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Promoting Child Behavioral Health in Homeless Services: A Community-Based System Dynamics Approach

Katherine Marcal
Washington University in St. Louis

WASHINGTON UNIVERSITY IN ST. LOUIS

Brown School of Social Work

Dissertation Examination Committee:
Patrick Fowler, Chair
Leopoldo J. Cabassa
Sanmay Das
Peter S. Hovmand
Melissa Jonson-Reid

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by
Katherine E. Marçal, MSW

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Abstract of the Dissertation

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Professor Patrick J. Fowler, Chair

Families with children comprise one-third of the entire homeless population (Henry, Watt, Rosenthal, & Shivji, 2017). Homelessness exposes children to chaotic, unsafe living environments that pose threats to healthy development; unsurprisingly, children in homeless services display high rates of mental health disorders compared to stably housed children (Bassuk et al., 2015; Buckner, 2008). Despite concerted efforts at the state and local levels to end family homelessness by 2020, rates have remained largely unchanged over the past decade (Henry et al., 2017; U.S. Interagency Council on Homelessness, 2015). Additional indicators such as increasing wait times, average length of stay, and reentry rates reflect substantial unmet need among families in the homeless services system that exposes children to ongoing risk for mental disorder. A developmentally informed homeless services system must aim to minimize children's time in homeless services, reduce exposure to chaos and instability in homeless services, and promote sustainable return to stable housing. This mixed methods study applies a community-based system dynamics approach to 1) Develop a dynamic hypothesis to explain observed rates of reentry, length of stay, unmet family need, and child risk among homeless

families, 2) Apply participatory system dynamics methods to build and test a theoretical model of feedback processes driving these outcomes, and 3) Elicit and test potential interventions to improve homeless system performance for families on key outcomes using participatory and simulation system dynamic modeling. Key informant interviews and qualitative group model building sessions with a range of stakeholders including homeless service providers and homeless shelter clients with children generate insights into the processes underlying patterns of service use that reinforce vulnerability to mental disorder. Simulation models incorporating these insights and calibrated using administrative data test interventions to improve homeless system performance. Results indicate elements of the current service system have counterintuitive impacts on system performance. Crowding in shelters erodes client empowerment, leading to longer stays in services which contributes to further crowding. Capacity constraints act as natural limits on the number of families in services and average length of stay, but compound unmet need as families are unable to access necessary assistance. Interventions that promote prevention and socioemotional supports in services offer promise for alleviating bottlenecks at service entrances as well as exits, and point to opportunities for future research implementing and testing systems-level change in homeless services. Improving the efficiency of the homeless service system can reduce children's exposure to conditions that threaten healthy development.

I. Introduction

Families with children comprise more than one-third of the homeless population in the United States. On a single night in January 2016, there were 116,830 children living in 61,265 such households, according to the U.S. Department of Housing and Urban Development (HUD)'s annual report to Congress on homelessness (AHAR) (Henry et al., 2016). Over half a million people in families used homeless shelters in 2015 (Solari et al., 2016). Despite sustained federal and local efforts to combat family homelessness across the country, prevalence remains largely unchanged and thousands of families continue to rely on shelters each year.

Homelessness signals family risk. Occurring in the context of extreme poverty, a homeless episode reflects a culmination of ongoing socioeconomic vulnerability in the context of an inadequate supply of affordable housing for low-income families (O'Flaherty, 2009). The chaos and unpredictability of life in poverty contribute to risk for housing instability; a homeless episode may be triggered by an unanticipated crisis such as job loss or health problem (Culhane, Metraux, Park, Schretzman, & Valente, 2007; Curtis, Corman, Noonan, & Reichman, 2013). Family structure changes, such as divorce, childbirth, or women fleeing domestic violence situations, can also lead to housing problems by straining limited resources and upending household routines (Curtis et al., 2013; Shinn, Knickman, & Weitzman, 1991; Shinn et al., 1998). Family homelessness also highlights stark racial and ethnic disparities. Although African Americans comprise 13.4% of all families with children in the U.S., they comprise over half (52.8%) of families in homelessness (Solari et al., 2016). Dramatic discrepancies exist by race and ethnicity in risk for homelessness across the life course (Fusaro, Levy, & Shaefer, 2018). Family homelessness in the United States impacts households with existing socioeconomic vulnerabilities, high levels of need, and few resources to withstand crises (O'Flaherty, 2009).

Child Development in the Context of Homelessness

Stable, stimulating environments are necessary in the early years for children to thrive. Healthy development depends upon access to adequate nutrition, medical care, language exposure, and stimulation (Shonkoff, 2012). Exposures to beneficial and adverse experiences in early childhood lay the foundation for divergent developmental trajectories (Hertzman & Boyce, 2010). These early experiences impact biological systems, altering risk profiles through a process of "biological embedding" (Shonkoff, Boyce, & McEwan, 2009).

Fundamentally, living in poverty exposes children to instability and chaos in their families, households, and neighborhoods. Poor children encounter more physical and psychosocial stressors than middle-income children such as family conflict, violence, food insecurity, and substandard housing conditions (Brooks-Gunn & Duncan, 1997; Evans & English, 2002). Many of these poverty-driven conditions increase risk for adverse emotional and behavioral problems as children develop (Aber, Bennett, Conley, & Li, 1997; Evans & Kim, 2007; Yoshikawa, Aber, & Beardslee, 2012). Furthermore, a cumulative effect exists such that the more time a child spends in poverty and the greater exposure to stressors, the more pronounced the physiological stress responses (Evans & English, 2002; Evans & Kim, 2007).

The home environment is thus critical to child development. Stable housing provides a foundation to promote healthy development and prevent mental disorder. In contrast, the chaos and unpredictability associated with lack of stable housing elevates psychosocial risk. Overcrowding, excessive noise, poor quality housing conditions, and frequent moves threaten the stability and security required for children to thrive. Rates of behavioral problems are elevated among children exposed to homelessness compared to the general population, and the enduring financial hardship facing many of these families continues to threaten healthy development even

when housing problems are addressed (Buckner, 2008; Masten et al., 1993; Rog, Holupka, & Patton, 2007). Assessments of children in homeless shelters find they display more behavioral problems than normative samples of children, with up to 40% exhibiting internalizing and externalizing symptoms such as anxiety and depression, attention problems, rule-breaking, and social problems (Bassuk et al., 2015; Buckner, 2008). Children exposed to homelessness are thus among the most vulnerable to emotional and behavioral disorders.

A large body of research over the past three decades has investigated whether housing problems and homelessness pose unique threats to child mental health above and beyond the consequences of poverty (Grant et al., 2013). Both children experiencing homelessness and low-income housed children experience high rates of emotional and behavioral problems, with significant implications for development (Buckner & Bassuk, 1997; Haskett et al., 2015). A "continuum of risk" has been hypothesized according to which children in homelessness experience the highest risk for mental disorder, followed first by poor housed children, then by non-poor housed children (Buckner, 2008; Masten et al., 1993). In addition to common conditions brought on by financial hardship such as food insecurity, inadequate medical care, or neighborhood violence, the experience of homelessness may expose children to further adversity such as disruption of peer and other supportive relationships, parental distress, forced school changes, and overall greater chaos and instability (Gewirtz et al. 2015; Masten et al. 1993; Vostanis et al. 1998).

Evidence of a continuum of risk remains mixed across numerous studies of families seeking homeless services. Although many early studies showed elevated rates of mental health problems among children in homeless shelters (Bassuk and Rosenberg, 1990; Buckner et al., 1999; Rescorla et al., 1991), others indicated no significant differences between these and

similarly disadvantaged housed children (Masten et al., 1993; Park et al., 2011). Inconsistent study findings regarding the independent impact of homelessness on child well-being may be explained in part by the overwhelming similarity between very poor families who do and do not lose their homes. Extreme poverty and homelessness are closely linked with the effects difficult to disentangle, and the differences in outcomes among homeless versus poor housed children may be underestimated (Buckner, 2008). The nature and dynamics of family homelessness obstruct efforts to draw clear distinctions between literally homeless children and comparably disadvantaged, low-income housed children; these groups tend to be more similar than they are different—particularly in comparison to middle- and upper-income children (Buckner, 2008). Comparing these two groups of children as distinct and mutually exclusive overlooks the dynamic, persistent vulnerability experienced by extremely poor families.

Further studies suggest that chronic instability, regardless of the source, drives child behavioral problems. The link between stressful or adverse childhood events and worse mental health outcomes has been well established (Evans & Kim, 2007; Utrzan, Piehler, Gewirtz, & August, 2017). In a New York-based longitudinal study of formerly homeless and low-income housed children, Shinn and colleagues (2008) tested the long-term impact of homelessness on child behavioral health. Families were followed up approximately 55 months after baseline (initial shelter entry for homeless families). Findings indicated few significant differences in behavioral health among children who had experienced shelter stays compared to low-income children who had never entered shelters; any differences that did emerge were largely mediated by the number of stressful life events experienced (Shinn, Schteingart, Williams, Carlin-Mathis, Bialo-Klein, & Weitzman, 2008). It is worth noting, however, that the stressful life events assessed including several indicators of housing instability that fell short of literal homelessness

such as the number of residential moves, poor quality housing, and difficulty affording basic needs.

Ultimately, failure to apply a systems perspective in research involving these vulnerable children risks overlooking important complexities inherent in extreme poverty and associated social problems. Given the limited availability of homeless services and efforts to which families may go to avoid homeless shelters, the boundaries of homeless versus housed often blur. Multiple factors aside from reduced homelessness may reduce rates of homeless service seeking; for example, lack of service availability, family reluctance to enter shelters, or lack of perceived benefits of services may all balance rates of homeless service utilization in spite of persistent housing-related risk across communities; for example, the number of families in shelters increased only 1% over the past decade, while family poverty increased 13%. These patterns indicate the presence of compensatory feedback processes that are not well understood, but leave families vulnerable to instability over time. Most importantly, these patterns suggest extremely high levels of vulnerability and need associated with a lack of safe, stable housing before, during, and after a period of literal homelessness.

Cumulative Risk Model for Children Exposed to Homelessness

The body of research thus supports a cumulative risk model of child development (McEwan, 2004). The impact of poverty on child well-being, for example, depends on the amount of time a child spends in poverty and the number of associated adverse physical and social risk factors the child experiences (Evans & Kim, 2007; Evans, Gonella, Marcynyszyn, Gentile, & Salpekar, 2005; McEwan, 2004). Homelessness represents one—albeit an extreme—type of adverse event that impacts healthy child socio-emotional development (Masten et al., 1993). Encompassed in the experience of homelessness are a number of potential adverse

experiences such as unsafe living environments, harsh parenting or maltreatment, or neighborhood violence (Evans & Kim, 2007; Marcal, 2018b; Park, Ostler, & Fertig, 2015). Exposure to these types of adversities risk harmful stress responses in children that threaten healthy development and contribute to behavioral problems (Shonkoff et al., 2009). Therefore, the context of homelessness—extreme poverty as well as chaotic and unstable living arrangements—introduces children to a level of instability that impedes positive parenting and disrupts child behavioral and emotional development (Bradley, McGowan, & Michelson, 2018). Limited research has applied a cumulative risk framework to children and families in homelessness (Samuels, Shinn, & Buckner, 2010), but approaches to promoting healthy development and preventing disorder must incorporate understanding of the underlying instability and ongoing risk that drives behavioral problems.

Recent research has more thoroughly probed child behavioral health within families in homeless services to understand the unique constellations and accumulations of risk these children face, and factors that mitigate vulnerability. One line of inquiry investigates the roles of caregiver mental health and parenting behaviors; the consideration of these factors acknowledges the unique stressors and chaotic conditions facing homeless families driven by the chaos and unpredictability of being without stable housing (Marcal, 2016, 2018a). A study of 138 caregivers (93% biological mothers) recruited from emergency homeless shelters in a midsized Midwestern city examined the role of parenting environments on child behavior (Labella, Narayan, & Masten, 2016). Parental warmth predicted child positive affect, and parental negativity predicted child negative affect and lower prosocial behaviors. Another recent analysis using the same sample (Utrzan et al., 2017) found that experiencing a greater number of stressful life events (e.g. death of a loved one, neighborhood or family violence, serious illness or injury,

eviction, or homelessness) increased child internalizing behavior problems in homeless families; this relationship was moderated by parental control—a construct that assessed the level of responsibility and self-efficacy parents felt toward raising children. A third study conducted with 52 homeless families living in transitional housing found that parental distress predicted child externalizing behavior problems, while this link was moderated by positive parenting practices such as offering praise and incentives (Smith, Holtrop, & Reynolds, 2015). Positive parenting environments may be particularly beneficial for children in at-risk families, buffering against socioeconomic risk, yet difficult for struggling parents to maintain.

