mosavel M & Simon C (2010). Exploratory health disparities research: The need to provide a tangible benefit to vulnerable respondents. Ethics Behav, 20, 1–9.
Myrah LL (2010). "It runs in the family": Intergenerational transmission of historical trauma among urban American Indians and Alaska Natives in culturally specific sobriety maintainence programs. Am Indian Alsk Native Men Health Res, 18, 17–40.
Myhra LL & Wieling E (2014). Intergenerational patterns of substance abuse among urban American Indian familes. J Ethnicity Substance Abuse, 13, 1–22.

Oetzel J, Duran B, Jiang, Y & Lucero J (2007). Social support and social undermining as correlates for alcohol, drug and mental disorders in American Indian women presenting for primary care at an Indian Health Service hospital. J Health Communication, 12, 187–206. doi: 10.1080/10810730601152771

Reno R. (2018). Using group model building to develop a culturally grounded model of breastfeeding for low–income African American women in the USA. J Clin Nurse, 27, 3363–3376.

Rosay AB (2019). Violence against American Indian and Alaska Native women and men. 2010 findings fr4om the National Intimate Partner and Sexual Violence Study. National Institute of Justice Research Report. Retrieved from https://www.ncjrs.gov/pdffiles1/nij/249736.pdf, January 18, 2020.

Sapra KJ, Jubinski SM, Tanaka MF & Gershon RRM (2014). Family and partner interpersonal violence among American Indians/Alaska Natives. Injury Epidemiology, 1, 1–14. doi: 10.1186/2197-1714-1-7

Sarche M & Spicer P (2008) Poverty and health disparities for American Indian and Alaska Native children: Current knowledge and future prospects. Ann N Y Acad Sci, 1136 126-136. doi: 10.1196/annals.1425.017.

Shorey RC, Stuart GL & Cornelius TL (2011). Dating violence and substance use in college students: A review of the literature. Aggression Violent Behavior, 16, 514–550. doi: 10.1016/j.avb.2011.08.003

South Dakota Advisory Committee to the U.S. Commission on Civil Rights, (2000). Native Americans in South Dakota: An erosion of confidence in the Justice System.

Sterman J (2000) Business Dynamics: Systems Thinking and Modeling for a Complex World. New York: The McGraw-Hill Companies, Inc.

Stuart GL, Moore TM, Elkins SR, O'Farrell TJ, Temple TR, Ramsey S & Shorey RC (2013). The temporal association between substance use and intimate partner violence among women arrested for domestic violence. J Consult Clin Psychol, 81, 681–690. doi: 10.1037/a0032876.

Steel AL, Watkins LE & Dilillo, DK (2017). Physical abuse in childhood as a predictor of intimate partner violence perpetration among dating couples: The role of negative affect during conflict. Partner Abuse, 8, 204–219. doi: 10.1891/1946-6560.8.2.204

Stockman JK, Hayashi H, & Campbell JC (2015). Intimate partner violence and its health impact on disproportionately affected populations, including minorities and impoverished groups. J Womens Health, 24, 62–79. doi: 10.1089/jwh.2014.4879

Stone R. (2015). Pregnant women and substance use: Fear, stigma and barriers to care. Health and Justice, 3, 2. doi: 10.1186/s40352-015-0015-5

Strine TW, Dube SR, Edwards VJ, Prehn AW, Rasmussen S, Wagenfield M…., & Croft JB (2012). Associations between adverse childhood experiences, psychological distress and adult alcohol problems. Amer J Health Behavior, 36, 408–423. doi: 10.5993/AJHB.36.3.11

Testa M, Livingston JA & Leonard KE (2003) Women's substance use and experiences of intimate partner violence; A longitudinal investigation among a community sample. Addictive Behaviors, 28, 1649–1664. doi: 10.1016/j.addbeh.2003.08.04

Vennix JAM (1999). Group model building: Tackling messy problems. System Dynamics Rev, 15, 379–401.

Wallerstien N & Duran B (2010). Community-based participatory research contributions to intervention research: The intersection of science and practice to improve health equity. Amer J Public Health, 100 S40–S46

Walters KL, Simoni JM & Evans-Campbell T (2002). Substance use among American Indians and Alaska Natives: Incorporating culture in an "indigenist" stress-coping paradigm. Public Health Reports, 117, S104–S117.