An additional, crucial element of cumulative risk is resilience. Some children will develop a level of resilience that balances the effects of ongoing adversity on their well-being (Masten & Coatsworth, 1995). Little research has examined resilience in children experiencing homelessness. One study of extremely poor housed and formerly homeless children in families in Worcester, NY found that resilience was associated with lower externalizing behavior problems, less depression and anxiety, higher self-esteem, and better self-regulation (Buckner, Mezzacappa, & Beardslee, 2003). Resilient children had also experienced fewer negative life events such as abuse or neglect, exposure to violence, death of a friend or relative, and incarceration of a parent, as well as less chronic strain such as food insecurity and lack of neighborhood safety. Overall, the presence of multiple adverse events that accumulate over time appears to be a crucial factor in children's developmental trajectories, and must be considered by the systems that serve them.

Homeless Services

Given the accumulation of risk factors inherent in homelessness, these families require timely connection to appropriate services that can adequately address the complexity of their

circumstances. Most services for homeless families are delivered through the homeless services system, which is comprised of local networks of agencies that deliver services and allocate resources. Service eligibility is determined by HUD, and communities may prioritize certain subgroups of the homeless population when allocating resources (U.S. Interagency Council on Homelessness, 2015). The primary goal of the homeless service system is to help families return to stable, sustainable housing as quickly as possible. Housing interventions range from temporary emergency shelter to permanent supportive housing programs. The structure of the homeless system includes multiple levels of services that vary in intensity. Temporary or emergency shelter is intended for brief crisis management and initial housing search support; families stay on average 60-90 days (Solari et al., 2016). Other families may receive rapid rehousing services and referrals to additional service systems, or transitional housing programs, which provide housing assistance plus more intensive psychosocial supports. Permanent supportive housing is the most long-term, intensive option, providing families with indefinite housing assistance and additional supports (U.S. Interagency Council on Homelessness, 2015).

Most effectiveness studies of housing interventions delivered through the homeless system have been limited to single adults, particular those with disabling mental health conditions (Bassuk & Gellar, 2006). Interventions frequently include both some type of temporary housing assistance or case management to aid in securing stable housing. Families experience unique psychosocial and household-level circumstances that can challenge housing stability such as larger family sizes, childcare and educational needs, and parent-child separations. A number of interventions for homeless families provide housing or housing assistance in order to return families to stable and independent living situations, but empirical

research on the outcomes associated with specific housing interventions for families versus single adults is limited (Herbers & Cutuli, 2014).

A 2014 systematic review of the effectiveness of housing interventions for homeless families found an overall dearth of evidence (Bassuk, DeCandia, Tsertsvadze, & Richard, 2014). Housing interventions identified to address homelessness among families with children included Housing First, rapid rehousing, Housing Choice Vouchers ("Section 8"), housing subsidies, transitional housing, and shelters. Other housing-related services included case management—particularly related to housing search assistance. Only seven articles representing six major studies were identified for inclusion in the review. Evidence of intervention effectiveness on housing outcomes was scarce. The housing status of families typically improved across follow-up periods to an extent; although literal homelessness declined, families in general remained unstably housed. In general, effects on child well-being and other indicators of family stability were likewise limited.

The largest and most rigorous empirical studies of housing interventions for homeless families to date is the Family Options Study (FOS), a randomized controlled trial currently in progress and conducted by the U.S. Department of Housing and Urban Development. Launched in 2008, the study recruited homeless families from emergency shelters and randomly assigned them to one of four intervention groups: permanent housing subsidies, temporary subsidies with limited services ("rapid rehousing"), project-based transitional housing, and usual care; the latter varied by location and consisted of any resources a family could gather on their own from local agencies and service providers (HUD, 2015). Intervention groups were balanced after random assignment such that no significant between-group differences were observed on key covariates (Gubits et al., 2013). Families were all "literally homeless" (staying in emergency shelters) at

baseline and followed up at 20- and 37-month intervals to assess housing status as well as several indicators of child well-being. Housing outcomes included homelessness (defined as staying shelters or any place not meant for human habitation), doubling up (defined as living with friends or relatives), residential mobility (defined as number of places lived), crowding (defined as persons per room), and housing quality (defined through self-report). Child outcomes covered a number of domains including meeting developmental milestones, school enrollment, school attendance and performance, and conduct and behavioral problems. The study tested the hypothesis that interventions would stabilize housing for families as a proximal outcome, which would promote more distal child well-being outcomes. Overall, results indicated positive findings for housing stability and child behavioral problems associated with permanent housing subsidies but few benefits of other interventions (Gubits et al., 2016).

Emergency Shelters

The majority of families who enter the homeless system utilize emergency shelters (HUD, 2018). Shelters may be single- or scattered-site, and sleeping arrangements may include private rooms for families or communal, dorm-style living. While emergency shelters tend to be the cheapest per-day service for families, costs per stay vary substantially (Spellman et al., 2010). Over the past decade in St. Louis City and County, over one-third of families spent longer than one month in emergency shelters, while 10-20% stayed over three months for a single homeless episode (Public Policy Research Center at the University of Missouri-St. Louis, 2016). Rates of reentry to emergency shelters for families hover between 10 and 20% in St. Louis City and County.

Rapid Rehousing

Rapid rehousing programs provide short-term assistance with the goal of helping families quickly stabilize housing and returning to self-sufficiency (National Alliance to End Homelessness, 2014). A recent study utilized Homeless Management Information System (HMIS) data from a community in Tennessee to examine the outcomes associated with a rapid rehousing program that included approximately five months of rental assistance, back utility assistance, and utility deposit assistance (Patterson, West, Harrison, & Higginbotham, 2016). Findings revealed that more than three-quarters (77%) of families returned to stable housing by the end of the three-year observation period, but longer follow-up data was unavailable.

The Supportive Services for Veteran Families Program (SSVF) is another rapid rehousing initiative that provides short-term housing assistance along with a range of support services to veterans in families (Department of Veterans Affairs, 2016). Specific services vary by location and household needs but 60% of funds must be allocated to rapid rehousing for homeless households. Additional supportive services include outreach, case management, connection to other VA programs, and temporary financial assistance. Among homeless veteran families who received SSVF services, approximately one in ten experienced a recurrent episode of homelessness one year after exiting the program, and one in six experienced a recurrent homeless episode two years after exiting the program (Byrne, Treglia, Culhane, Kuhn, & Kane, 2015). Despite promising initial findings, however, little is known about the long-term effectiveness of rapid rehousing programs after short-term assistance is discontinued.

Families in the Family Options Study assigned to receive community-based rapid rehousing saw no improvements in homelessness, doubling up, residential mobility, or housing quality at the either the 20- or 37-month follow-up compared to families assigned to usual care

(Gubits et al., 2015, 2016). Similarly little impact was seen on child well-being. The only significant findings in the domain of child well-being at 18 months were observed in school enrollment and absences, but in contradictory directions; children assigned to the treatment group displayed significantly lower school enrollment but also fewer absences compared to the usual care group; differences diminished by the 37-month follow-up, where the only significant finding for child well-being was slighter fewer behavior problems in the treatment group.

Transitional Housing

Other housing interventions provide temporary housing assistance with supportive services, aiming to help families re-stabilize and gain self-sufficiency. One such project, the Sound Families Intervention, was implemented at ten sites in three Washington State counties (*N* = 1,487; Bodonyi, 2008). Families were recruited from homeless shelters to receive up to two years of housing along with individualized case management, and additional services were available at different sites. Families spent on average approximately one year (12.3 months) in transitional housing, and over two-thirds (68%) of all families exited the program into permanent housing. However, one quarter of families were evicted or asked to leave transitional housing before completing the program, primarily because of substance use or mental health disorders; only one in six of these families exited to permanent housing. Approximately half (48%) of families also experienced increases in income, while the percentage of those employed full time doubled (22% to 45%). Although short-term outcomes were generally promising for families who successfully completed transitional housing, it is unclear whether families were able to maintain housing stability long-term after exiting transitional housing; furthermore, one in four families were not allowed to complete the program. Findings are therefore not generalizable to

the broader population of homeless families, many of whom struggle with persistent substance use and mental health disorders.

Findings from the Family Options Study across three years showed few benefits associated with transitional housing (Gubits et al., 2015, 2016). Compared to families assigned to usual care, fewer families assigned to project-based transitional housing reported spending at least one night homeless in the past six months at the 18-month follow-up; however, this difference disappeared by the three-year assessment (Gubits et al., 2016). No other differences on housing instability emerged, nor were any differences across multiple domains of child well-being observed. The only significant findings with regards to child well-being at 20 months was that slightly more children assigned to the treatment group had access to a regular source of medical care compared to those assigned to usual care (95.7% compared to 91.4%). By the 37-month follow-up, no benefits were observed among children assigned to the treatment group (Gubits et al., 2016).

Permanent Housing

Permanent housing interventions, typically vouchers or other rental assistance, target poverty and lack of affordable housing as the drivers of homelessness. The most notable of these interventions, the Housing Choice Voucher Program ("Section 8"), is federally funded by HUD but administered through state and local housing agencies. Eligibility is determined by income level, and those who receive vouchers are required to pay only up to 30% of income toward rent each month, while the remaining costs are subsidized. In 2016, nearly half of vouchers (44%) in use were held by households with children (Center on Budget and Policy Priorities, 2017). Families may hold vouchers indefinitely, as long as they remain eligible and program rules are followed.

Permanent housing assistance programs have been shown to relate with improved housing stability for families with children experiencing homelessness. A non-randomized study examined a sample of homeless female-headed families with children and a comparison group of non-homeless female-headed families with children receiving welfare in New York City (Shinn et al., 1998). Non-homeless families were more likely to have received subsidies, and subsidies were associated with improved housing stability over five years, controlling for a number of demographic and social risk factors for homelessness. However, the study was not experimental in design; receipt of subsidies was not randomly assigned, but rather dependent on shelter resources, and whether families remained in shelter long enough to reach the top of waiting lists for subsidies (Shinn et al., 1998).

The Family Options Study demonstrated promising findings associated with permanent housing (Gubits et al., 2015, 2016). Intent-to-treat effects from both the 20- and 37-month follow-up assessments indicated that permanent subsidies were associated with significant reductions in homelessness and doubling up, as well as increases in independent housing compared to usual care (Gubits et al., 2015, 2016). Approximately one in six families (15.8%) receiving permanent subsidies had spent at least one night homeless or doubled up in the past six months compared to more than one-third (34%) of families assigned to receive usual care at the 37-month follow-up. Families assigned to receive permanent subsidies also experienced higher rates of independent housing, lower mobility, and less overcrowding than families who received services as usual.

Some improvements in aspects of child well-being were observed among those assigned to receive permanent subsidies. Children in families receiving permanent subsidies attended significantly fewer different schools compared to those in the usual care group, which was likely

due to the fact that they experienced less housing mobility. Children displayed small but significant reductions in behavior problems and improvements in prosocial behavior across the 20- and 37-month follow-up assessments (Gubits et al., 2015, 2016). Children displayed significantly more positive attitudes toward school, but no improvements were observed on math or verbal abilities.

Permanent Supportive Housing

Other interventions aim to provide supportive services in addition to housing assistance to address a range of needs that are thought to contribute to a family's vulnerability to housing instability. Services may include case management, mental health or substance use treatment, or parent training. A qualitative analysis of a permanent supportive housing program serving families in Cleveland, OH found that while most clients were able to exit shelters, families were uniquely challenging to serve due to their complexity of needs (Collins, D'Andrea, Dean, & Crampton, 2016). Another program implemented in Los Angeles County served families referred from over 60 collaborating social service agencies (e.g. emergency and domestic violence shelters, transitional housing, and substance use treatment facilities; Einbinder & Tull, 2005). Program components included housing specialists to help families find and move into permanent housing; when possible, specialists assisted families in negotiating leases and accessing housing subsidies. After move-in, families received intensive case management for up to one year to address additional challenges in the families' lives. Einbinder and Tull (2005) contacted 200 previously homeless families who had completed the Housing First program two to seven years prior and assessed their long-term stability. Target outcomes were increased housing stability, increased employment and education skills, participation in treatment programs when appropriate, improved life management skills, and regular school attendance and health care for

children. Families were almost exclusively headed by single mothers (97%), and majority African American (64.5%). Nine out of ten families had maintained stable housing since completing the intervention, while 21 families (10.5%) experienced one or more subsequent homeless episodes. However, families remained poor, and more than one in four families (27%) reported having difficulty making rent payments on time. Section 8 vouchers protected against repeat homelessness. Overall, the majority of families were able to achieve stable housing within a relatively short time period and maintain their living arrangements over a period of several years.

The Homeless Families Program, implemented at nine sites across the United States, is one such program that provided housing vouchers and intensive case management to monitor families' needs and progress as well as facilitate access to additional community services (N = 1,298; Rog, Holupka, McCombs-Thornton, 1995). An evaluation of housing outcomes from six sites that provided public housing authority data indicated that nearly nine in ten families (88%) who received housing vouchers remained stably housed after 18 months, while the remaining families had either returned their vouchers or lost them due to rule violations.

Another program, Keeping Families Together (KFT), was piloted in New York City to provide permanent housing along with supportive services for homeless families with open child welfare cases (N = 29), and a group of comparison families who met eligibility for the program but were not placed in supportive housing (N = 15; Swann-Jackson, Tapper, & Fields, 2010). Families who received KFT were placed by one of six supportive housing providers throughout the city; four offered single-site apartments, one was scattered-site, and one was integrated. All families received case management in addition to housing, and other supportive services varied by site. Examples of services available for families included mental health or substance use

counseling, domestic violence counseling and prevention, job training, and therapeutic childcare. KFT families showed greater improvements in child welfare outcomes compared to the non-KFT families; more than half of families in supportive housing with open child welfare cases had their cases closed. KFT families were also reported less for maltreatment than the comparison group.

Homelessness Prevention

Homelessness prevention has gained traction in the United States in recent years. Homelessness prevention was a key strategy included in the United States' strategic plan to address homelessness (U.S. Interagency Council on Homelessness, 2015). In 2009, $1.5 billion was appropriated to create the Homelessness Prevention and Rapid Re-housing Program (HPRP) as part of the American Recovery and Reinvestment Act (Pub.L. 111-5; HUD, 2016). Eligible families had household incomes at or below 50% of the local median income, homeless or at risk of homelessness, and lacking resources to obtain housing without assistance. Activities funded through HPRP included short- or medium-term rental assistance, utility payments or security deposit assistance, and case management services (HUD, 2016). Given the complexity of needs among families at risk for homelessness, it can be difficult to predict who will fall into homelessness, thus confounding efforts to accurately target prevention services (Fowler, Hovmand, Marcal, & Das, 2019; Shinn, Baumohl, & Hopper, 2001; Shinn, Greer, Bainbridge, Kwon, & Zuiverdeen, 2013).

The Homebase Community Prevention Program is one program funded through HPRP in New York City. Homebase is comprised of a network of agencies designed to help families avoid becoming homeless or avoid repeat stays in homeless shelters; families are assigned a case manager who works to help families maintain their housing and develop a personalized long-term plan for housing stability. A randomized controlled trial was conducted across 27 months to

assess the impacts of Homebase on homeless shelter and other service use among homeless families with children (Rolston, Geyer, Locke, Metraux, & Treglia, 2013). Participating families were randomly assigned to either a treatment group that received Homebase services ($N = 150$) or a control group that received other services available in the community ($N = 145$). Results of intent-to-treat analysis at the 27-month follow-up showed statistically significant differences in shelter usage associated with Homebase; families in the treatment group spent on average 22.6 fewer nights in homeless shelters than those in the control group, and Homebase families had an 8.0% chance of utilizing shelter at all compared to a 14.5% chance for control families. No treatment effects were observed on child protective services or receipt of public assistance benefits through TANF or SNAP (Rolston et al., 2013).

Summary of Effectiveness of Housing Interventions

This body of research suggests permanent housing subsidies offer the most promise for families struggling to maintain stable housing. Three-year findings from the Family Options Study suggest assignment to long-term financial assistance promotes housing stability among homeless families, while assignment to time-limited subsidies and project-based transitional housing is associated such impacts. Small improvements in child behavior associated with permanent subsidies were observed, although few effects were seen in other domains of child well-being such as physical health and school performance (Gubits et al., 2016). It appears that while sustained rental assistance reduces homelessness and housing problems for families, stabilizing housing may not be sufficient to address all areas of child well-being impacted by homelessness and the limited availability of permanent housing interventions in communities across the country impedes efforts to stabilize families and promote healthy child development. Findings must be interpreted with caution as analyses were conducted to obtain intent-to-treat

treatment effects, and some lack of intervention uptake occurred; for example, only 60% of families assigned to the rapid rehousing treatment group actually followed up on their referrals, met local program eligibility requirements, found appropriate housing units, and received rental subsidies. Furthermore, little research exists on relatively recent homelessness prevention interventions.

Major challenges exist regarding the feasibility and scalability of effective housing interventions. Vouchers programs typically have long waitlists, and affordable housing remains inaccessible to low-income families in most communities across the country (Fowler, Farrell, Marcal, Chung, & Hovmand, 2017). Demand for housing assistance far outstrips supply, and particularly resource-intensive interventions such as supportive housing are prohibitively expensive for struggling agencies and communities. Limited availability of the most effective housing interventions—permanent housing and permanent supportive housing—constrains scale-up such that few families in need will actually receive them. Thus, threats to family stability and child behavioral health associated with extreme poverty and homelessness persist over time.

Furthermore, the evidence base for housing interventions is limited by the tendency to evaluate interventions in isolation rather than taking into account the entire homeless system. The current approach to homeless services triages families by targeting the most intensive interventions to the most vulnerable families, which may diminish effect sizes of interventions (Fowler et al., 2017). Little research examines how to allocate scarce housing resources most effectively, or how allocation of interventions erodes availability and influences service decisions for other families.

Finally, the lack of systems-level research on homeless services impedes understanding of how families "churning" through homeless services creates complex problems for both the

homeless system as well as the families themselves. Families who reenter homeless services after exiting are more vulnerable than those with an isolated homeless episode for a number of reasons. A study of 220 homeless mothers found those who had experienced multiple shelter stays had worse mental health than those who were first-time shelter users (Bassuk et al., 2001). Examining the shelter and other service use patterns of families in New York, Philadelphia, and Columbus, Ohio, a study conducted by Culhane and colleagues found heads of households in families who experienced repeated shelter stays relied more often on inpatient psychiatric and substance use treatment, were more likely to be involved in the child welfare system, and used more types of services overall than families who experienced one-time shelter stays (Culhane et al., 2007). The process of families re-cycling through homeless services not only strains providers and service capacity, but also drives ongoing and intensifying family needs over time.

Developmentally-Informed Homeless Services

The enduring instability experienced by children who lack secure housing poses unique challenges to implementing and evaluating efforts to improve child mental health and well-being (Sulkowski & Michael, 2014). For some, return to stable housing may promote mental health; in these cases, emphasis on rapid rehousing may be sufficient mental health intervention. Other children will require ongoing support for persistent behavioral or emotional problems. Homeless shelters may offer some brief, in-house counseling, but the nature and scope vary widely by agency and location (Swann-Jackson et al., 2010). In-shelter services targeting child well-being frequently emphasize case management to address return to stable housing and parent-child relationships (Brinamen et al., 2012), and evaluation of shelter-based services has focused on housing-related outcomes (Glisson, Thyer, & Fischer, 2001). Despite homeless children's

developmental vulnerability, however, even screening and treatment for mental health and behavioral disorders is limited (Lynch et al., 2015).

Some shelter-based mental health interventions for children have shown potential benefits. The HOPE Family Program, a family-centered intervention designed to promote mental health among adolescents, offers eight weekly one-hour sessions with both youth and caregivers in homeless shelters; youth and caregivers attend some sessions together and some separately (Lynn, Acri, Goldstein, Bannon, Beharie, & McKay, 2014). The program material emphasizes communication, parental monitoring and supervision, and coping. A study conducted among families in New York City homeless shelters found that HOPE was associated with a reduction in suicidal ideation among young adolescents (aged 11-14 years) compared to a group of youth who did not participate in the family-centered prevention program (Lynn et al., 2014). However, a small sample ($N = 28$) in a single shelter limited generalizability of findings, and implications for program implementation and scale-up remain unknown.

A small study conducted in the United Kingdom evaluated the impacts of a mental health outreach service (MHOS) on short-term psychosocial outcomes for homeless children (Tischler, Vostanis, Bellerby, & Cumella, 2002). Children in families staying in homeless shelters who received the MHOS ($N = 27$) were compared to an unmatched control group of children in shelters that did not offer the intervention ($N = 27$). The MHOS included mental health screening and brief treatment by clinical nurse specialists trained in child mental health. Child psychosocial functioning was assessed at baseline and six months later, usually after families had left shelters and returned to stable housing, using the Strengths and Difficulties Questionnaire (SDQ). Analyses found that children in the experimental group experienced significantly greater improvements in SDQ scores than the comparison group. Although findings were promising,

interpretability was limited by the small sample size and lack of randomization. Thus, evidence of interventions that sustainably improve mental health outcomes among children exposed to homelessness is limited, and the long-term dynamics of mental health needs in the context of ongoing instability are poorly understood.

Little is known about the patterns of mental health service use among homeless children. Shelters may provide important points of access to mental health services for children, with in-shelter screening and referral shown to be feasible and effective means of connecting children to resources (Lynch et al., 2015). Additional research suggests children may be more likely to receive mental health services upon shelter entry, perhaps because the stress of becoming homeless can trigger mental health problems, increased visibility of problematic behaviors in the shelter setting, or overlap between homeless services and the child welfare system, which frequently serves as a gateway to mental health treatment (Fowler et al., 2013; Park et al., 2012). Although increased access through shelters is an important achievement, lack of coordinated care before and after shelter stays may disrupt services and reduce their impact.

An investigation of the patterns of service use among homeless heads of households found that rates of outside service use dropped during shelter stays but rebounded to even higher levels upon shelter exit, though the patterns of child service use were not explored (Culhane, Park, & Metraux, 2011). Administrative data was obtained on public shelter utilization and Medicaid claims files. The sample included families with children who entered publicly funded homeless shelters in Philadelphia for the first time between 1999 and 2000 (N = 1,564). Each family was tracked over a three-year period to obtain data before, during, and after the shelter stay. Mental health service use was defined as a record for inpatient behavioral health care for mental disorders or substance use disorders according to International Classification of Diseases-

9 (ICD-9) codes 290-319 for the heads of household. Families were divided into three subgroups by their shelter utilization patterns: temporary (a single, brief shelter stay), episodic (multiple brief stays), and long stay (a single, extended stay). Across all three groups, rates of inpatient behavioral health care dropped during the shelter stay and rebounded upon shelter exit. Rates of inpatient psychiatric care for the temporary group before, during, and after the shelter stay were 7.7%, 1.3%, and 9.6% respectively. Among the episodic group, rates were 12.3%, 7.7%, and 19.2%; among the long stay group, rates were 4.3%, 1.9%, and 2.8%. The authors concluded that homeless shelters may replace mental health services during the homeless episode, but fail to reduce need over time as evidenced by the rebound effect. While the inclusion criteria for this study was homeless families with children, only the mental health service use of heads of household was examined; furthermore, assessing inpatient psychiatric care only may capture the most extreme, vulnerable cases.

The rebound effect of service use observed by Culhane and colleagues along with additional research indicate children's needs for mental health services persist after shelter exit regardless of length of stay and homeless services utilized (Vostanis et al., 1998). These findings may be interpreted in multiple ways. One interpretation is that the need for mental health services disappears during a shelter stay but returns upon exit. Although theoretical possible, this interpretation seems unlikely to be true given the high rates of emotional and behavioral problems observed among children in shelters (Bassuk et al., 2015). Another interpretation is that homeless shelters provide the equivalent of all mainstream services "in-house," eliminating the need for outside services during a shelter stay. Many shelters do provide a number of services to families, but type and quality of services differ widely by shelter and city (Lorelle & Grothaus, 2015; Samuels et al., 2015) A third interpretation is that upon shelter entry and throughout the

duration of a shelter stay, families are unable to maintain contact with mainstream services, even when services are still needed. Little research has examined continuity of care and coordination of multi-system services for homeless children throughout a homeless episode, so the extent of service disruption is unknown. Nonetheless, Culhane and colleagues' (2011) findings suggest that shelter use supplants external service use temporarily but fails to stabilize families and reduce need over time, incurring greater costs across multiple social service systems and contributing to enduring mental health problems among homeless children.

Homeless children frequently encounter services across multiple systems due to needs across multiple domains, but this approach may in fact contribute to the chaotic nature of residential instability and poverty. High rates of service use among homeless children do not translate to improved child psychological well-being. Services are frequently provided by independent agencies for discrete needs, and may not be accessible or feasible for all families (Kilmer et al., 2012). For some children, return to stable housing may be sufficient while other children will require ongoing psychological or educational support (Bassuk et al., 2010). Lack of coordination among service providers may pose barriers to access and increase the burden on families. Although a large body of research has addressed mental health disorders in homeless children, there is a lack of consensus on the causes and appropriate strategies for addressing psychopathology in this population. Little theoretical work has examined why mental health problems persist among homeless children despite extensive service provision across multiple domains. Linear, individual-level explanations of psychopathology in this population fail to effect widespread change by implementing simple solutions to a complex and adaptive set of problems. A comprehensive framework must address the underlying household- and family-level

vulnerabilities that result from poverty, as well as the impact of instability and stress on child development.