Weeks MR, Li J, Lounsbury D, Green HD, Abbott M, Berman M …& Mosher H. (2017) Using participatory system dynamics modeling to examine the local HIV test and treatment care continuum in order to reduce community viral load. Amer J Community Psychol, 60, 584–498. doi: 10.1002/ajcp.12204

Wenzel SL, Tucker JS, Elliott MN, Marshall GN & Wililamson SL (2004). Physical violence against impoverished women: A longitudinal analysis of risk and protective factors. Women's Health Issues, 14, 144–154. doi: 10.1016/j.whi.2004.06.001

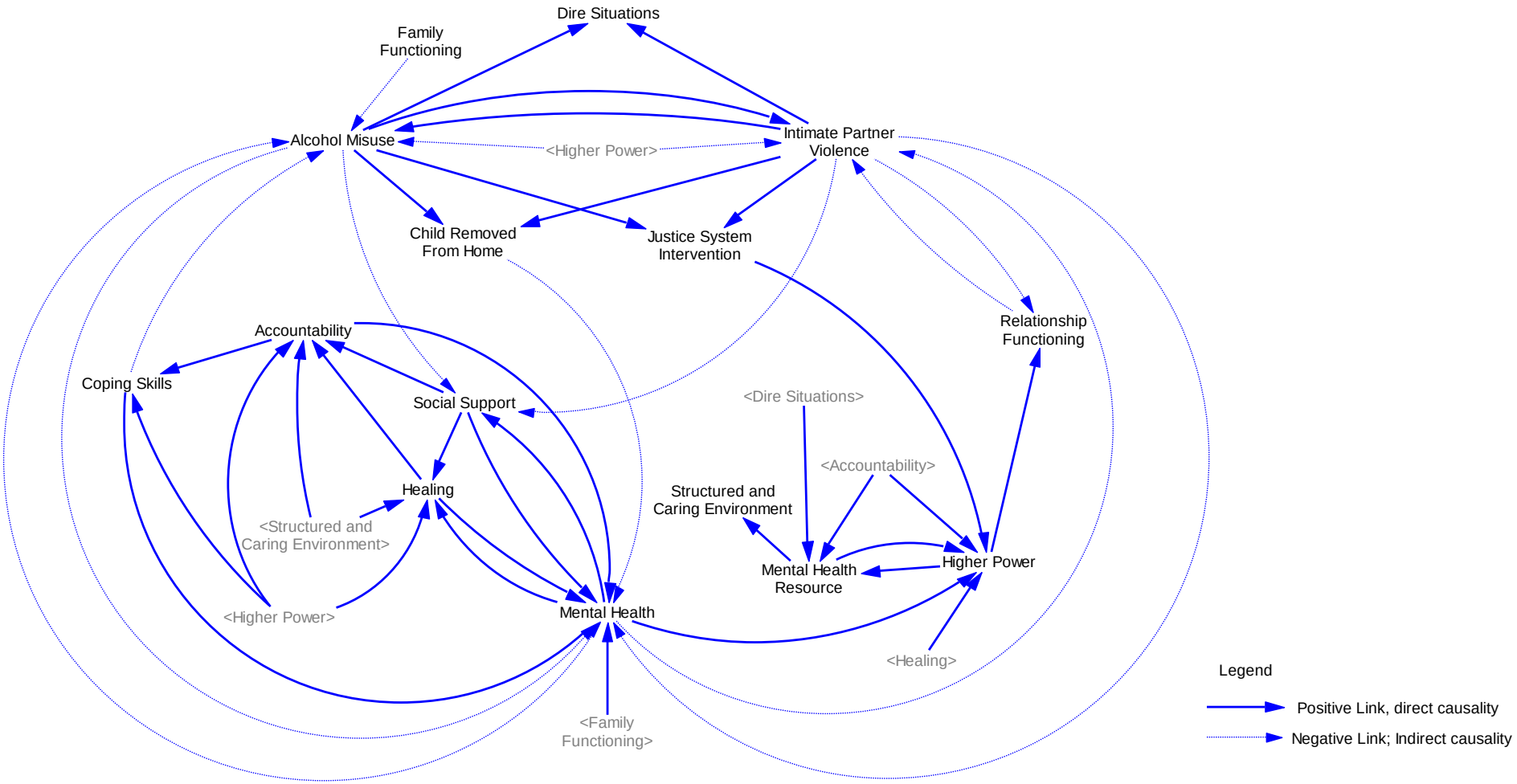
Wilmon-Hague S & BigFoot DS (2008) Violence and the effects of trauma on American Indian and Alaska Native Populations. J Emotional Abuse, 8, 51–66. doi: 10.1080/10926790801982410

Whitebear L. (2019). VAWA Reauthorization of 2013 and the continued legacy of violence against indigenous women: A critical oustisder jurisprudence perspective. U Miami Race Soc Just L Rev, 75.