Some research has begun to investigate the strategy of providing short-term, intensive mental health services in concert with housing support through shelters. This approach acknowledges research suggesting homelessness, like many mental health disorders, is frequently episodic and may require brief supports to stabilize families (Bassuk, Volk, & Olivet, 2010; Culhane et al., 2007). Shinn and colleagues conducted a randomized trial assessing the effects of the Family Critical Time Intervention (FCTI) in Westchester County, NY following this framework (Shinn et al, 2015). FCTI is an evidence-based mental health intervention that provides time-limited intensive case management for homeless families. An adaption of the empirically-supported Critical Time Intervention (CTI) for homeless adults, FCTI is a nine-month intervention delivered in three three-month phases that support homeless families with caregiver mental health or substance use problems throughout their shelter stay and transition back into independent housing. Each homeless family is assigned an FCTI team that includes a case manager, a psychiatrist, and supervisory staff. FCTI addresses the logistical challenges homeless families face in accessing mental health services during a shelter stay. These families typically lack transportation, health insurance, or knowledge of available local mental health providers. Furthermore, mental health treatment is often overlooked for the more urgent issue of securing housing. By providing psychiatric care within a homeless shelter, FCTI allows families to address both mental health and housing concerns simultaneously.

In the first phase, FCTI caseworkers help families connect with resources such as mental health, substance use, and trauma care as well as practical services like transportation and childcare. In the second phase, emphasis shifts to helping families secure stable housing and

establish a support network to maintain it. Finally, the third phase involves the caseworker scaling back involvement as the family gains independence. A randomized controlled trial of FCTI was conducted in a county outside New York City. FCTI was shown to help families in the treatment group more rapidly return to independent housing compared to a control group of families who received shelter services as usual (Samuels, Fowler, Ault-Brutus, Tang, Kline, & Marcal, 2015). The control condition included less intensive case management and general housing preparedness. Families were stratified by size and randomly assigned to either the treatment (n = 97) or control (n = 103) group upon shelter entry. The sample included homeless mothers with a diagnosable mental health or substance use disorder, and at least one child aged 1.5-16 years. Mental health and exposure to traumatic experiences were assessed among children in all age groups. Children aged 6-10 completed the Children's Depression Inventory (CDI). Children who were at least six years old reported on the number of negative life events experienced in the past six months, such as getting mugged or beaten up, or a family member being arrested. Assessments were conducted at shelter entry (baseline) as well as 3-, 6-, 9-, 15-, and 24-month follow-up interviews.

Results showed some benefits of FCTI to child mental health (Shinn, Samuels, Fischer, Thompkins, & Fowler, 2015). Children aged 1.5-5 years in the treatment group displayed significant reductions in both internalizing and externalizing behaviors compared to the control group. Intervention effects on mental health were not seen in children aged 6-10 years, although behavior problems and depressive symptoms did improve over time in both groups as children returned to stable housing. Children aged 11-16 years in the treatment group displayed significant improvement in externalizing behaviors compared to the control group. FCTI families also returned to permanent housing faster than the control group. Findings indicate effectiveness

of FCTI at improving mental health outcomes for children that differ by age group, and more rapid stabilization of family housing situations.

Service delivery for homeless families is fraught with financial and logistical challenges. When clients lack permanent addresses or telephone numbers, it can be nearly impossible for providers to schedule appointments, follow up, or refer for additional services. Furthermore, homelessness tends to be a dynamic state in which families move around frequently, either between their own homes, the homes of friends or relatives, or shelters. This hinders continuity of care and service coordination among providers, often leaving homeless individuals unable to access mental health treatment when they need it. Integrating mental health and behavioral services in other nontraditional settings such as schools or shelters offer promise, but insufficient research exists to demonstrate their effectiveness at improving access and mental health outcomes among homeless children. Contact with multiple service systems suggest high levels of need among homeless children, but may also indicate systemic inefficiencies and potential leverage points for improvement.

Review of Services to Support Behavioral Health for Homeless Children

The range of service needs and optimal means of targeting services to promote behavioral health for homeless children are not well understood. For some children, return to stable housing may be sufficient to address behavioral problems that emerge in response to homelessness exposure while other children will require ongoing psychological or educational support (Bassuk, Volk, & Olivet, 2010; Gubits et al., 2016). Permanent housing subsidies have been shown to effectively stabilize housing situations and prevent subsequent homelessness for vulnerable families, but investigation of impacts on child behavioral health are limited and yield mixed results (Anderson, St. Charles, Fullilove, Scrimshaw, Fielding, & Normand, 2003). A

randomized trial that provided permanent housing vouchers to low-income families (the "Moving to Opportunity" study") found that permanent housing subsidies had few beneficial effects on child behavioral outcomes, with some variation across age and gender (Mills et al., 2006; Nguyen, Rehkopf, Schmidt, & Osypuk, 2016). Meanwhile, a recent randomized controlled trial testing the impacts of three different housing interventions found small reductions in child behavior problems and increases in pro-social behaviors associated with receipt of permanent housing subsidies; however children and families continued to display a range of psychosocial and socioeconomic risks that suggest persistent threats to behavioral health (Gubits et al., 2016). Underwhelming findings may be due to delays such that stabilizing housing does not immediately improve child behavioral health, that families continue to experience ongoing needs besides homelessness that have cumulative effects on children's behavioral health, or that more complex decision-making and prioritization processes take place that have not yet been considered.

Children exposed to homelessness experience complex needs and service use patterns, with access and continuity of care emerging as major challenges (Ungar, Liebenber, & Ikeda, 2014). These children frequently encounter multiple types of service due to needs across multiple domains, but this approach may in fact contribute to the chaotic nature of residential instability and poverty (Marcal, 2016); needs and outcomes of children in homeless families are complicated by unique service use patterns, and increased service involvement may strain families already facing chaotic circumstances. Access and continuity of care emerge as major challenges (Ungar et al., 2014). Contact with one service system may lead to contact with others; for example, entering a homeless shelter increases likelihood of child welfare investigation, and foster care placement increases likelihood of referral for mental health services (Garland, Hough,

Landsverk, & Brown, 2001; Park et al., 2012). The bulk of research on targeting improved mental and behavioral health among homeless children focuses on individual-level risk factors for behavioral health problems (Buckner et al., 1999; Buckner, 2008; Zima, Bussing, Bystritsky, Widawski, Belin, & Benjamin, 1999) or tests single interventions targeting particular behavioral health problems in homeless children (Guo, Slesnick, & Feng, 2016; Shinn, Samuels, Fischer, Thompkins, & Fowler, 2015; Walsh & Jackson, 2005). Empirical examination of service use patterns is limited, as are system-level outcomes such as referral patterns, service availability, and appropriate allocation of services.

Homeless shelter service providers often serve as the first line of aid for families who lose their homes. These providers may be responsible for in-house case management as well as making decisions about referrals to outside service systems (Mayberry, 2016). However, little empirical evidence examines how these decisions are made and how well they align with family and child needs. Research examining how homeless families make housing decisions provides some insight. Analysis of qualitative data collected as part of a randomized controlled trial of the Family Unification Program, a permanent housing intervention delivered through the child welfare system, found decisions must be made with limited time, information, and options (Rufa & Fowler, 2017). Caregivers of children noted the difficulties of optimizing housing services when decisions needed to be made last minute, there was a lack of housing options, and multiple factors such as location, accessibility, availability of family and other social support, and costs were considered. The authors describe a "push-pull" dynamic in which families experience either undesirable factors that cause them to avoid or be forced out of certain accommodations, or desirable or attractive factors that pull them into other ones.

This complexity is likely experienced in relationship to non-housing services, although less research has examined these dynamics. The context of homelessness can limit service options, and some referrals may be driven by availability or agency policy rather than need (Culhane et al, 2007; Kushel, Vittinghoff, & Haas, 2001). Services are frequently provided by independent agencies for discrete needs, and may not be accessible or feasible for all families (Kilmer, Cook, Crusto, Strater, & Haber, 2012). Alternately, entry into one system may trigger contact with additional systems, creating reinforcing patterns of service use (Garland et al., 2001; Park et al., 2012). Furthermore, caregiver priorities can shift as they face competing demands, shaping their service-related decision-making over time and determining which services families pursue (David, Gelberg, & Suchman, 2013). These processes can all lead to families receiving services that are not timely or appropriate for their current needs, but little empirical evidence has explored the dynamics of these processes (Culhane et al, 2011; Duchon, Weitzman, & Shinn, 1999). Navigating services in the context of economic scarcity exacerbates the chaos and strain facing inadequately housed families, hindering efforts to stabilize living situations and protect children from threats to behavioral health (Bassuk et al., 2010; Kilmer et al., 2012; Marcal, 2016). When families are forced to make quick decisions in the face of extreme stress, inadequate information, and limited options, the likelihood of needs remaining unmet and families returning to homeless shelter is elevated. This accumulation of instability undermines efforts to promote healthy child development and threatens the behavioral health of children involved in homeless services over time.

System Dynamics Approaches to Examining Homeless Services

A systems dynamics perspective allows examination of endogenous sources of behavior within a finite system. This endogenous perspective looks to interactions of elements within the

system as driving patterns of system outcomes (Figure 1.1). System dynamics is particularly useful for complex social problems that include multiple moving parts (e.g. multiple service systems, heterogeneous client needs) and adaptation over time (e.g. service system or provider changing policies, evolving family needs), and persist over time despite intervention, indicating policy resistance (Hovmand, 2014).

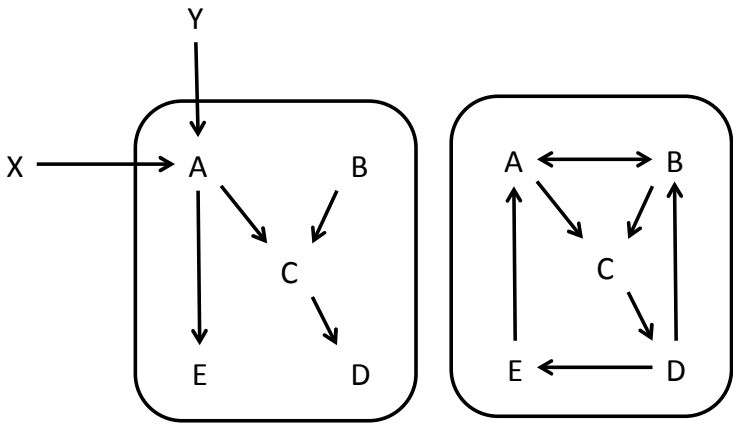


Figure 1.1 Diagram of exogenous versus endogenous perspective. From the endogenous or feedback perspective (right panel), system behavior is considered to be a function of factors within the system itself (image adapted from Richardson, 2011).

A system dynamics study develops and tests a *dynamic hypothesis*. A dynamic hypothesis articulates a target problem in terms of a trend or trends over time ("reference mode(s)"), and proposes a structure comprised of causal feedback mechanisms driving those trends (Albin, 1997; Sterman, 2000). These reference modes include historical data with projected "hoped" and "feared" future trajectories. The theoretical model proposes a causal feedback theory driving those trends; analyses then tests the validity of the theory (Hovmand, 2014). From this perspective, outcomes of interest are expressed as trends over time resulting from dynamics within the system, rather than point estimates.

A community-based system dynamics approach includes stakeholders in the process of elucidating and modeling a particular system from this perspective, leading to important insights about system structure, behavior, and stakeholder mental models (Hovmand, 2014). Group model building is a participatory system dynamics tool that empowers stakeholders by including them in the modeling process. The inclusion of multiple stakeholders allows for a more nuanced and complete understanding of a problem by eliciting multiple perspectives; this can lead to greater system insight and recommendations for policy change.

Limited research has applied system dynamics to improving homeless services, and even fewer studies do so among families. Using a case study of efforts to end homelessness in a Michigan community, Stroh and Goodman (2007) apply a feedback perspective to understand the persistence of homelessness. The authors note that lack of availability of services such as permanent housing and mental health treatment prevent people from maintaining stable housing after leaving shelters, creating delays that exacerbate people's vulnerabilities. Additionally, greater reliance on shelters eroded the capacities of outside services to meet the needs of homeless clients, creating a reinforcing vicious cycle of homelessness. In a review of evidence on youth homelessness, Staller (2004) presents a theoretical framework of youth homelessness and finds that linear perspectives may fail to capture the complexity of youth homelessness and services for homeless youth. For example, Staller hypothesizes that youth shelters, while serving an important purpose for runaway youth, in fact reinforce running away behavior by providing a safe alternative to the streets for youth with undesirable home lives; she notes shelter recidivism of youth who return home as evidence of this loop, suggesting support for a feedback perspective. Furthermore, feedback loops exist between utilization of shelters and outside services. System dynamics has been applied to examine supply and demand in private and public

housing markets to examine housing-related decision-making in the United States and Egypt (Metcalf, 2014; Marzouk & Azab, 2017; Marzouk & Hosny, 2016) as well as adult homeless service coordination in the United States (Fowler et al., 2017), but system dynamics approaches for homeless families are limited. Furthermore, no empirical studies exist that use system dynamics to examine decision-making and utilization patterns that contribute to ongoing "churn" of families through the homeless service system, and stakeholder involvement has been limited.