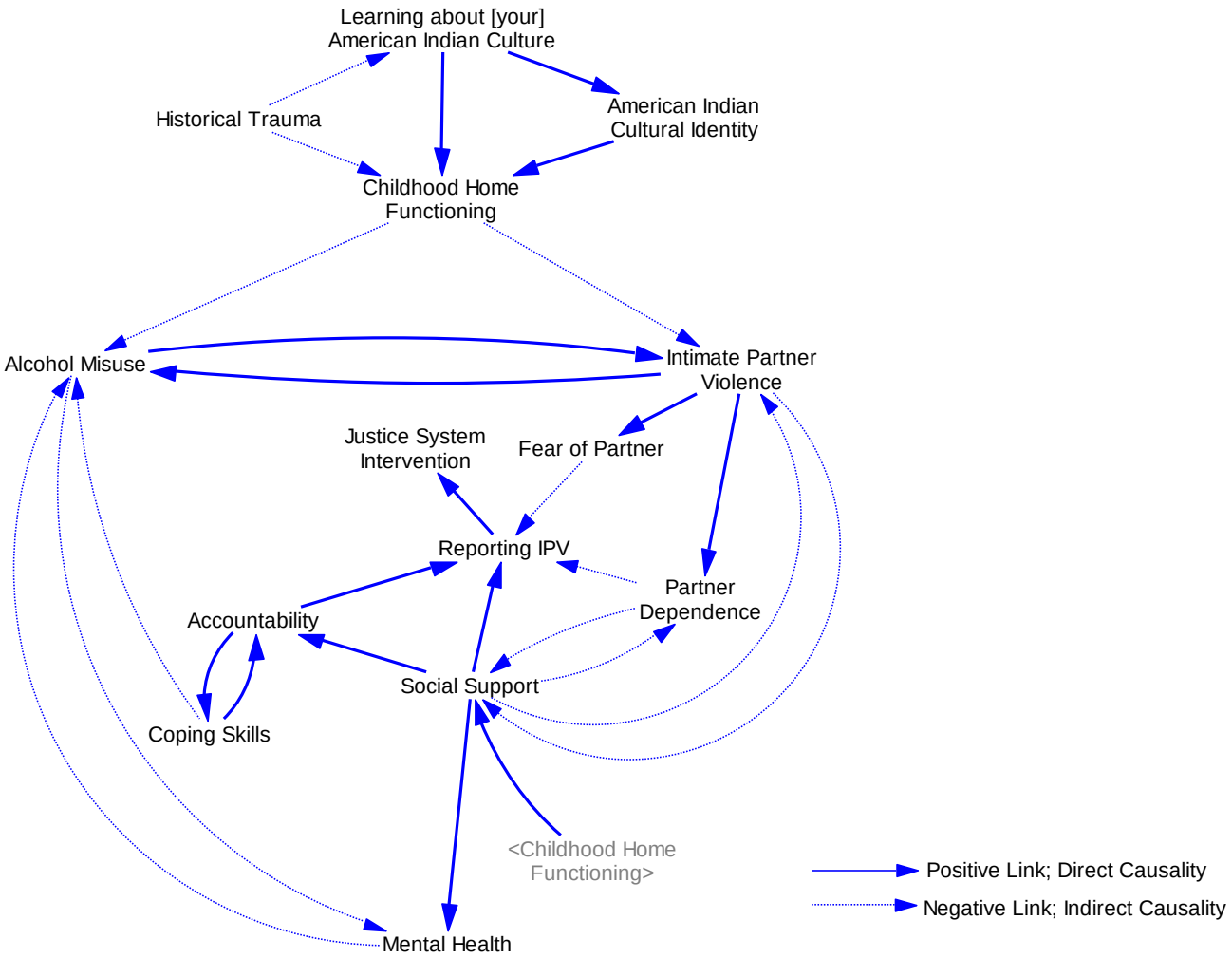
Yellow Horse Brave Heart, M. (2011). The historical trauma response among Natives and its relationship with substance abuse: A Lakota illustration. Journal of Psychoactive Drugs, 35, 7-13. doi: 10.1080/02791072.2003.10399988