Homeless System Performance Outcomes

Improving homeless system performance is there an area of opportunity for supporting high-risk families and children. Key system performance measures have been established by the Department of Housing and Urban Development's recent guide on assessing system performance (HUD, 2015). The goal of the homeless system is to help families return to stable permanent housing as quickly as possible and remain stably housed, thus aiming to optimize service delivery to those in need while minimizing *length of stay* and *reentry rates* (HUD, 2019a). The cumulative risk model of child development likewise supports an approach that stabilizes families as quickly as possible in order to minimize exposure to adverse events and conditions (Evans & Kim, 2007). At the same time, an emphasis on reducing time in services risks families exiting too soon with persistent unmet needs, increasing likelihood for reentry and further child exposure to instability. Therefore, a sustainable, effective homeless services system should focus on minimizing length of stay and rate of reentry without contributing to unmet need or child risk.

Innovation of a System Dynamics Approach to Family Homeless Services

This study applies both conceptual and methodological innovations that will direct future research on service delivery for vulnerable children with complex needs. This project is the first to our knowledge that applies system dynamics methodologies to examine service-related

decision-making and utilization patterns among families seeking homeless services. The engagement of caregivers and providers along with the application of an endogenous systems perspective will advance theory development, seeking to explain current patterns of homeless system behavior driven by the system structure itself. Rather than relying on linear explanations for persistent child behavior problems among families experiencing homelessness, the present study tested how features of the current service delivery mechanisms interact to reinforce child vulnerability over time. Multiple, often competing family needs such as housing or financial assistance, mental health treatment, and child care may make it difficult for shelter providers to address all the needs that may hinder return to and maintenance of stable housing. Despite shelters frequently serving as the first line of defense for families who become homeless, little is known about how shelter providers target services and connect families to resources (Buckner, 2008). Using the insights gained from the group modeling building (GMB) sessions, the study developed computer simulation models that replicated current homeless service system functioning in order to understand key mechanisms behind patterns of service referrals and utilization over time that contribute to ongoing instability that threatens child behavioral well-being (Evans & Kim, 2007). The process of eliciting feedback from GMB participants as well as building the simulation model generated robust knowledge on the ability of shelter providers to support families' returns to stable housing while minimizing the period of instability, and mechanisms that impede this ability.

The complexity of the needs and service use patterns of homeless families necessitates conceptual approaches that encompass the multiple interacting systems and their adaptive natures over time. The present study was informed by theoretical work on complex adaptive systems, which provides a framework for examining complex system behavior over time (Ellis &

Herbert, 2011). Complex adaptive systems are those comprised of multiple interacting systems—whether human physiological systems, family systems, or service systems—that involve multiple "moving parts" across time. The key feature of an adaptive system is that elements change over time in response to patterns of system behavior; thus, feedback or recursive relationships exist such that patterns of behavior are driven by the system structure itself. Examples of this include service providers hiring more staff in response to an influx of clients which may encourage more clients to seek services, children adapting to stress conditions by developing adverse coping mechanisms that create more stressors for families, or new demands on providers reducing their capacity to meet demands in other areas—contributing to a backlog of demands and further eroding provider capacity to meet needs. The present study examines the problem of "churn" in the homeless service system as indicated by ongoing unmet needs and reentry from the perspective of complex adaptive systems. Families and service providers must make decisions in the context of complex circumstances and scarce resources. Shelter providers are strained by overwhelming demand, which leaves some families' needs unmet; unmet need contributes to longer shelter stays and increased likelihood of reentry, reinforcing strain on providers. Higher unmet family needs erodes time, capacity, and urgency for prioritizing child behavioral health.

System dynamics provides means of both developing theory of dynamic processes and empirically investigating the mechanisms that drive them, system-level outcomes, and intervention points to alter system behavior. "Stocks" or state variables represent accumulations within the system, and "flows" or rate variables represent transitions; feedback loops articulate causal relationships that influence system activity (Forrester, 1968; Richardson, 2011). Benefits of system dynamics include the ability to simulate system behavior over time, incorporate feedback loops that model nonlinear relationships, identify unexpected consequences, and test

the impact of potential interventions. This feedback or "endogenous" perspective explains system behavior as resulting from relationships between variables within the system itself. Rather than relying on a linear interpretation of cause and effect, the endogenous perspective "states that the modes of behavior under study are created by the interaction of the system components within the boundary" (Forrester, 1968; pg. 84). For entrenched complex social problems such as homelessness, this perspective provides an important opportunity.

A key feature of system dynamics is the ability to simulate potential interventions. These offer utility for practitioners and policymakers who aim to make decisions about allocating resources and delivering services with limited empirical information. Furthermore, simulations can test research questions about interventions or issues for which randomized controlled trials or other experimental designs are infeasible or unethical. In the area of family homelessness, several options for intervention exist and policies are constantly evolving, but little is known abut how the system as a whole responds to these shifts. For example, HUD has recently shifted toward prioritizing the most vulnerable families by emphasizing the most resource-intensive homeless interventions (e.g. permanent supportive housing), which reduces available resources for other service types such as transitional housing or rapid rehousing. The recent passage of the HPRP provides additional funding for prevention services, but little empirical evidence supports the best way to allocate and deliver these programs. A simulation model can incorporate the best available data to test hypotheses about the most efficient ways to serve families, forecast unintended consequences to intervening, and assess tradeoffs associated with policy shifts.

Present Study

This study was designed to build theory through qualitative data collection, validate the theory through quantitative computer simulation modeling, and simulate potential interventions

to test impacts on system functioning. Historical data and prior empirical literature were used to develop a dynamic hypothesis of feedback mechanisms driving trends in key outcomes over time. Semi-structured interviews and group model building (GMB) sessions, a type of qualitative data collection through structured focus groups, were held with homeless caregivers of children as well as with providers recruited from three family homeless shelters in St. Louis City and County, Missouri. Interviews and GMB sessions were designed to elicit perspectives from multiple stakeholders on needs of homeless families and drivers of service utilization patterns. Data collection focused on service-related decision-making processes and the motivators behind referrals and service engagement, as well as potential leverage points to improve the efficiency of service delivery. Insights from the interviews and group model building sessions were used to develop a causal theory, which was compared to the dynamic hypothesis. These feedback insights were used to design a simulating system dynamics model calibrated using administrative data from homeless services agencies in a Midwestern metropolitan region. Finally, interventions at potential leverage points identified in GMB sessions were built into the simulation model to test system responses and generate policy and practice recommendations.

Specifically, the study sought to address the following aims:

Aim 1: Develop a dynamic hypothesis to explain observed rates of reentry, length of stay, unmet family need, and child risk among homeless families.

Aim 2: Apply participatory system dynamics methods to build and test a theoretical model of feedback processes driving observed rates of reentry, length of stay, unmet family need, and child risk among homeless families.

Aim 3: Elicit and test potential interventions to improve homeless system performance for families on key outcomes using participatory and simulation system dynamic modeling.

II. Methods

Setting

The study focused on homeless families navigating services in the context of homelessness and service provider decision-making in St. Louis City – a medium-sized city located on the eastern edge of the state – and St. Louis County, the region to the west of the City comprised of 88 municipalities. St. Louis was an appropriate place to conduct the present study due to the socioeconomic risk factors for homelessness as well as limited service options. Approximately one in four members of the city's general population and more than one in three children lived below the federal poverty level in 2016; furthermore, more than one in ten residents lived in extreme poverty (below 50% of the poverty level; U.S. Census Bureau, 2016). These rates were substantially higher than the corresponding national rates of overall and child poverty (14.1% and 19.5%, respectively). The homelessness rate among low-income St. Louis residents in 2014 was 6.1% compared to 1.3% nationally.

Data Sources

Homeless Administrative Data

The administrative dataset used to generate reference modes came from the Homeless Management Information System (HMIS). HMIS is the information system used by each local Continuum of Care (CoC)—the network of homeless services agencies in a community—to comply with HUD requirements to collect universal data elements on homeless service provision across the country (HUD, 2017c). HMIS requirements were established in 2004 to facilitate coordination of homeless services across communities (HUD, 2004). CoC agencies are required to collect information on 29 elements including identifiers, demographic information (e.g. race, ethnicity, gender, veteran status), service use (e.g. dates of entry into and exit from services), and

other personal factors (e.g. current living situation, mental health problems, domestic violence victimization, and physical disability). Data elements are collected by agencies when clients enter, exit, and transition from services. HMIS records for the St. Louis CoC for the years 2007-2013 were available to the study team as part of an ongoing community-research partnership examining local homeless services.

Administrative for the present study were cleaned and analyzed in R Version 3.5.0. The analytic sample was limited to households defined as "families" (comprised of at least one adult and one child under the age of 18 years) who had received services through the homeless system (emergency shelter, transitional housing, rapid rehousing, permanent supportive housing, or homelessness prevention services) in St. Louis City or County at least once between 2007 and 2012 to ensure at least two years of follow-up data ($N = 4,771$).

Qualitative Data

Additional data were gathered using community-based system dynamics (CBSD). Group model building, a CBSD tool that engages stakeholders in the process of developing a causal feedback theory, (Hovmand, 2014). This qualitative, participatory approach elicited diverse perspectives on system structure, stakeholder and researcher assumptions, and formal and informal policies in order to develop insights about system behavior (Andersen & Richardson, 1997; Hovmand et al., 2011). Group model building has been noted as a key strategy to improve implementation (Powell et al., 2017) and used to address a range of complex problems including racial disparities in breast cancer treatment and mortality rates (Williams, Colditz, Hovmand, & Gehlert, 2018), inefficiencies in collaboration among homeless service providers (Fowler, Wright, Marçal, Ballard, & Hovmand, 2017), and health service delivery in conflict zones (Ager et al., 2015). Key strengths of GMB include the emphasis on community-engagement and

evidence-based procedures for eliciting complex systems thinking (Hovmand, 2014). The present study utilized GMB along with key informant interviews to generate stakeholder insights on key study outcomes.

Procedures

Generating the Dynamic Hypothesis

Administrative records were used in combination with U.S. Housing and Urban Development reports and prior empirical literature to establish a dynamic hypothesis. Trends over time for families using services at a given point in time came from HUD's Annual Homeless Assessment Reports (AHAR; HUD, 2007-2018). Rates of service entries, exits, reentries, and transitions as well as average lengths of stay were calculated from the HMIS administrative records. Hypothesized causal links between variables were drawn from prior empirical and theoretical literature. A system dynamics perspective was applied to identify feedback loops driving reference modes over time.

Group Model Building

The target populations for group model building were homeless service consumers with children and service providers. Because needs and service provision varies by population, emergency shelters are typically designated for either families or single adults (HUD, 2019). In family shelters, for example, staff helps families seek services for themselves as well as their children, pursue specialized services such as parenting classes or childcare, and navigate connections to other child-serving systems such as the child welfare system or schools. In the present study, the inclusion criteria for consumers (hereafter "consumers" or "caregivers") were 1) A client of a family homeless shelter in St. Louis City or County, and 2) the primary caregiver for a child under age 18 years. The inclusion criteria for providers ("providers" or "staff") were

1) Employed at a family homeless shelter in St. Louis City or County, 2) Having frequent, direct contact with families with children.

Study Sites

Recruitment occurred at three family homeless shelters in the St. Louis metropolitan area covered by the St. Louis City and St. Louis County Continuums of Care (Figure 2.1).

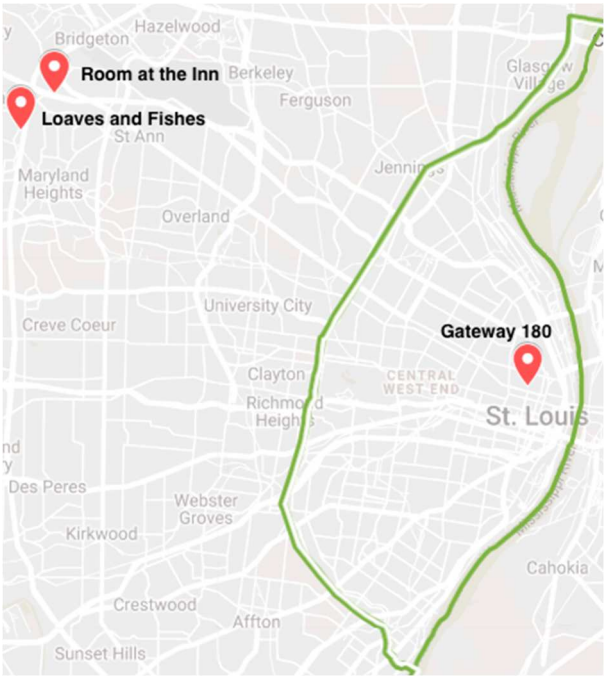


Figure 2.1. Group model building sites (city outlined in green)

Gateway 180. The largest site and only agency located within St. Louis City, Gateway 180 had a capacity of 162 beds, with seasonal overflow of approximately 20 beds, and served families with children (at least one adult and one child), childless single women, and childless couples. Single, childless men were not admitted (HUD, 2018b).

Room at the Inn. The second site was a smaller agency, serving only 20 families at a time, located in the city of Bridgeton in St. Louis County. Rather than a traditional night-site shelter, Room at the Inn instead contracted with local churches that provided space to sleep; families were bussed to the churches at night and returned to the shelter in the morning.

Loaves and Fishes. The third site was situated in a former church in the city of Maryland Heights, also in St. Louis County. Loaves and Fishes was a traditional night-site emergency homeless shelter and doubled as a food pantry. Approximately 8-10 families were served at a time (HUD, 2018a).

Group Model Building Procedures

Group model building participants were recruited from three family homeless shelters in St. Louis City and County, MO. The PI distributed flyers with information about the study throughout the shelters and visited multiple times before sessions occurred to answer questions and provide further information about the study. Agency leadership also provided connections to staff, who assisted with informing clients about the study and distributing contact information for the research team. Prior to consenting, each participant was informed about study purpose and procedures, and was provided time to review the consent document and ask questions. Each participant was compensated with a $20 gift card for each session in which he or she took part. Study procedures were approved by the Washington University in St. Louis Institutional Review Board as well as the National Institute of Mental Health Human Subjects Protection Board.

Each caregiver was invited to take part in two one-hour group model building sessions that included three to 14 participants each, so that each participant completed one initial and one follow-up session (Table 2.1). Staff members participated in a single session. Each session included at least one script to generate insights into key factors driving patterns of service use, trends in those factors over time, and causal feedback relationships linking factors.

Variable elicitation: The purpose of this script was to generate ideas about the key variables involved in the service-related decision-making processes of providers and homeless families (Luna-Reyes et al., 2006). The facilitator presented an initial problem statement to the group—"It is hard to get appropriate services for my family necessary to return to stable housing quickly"—and give examples of both tangible and intangible variables such as "long waitlists for services," "provider burnout," "emotional strain," etc. that may be important. Participants were encouraged to think about variables that could accumulate or deplete over time (e.g. potential

stock variables for a stock and flow diagram). Participants spent 5-10 minutes individually writing down what they perceived to be important causal or outcome variables. The facilitator then reconvened the group and gave participants turns presenting and explaining the variables they listed in a "round robin" fashion so that everyone had a chance to contribute equally. The facilitator asked probing or clarifying questions so that each variable was clearly articulated and understood by everyone in the group, including the modeling team. The target output from this script was a list of key variables that would later be used to develop a qualitative model articulating processes driving service utilization patterns among homeless families.

Graphs over time. Through facilitating this script, the modeling team aimed to gain insight into trends over time of key variables. Client participants were asked to provide graphs of key variables over time, while staff members were asked to complete both variables over time as well as bivariate graphs illustrating the relationships between two variables (Figure 2.2). The facilitator provided sheets of paper; some had the axes labeled with variables identified in the prior script, while others were blank. On graphs over time, the *x* axes were labeled from a minimum of *Day of Entry* to a maximum of *Day of Exit* to capture average behavior over the duration of a typical shelter stay. The *y*-axes were labeled from *Low* to *High* to capture general trends rather than specific parameter values. Participants were asked to draw patterns of behavior of variables over time. Staff members were also asked to draw relationships between two variables. Then, each client was asked to present graphs in a round-robin fashion; facilitators or other participants posed clarifying questions to that the "story" of each variable or relationship was well-understood by the group. The graphs were then taped up to a wall in clusters visible to everyone for reference. The facilitation team pointed out similarities and differences between perspectives, and solicited feedback on what might account for discrepancies.

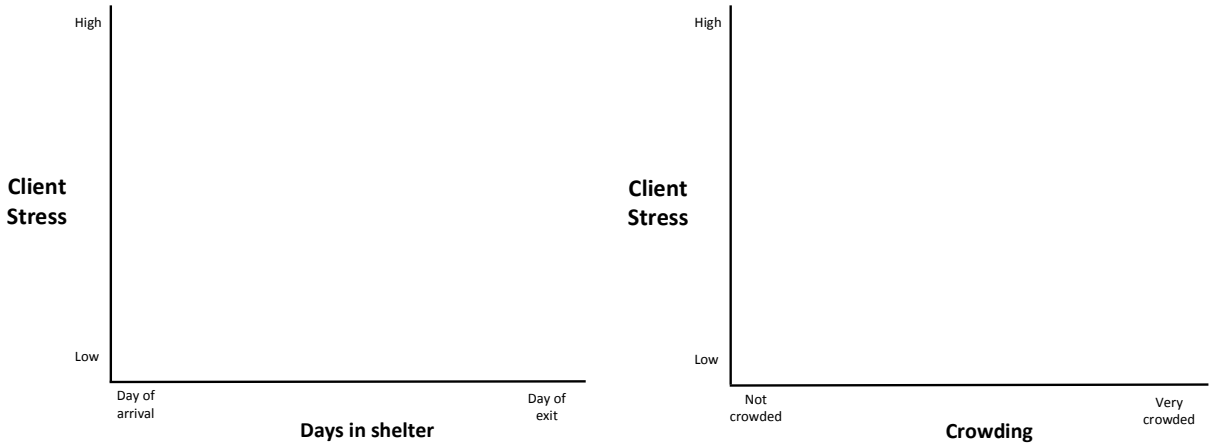


Figure 2.2. **Graphs over time templates.** Sample templates of graphs for mapping variables over time (left panel) and bivariate relationships (right panel) provided to participants.

Initiating and elaborating a causal loop diagram. The purpose of this script was to use the variables elicited above to develop a theoretical model (causal loop diagram; CLD) of how homeless families and providers make decisions about navigating services (Richardson & Andersen, 1995; Vennix, 1995). After displaying all variables on a whiteboard or large flipchart paper, the facilitator asked participants to describe causal connections between variables (e.g. "lack of affordable housing increases length of stay") based on their experiences. The modeler drew arrows between variables, with + or – signs to indicate the directionality of the effect. When disagreement emerged among participants about any causal link, the facilitator elicited further discussion from the group to create consensus. The target output from the script was a CLD articulating causal links that explained how service-related decisions were made, driving service utilization patterns.

Causal mapping with seed structure. In the follow-up session, the facilitator presented a seed structure based on the CLD developed in the initial session (Luna-Reyes et al., 2006). Participants were asked to examine the model as an articulation of theories that emerged from

the initial session, and encouraged to provide feedback on what was right, wrong, or incomplete. With assistance from two participant co-facilitators, the facilitator and modeler worked together to revise the seed structure to more comprehensively represent participants' perceptions.

Key Informant Interviews

Subsequent to group model building sessions, individual interviews were conducted with three staff members serving in various roles at the sampled agencies. Inclusion criteria were: (1) being employed at one of the three agencies, and (2) having frequent direct contact with clients. Key informant interviews were conducted with an executive director, a shelter manager, and a case manager who all offered unique perspectives on client experiences of shelter stays, their own experiencing providing services, and their understanding of their agency's role in the broader homeless services system. Each key informant completed a 45- to 60-minute semi-structured interview that covered his or her experiences working in the agency, as well as understanding of the service system structure and policies.

Analytic Strategy

Analyses occurred in phases. Qualitative data were used to develop a causal feedback theory explaining patterns in family homeless service use and child risk; this qualitative feedback theory was incorporated into a generic "stock and flow" simulation structure that was calibrated using a combination of qualitative data and administrative records. Finally, potential interventions were built into the structure to test impacts on key outcomes.

Building a Causal Feedback Theory

Qualitative data were analyzed to develop a causal feedback theory of service use and child risk for mental disorder using a community-based system dynamics approach. Outputs from each group model building session were reviewed and summarized in memos by the

research team. Memos from each session were reviewed by the PI and at least one other team member, who independently grouped variables into broader themes using content analysis with emergent coding (Blair, 2015; U.S. Department of Health and Human Services, 2018). Key themes were those that emerged in multiple sessions, and in particular constructs that could be expressed as accumulations (i.e. increasing or decreasing over time). Two research team members independently identified key themes and causal links between them, and compared findings. Causal maps developed during group model building sessions were thus combined to create a single representative CLD of clients' experiences, and then modified to incorporate insights from key informant interviews. Both reinforcing and balancing processes were hypothesized, as indicated by reference modes that showed equilibrium over time. Causal links and feedback loops were cross-checked with existing literature and expert consultation to assess convergence with current knowledge. The final diagram was reviewed by multiple team members as well as key experts to assess whether themes accurately represented the substance of the group model building sessions and was supported by prior theory. This causal loop diagram was compared to the causal theory developed for the dynamic hypothesis.

Simulation modeling

The original seed structure for the simulation model was a generic structure based on Ghaffarzadegan and colleagues' "swamping insight" model (2011). Stocks represented people in services and after exiting services, while flows represented entries, exits, and reentries. Model parameters were calculated in a number of ways. Time constants (e.g. *average length of stay*, *average wait for services*) were calculated using basic univariate statistics. Fractional rates were calculated as the raw percentage of families who experienced a particular type of transition across the time horizon of the model; these parameters were cross-checked by building small

sub-structures that were simulated across a longer time horizon, and checking that the expected proportion of families made certain transitions within a particular time period. The simulation model was adapted to incorporate insights from group model building and key informant interviews. Psychological variables were calibrated on a 0-10 scale. Levine (2000) recommends setting psychological variables on a factor ten scale when measures using validated individual assessment tools are not available; he distinguishes between "measuring" or operationalizing a psychological variable, as is often the goal in traditional statistical analyses, versus *quantifying* a psychological variable for the purposes of modeling a feedback relationship. In the latter, the purpose is to assess how an accumulation of a psychological or emotional factor may affect other processes in the model – in the present case, movement of families through the homeless services system (Sterman, 2002). System dynamics models are simulated using a series of integral equations (Equation 1) or equivalent differential equations (Equation 2). While the former captures stock values over time by integrating the inflows and outflows, the latter calculates change in the system over time.

Equation 1: $$Stock = \int_{t_0}^{t} [Inflow(u) - Outflow(u)]du + Stock(t_0)$$

Equation 2: $$\frac{d(Stock(t))}{dt} = Inflow(t) + Outflow(t)$$

Once the simulation model was built, calibrated, and validated, analyses sought to identify and test potential interventions to improve the four main system outcomes: average length of shelter stay, rate of reentry, unmet need, and child risk. Potential interventions were identified from qualitative data as well as prior literature and theory, built into the model, and simulated to test impact on system performance. Models were simulated across 120 months (10 years), with interventions beginning Month 60. Run 1 represented a base run, representing

"business as usual" or current system functioning; subsequent runs tested system functioning with interventions implemented one at a time.

III. Aim 1: Developing a Dynamic Hypothesis

The present study applied a system dynamics perspective to the problem of stagnant rates of homeless service use and risk to child mental health among families experiencing homelessness. Given there has been limited systems research in this substantive area, the first aim of the study established a dynamic hypothesis. The PI drew upon existing data and empirical literature to 1) Articulate the scope and nature of homeless service use and corresponding risks to child mental health as a complex dynamic problem, and 2) Hypothesize a causal feedback theory driving the problem.

Unmet Need in St. Louis Homeless Services

The St. Louis region, home to 1.3 million residents, has struggled to address persistent family homelessness. Over one in four (27.1%) City residents and over one in ten (10.3%) County residents lived below the federal poverty line in 2016. Among children, rates were nearly 40% and 14% in the City and County respectively (U.S. Census Bureau, 2016). Rates of family homelessness have been largely static in the region over the past decade, with over 10% of clients returning to services within 2 years of exiting (Institute for Community Alliances, 2016a, 2016b). Furthermore, capacity in the St. Louis City and County Continuums of Care has changed little over this same time period (HUD, 2019b; Figure 3.1).