Zimmerman, L., Lounsbury, D. W., Rosen, C. S., Kimerling, R., Trafton, J. A. & Lindley, S. E., (2016). Participatory system dynamics modeling: Increasing stakeholder engagement and precision to improve implementation planning in systems. Administrative Policy and Mental Health, 43, 834–849. doi: 10.1007/s10488-016-0754-1

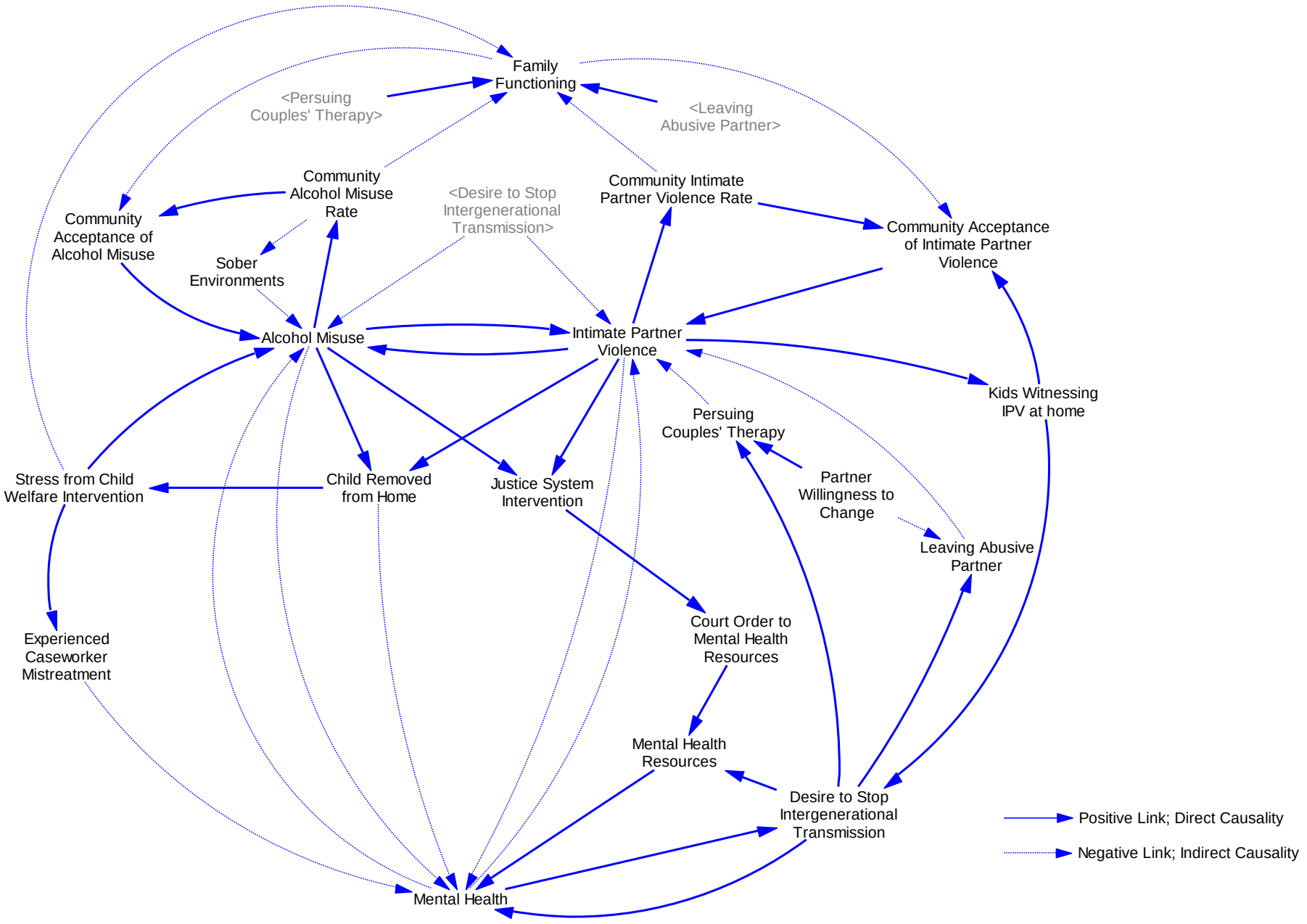
Supplemental Figures



Supplemental Figure 1: Group 1 (Faith-Based Re-entry Program) Model



Supplemental Figure 2: Group 2 (Substance Rehabilitation for Pregnant Women and Mothers) Model



Supplemental Figure 3: Group 3 (Domestic Violence Shelter) Model