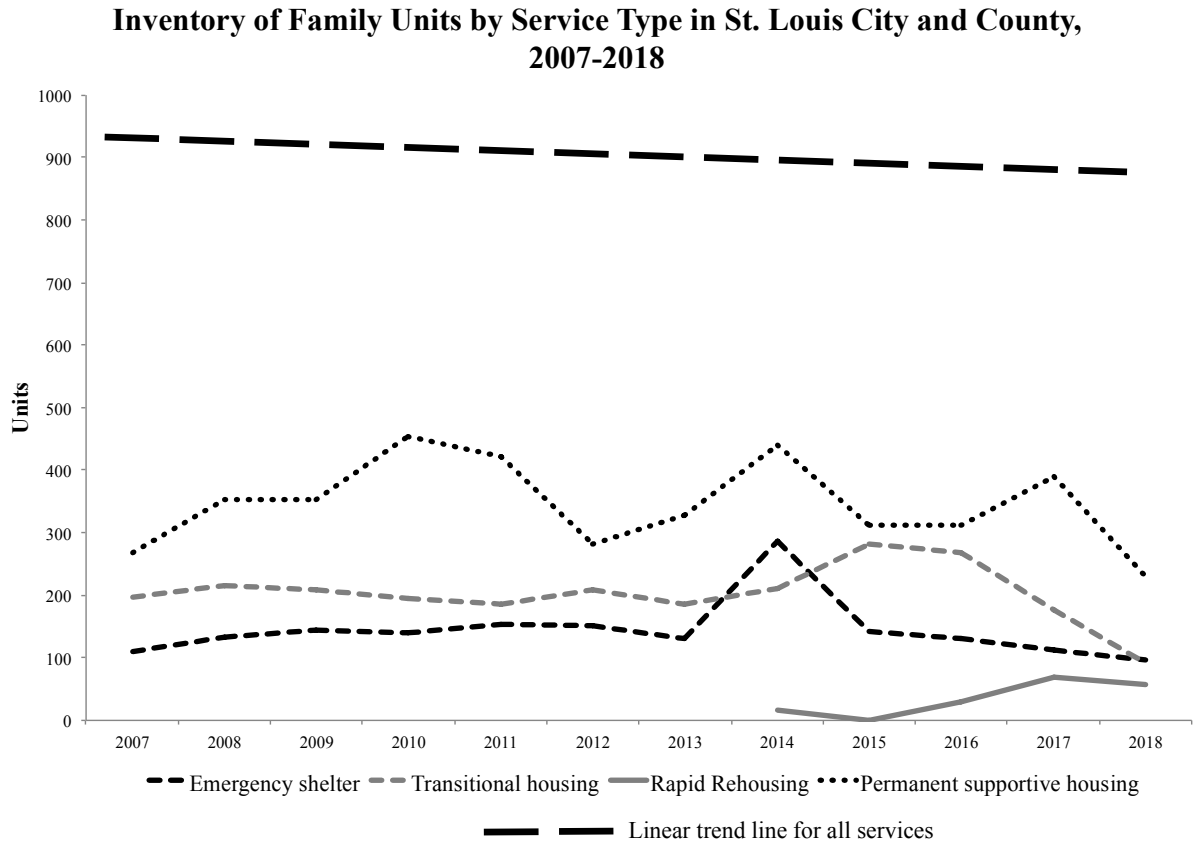
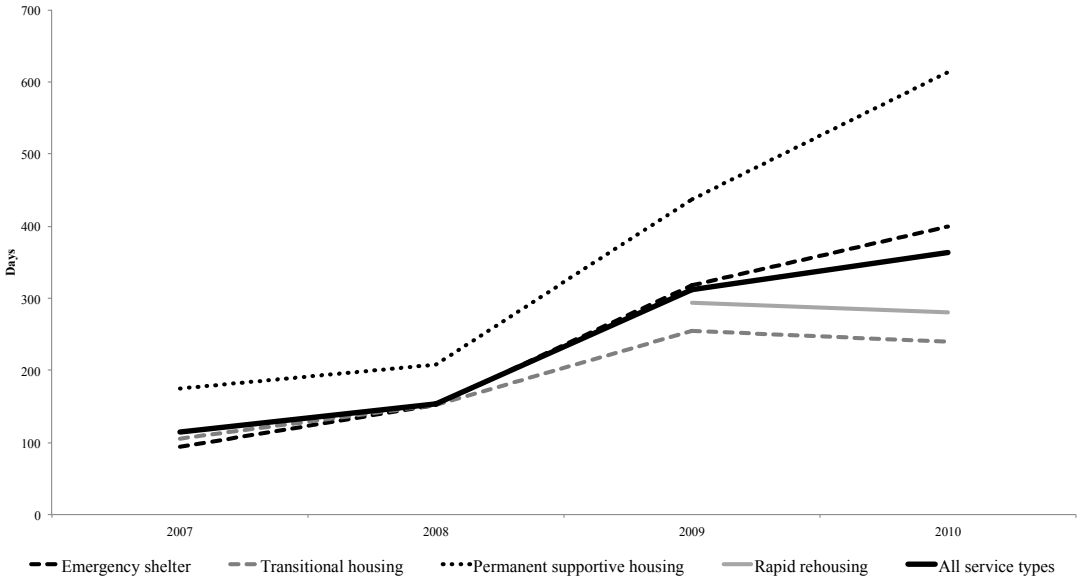


Figure 3.1 Inventory of family units by service type In St. Louis City and County, 2007-2018 (HUD, 2019b)

Other indicators suggested high levels of unmet need among families seeking services. Wait times for families entering services have increased substantially in recent years (Figure 3.2). Furthermore, families called the homeless hotline on average 12 times before receiving services between 2007 and 2014. These snapshots of family emergency shelter use rates in the St. Louis region showed little change over the past decade, while demand for shelter remained high (Figure 3.3).

Figure 3.2 Average wait time for families seeking homeless services in St. Louis City and County, 2007-2010 (below)



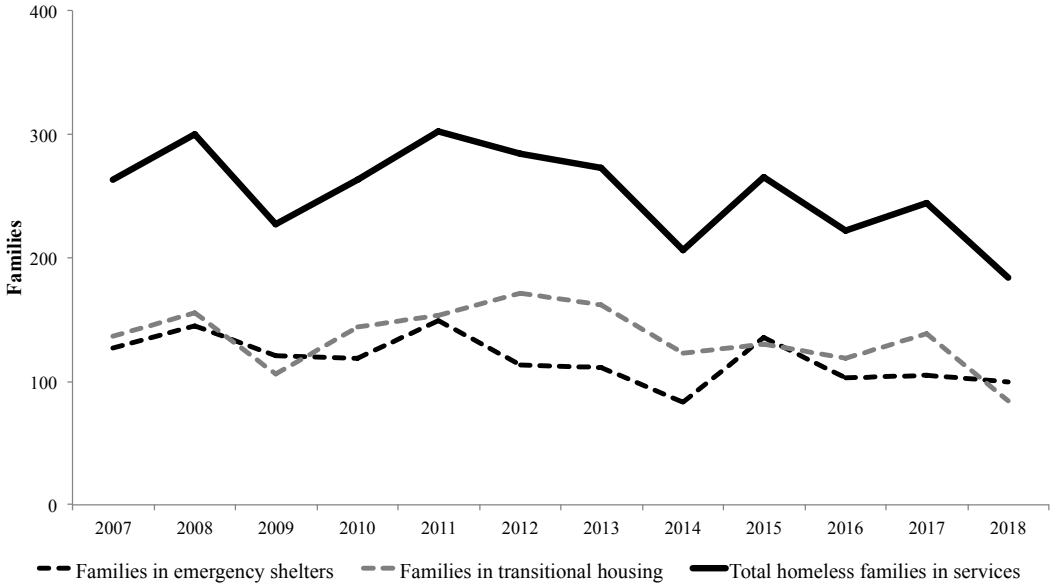


Figure 3.3 Point-in-time counts of families in homeless services in St. Louis City and County 2007-2018

Reference Modes

Key indicators of system performance were drawn from administrative data. Trends over time were tracked for the rate of reentry, or proportion of families who returned to services within two years of exiting. With some fluctuation over the past decade, rates hovered between 10 and 20% of families returning to services. "Hoped" and "feared" future trends captured ongoing stagnation versus a decline in reentries (Figure 3.4). Finally, length of stay was tracked. Over the period from which study data was tracked, the median length of shelter stay for families with children remained relatively flat, but nearly 50% higher than the HUD goal of 30 days (Figure 3.5).

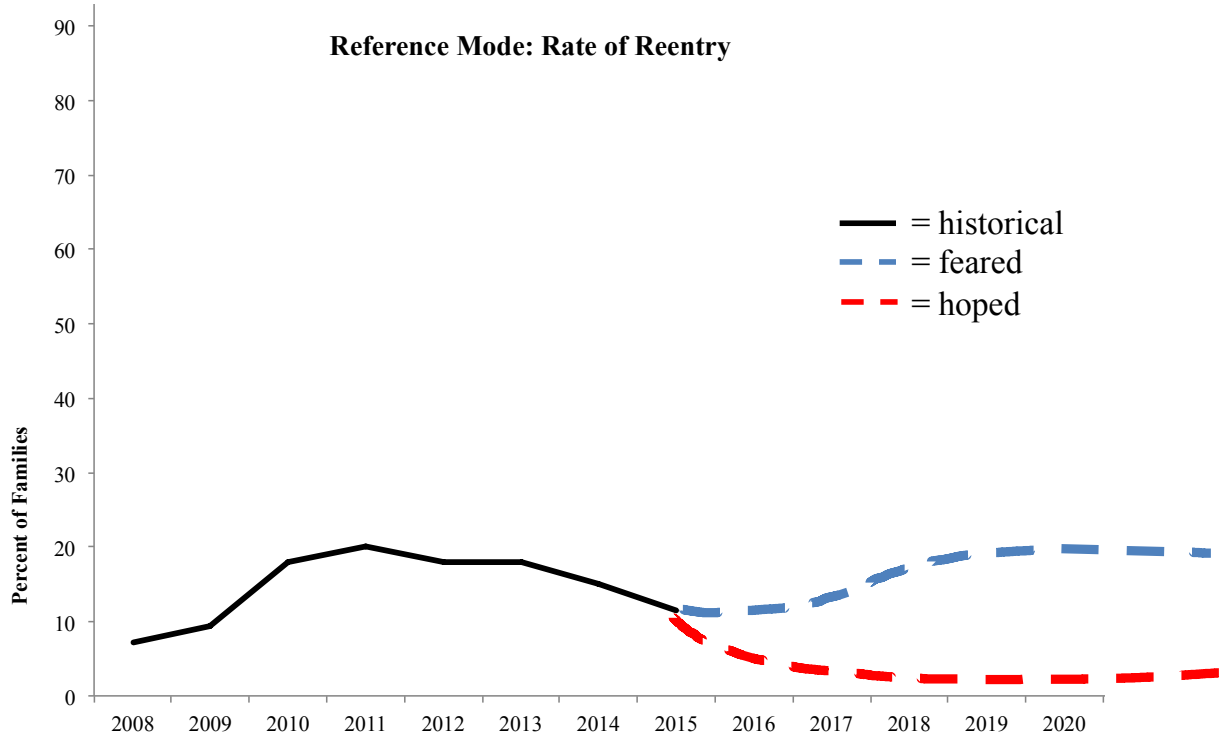


Figure 3.4 **Reference mode of rate of reentry**. Percent of families who reentered homeless services within 2 years of a prior exit in St. Louis City and County, 2008-2015, with "hoped" and "feared" future trends

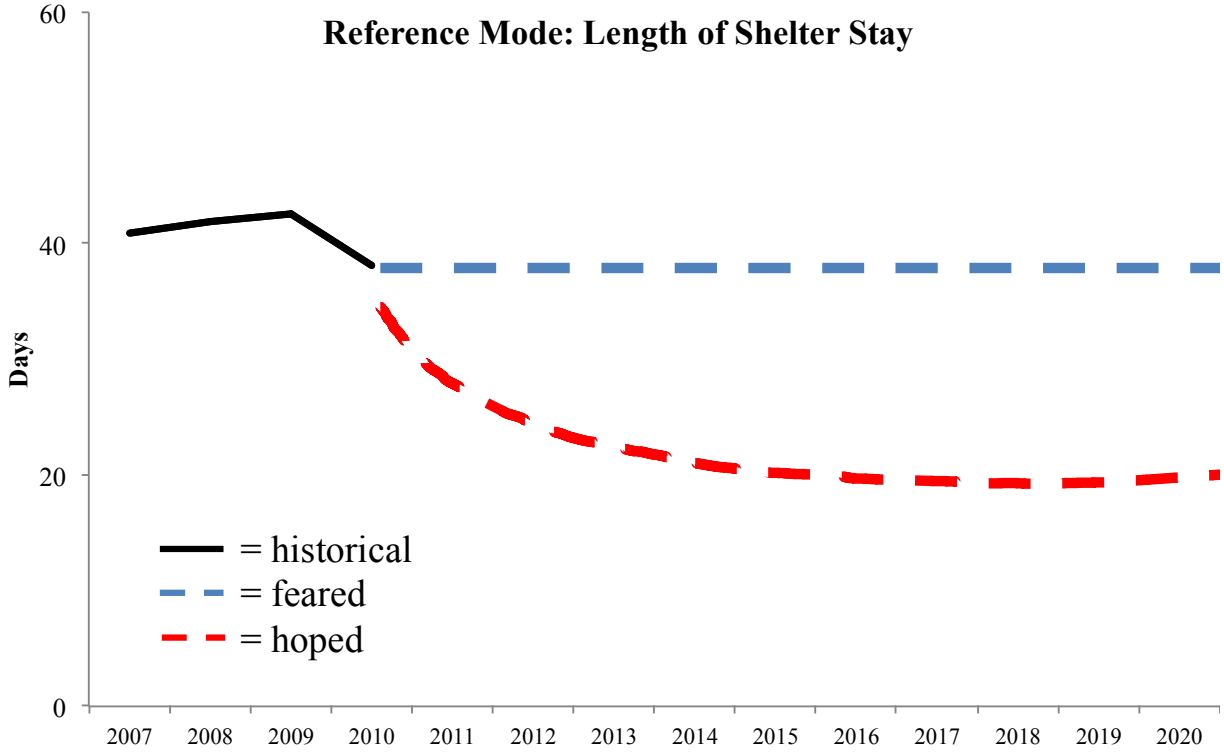


Figure 3.5 Reference mode of length of stay. Median length of stay in emergency shelters among families with children in St. Louis City and County, 2008-2017, with "hoped" and "feared" future trends.

The two remaining key outcomes – unmet need and child risk – lacked empirical data. Therefore, two additional exploratory reference modes were hypothesized. *Unmet family need* captured the unmet demand indicated by increasing wait times and repeated calls for services. It was hypothesized that this unmet need was growing over time (Figure 3.6). A "feared" trajectory

predicted continued growth, while the hope was decline.

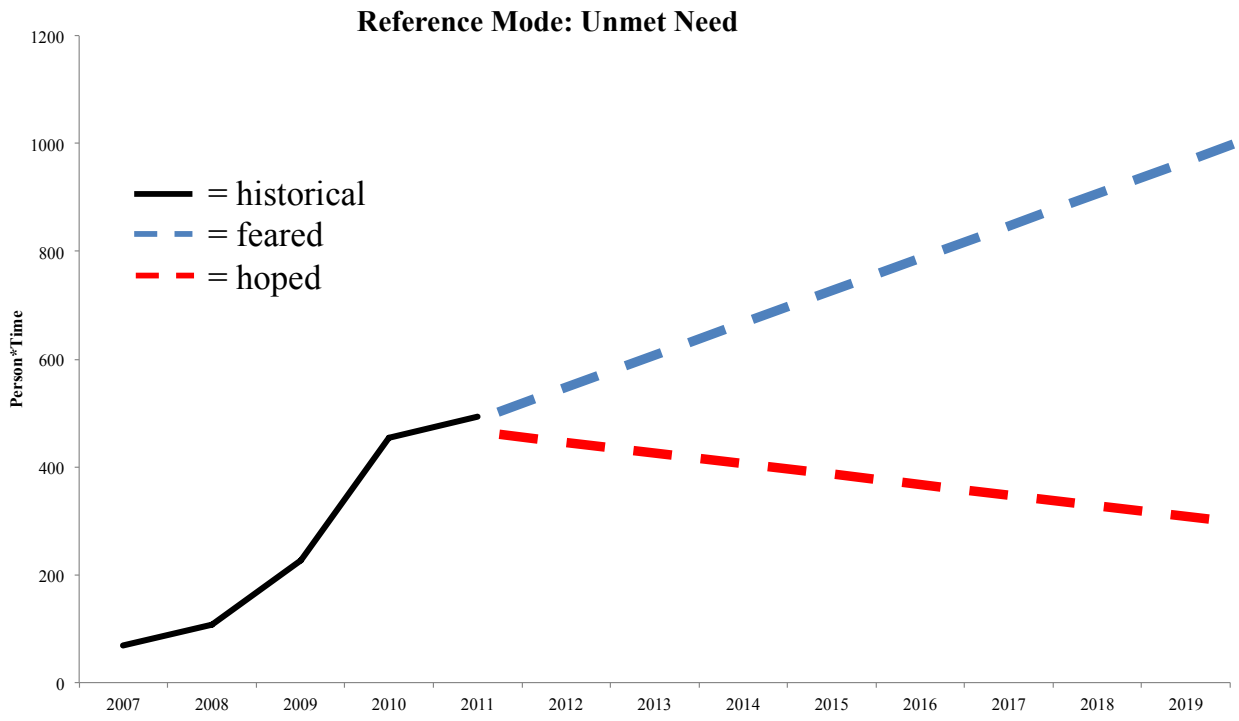


Figure 3.6. Reference mode of unmet need

Next, a construct of *child risk* captured the accumulation of exposure to adverse events common to children in homelessness (Figure 3.7). This was hypothesized to increase over time, with a "feared" trajectory of continued growth and a "hoped" decline over time.

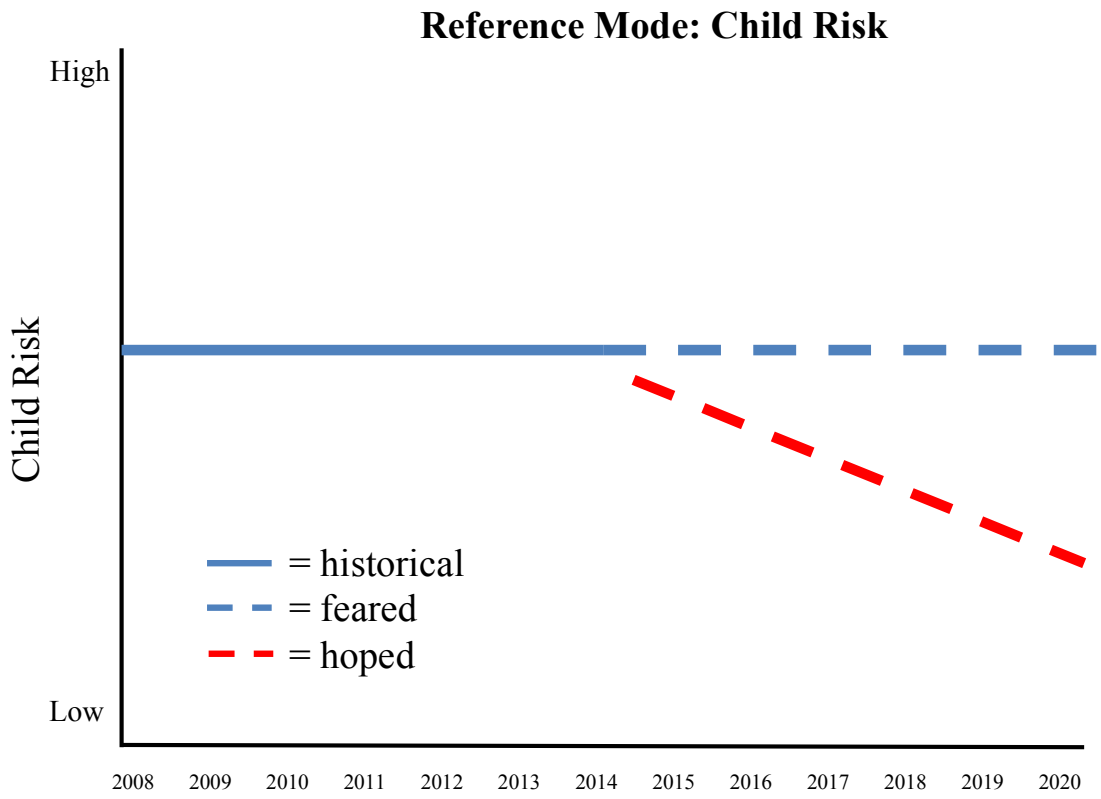


Figure 3.7. Hypothesized reference mode of child risk

Hypothesized Causal Theory

The present study tested the dynamic hypothesis that these trends have been driven by a series of feedback loops (outlined in red; Figure 3.8) influencing average length of stay, rate of reentry, unmet need, and child risk. As families stay longer and services become more crowded, homeless service providers face strain as they attempt to adequately assess, serve, and refer families (R1; Levin & Roberts, 1976); this contributes to ongoing unmet family needs, which contributes to longer stays as well as increased likelihood of reentry after exit; longer stays and the "revolving door" of service delivery increase strain on providers, further eroding capacity to serve (Fowler, Wright, Marcal, Ballard, & Hovmand, 2017; Ghaffarzadegan, Levin & Roberts, 1976).

At the same time, families simultaneously face the complex task of evaluating of their own needs, and making decisions about which services to pursue; the perceived desirability of pursuing homeless services versus alternative options influences how long families receive homeless services, whether they seek other services, and how likely they are to return (Mayberry, 2016; Rufa & Fowler, 2018). When homeless services are perceived to be more desirable and accessible, length of stay and likelihood of reentry increase (B1; Buckner, 2008). In a hypothesized balancing process, more families receiving homeless services reduces the perceived desirability and accessibility, reducing length of stay and reentry; similarly, the number of families in homeless services is balanced by the reduction in availability (B2). The system is further constrained by provider capacity to serve a limited number of clients at a time and the limited number of homeless service agencies in the region (B3).

According to this hypothesis, two main processes reinforce unmet family need. First, length of stay increases strain on providers as shelters become more crowded over time, which erodes their ability to adequately assess and address client needs (R1). This contributes to unmet need, which further reinforces length of stay. Second, length of stay increases child risk through ongoing exposure to chaos and instability; these more complex needs compound length of stay (R2).

The combination of these balancing and reinforcing processes result in a state of equilibrium by which the numbers of families entering and exiting homeless services remain constant over time (Levin & Roberts, 1976); in order to reduce the number of families relying on homeless services and promote more sustainable approaches to meeting families' needs, one or more of these processes must be disrupted (Figure 3.8).

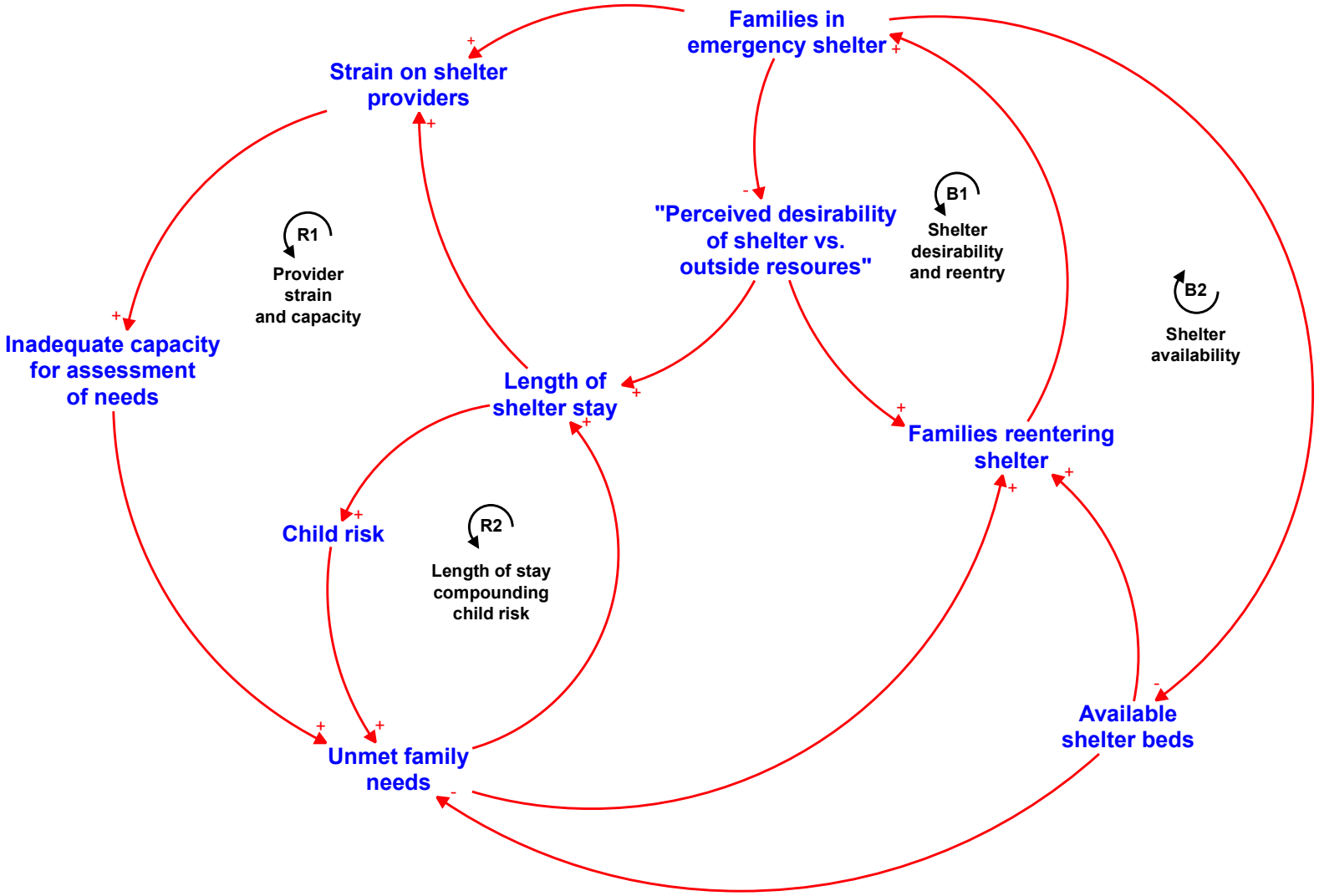


Figure 3.8 Hypothesized feedback theory driving reference modes. *Loops labeled "R" indicated reinforcing or positive feedback loops; loops labeled "B" indicate balancing or negative feedback loops.*

IV. Aim 2: Building a Causal Feedback Theory

Information was drawn from a variety of sources to build a causal theory of service use and child risk. Administrative records as well as qualitative data collected through group model building and key informant interviews were integrated to develop further understanding of the feedback processes driving patterns of service use and unmet need, and test assumptions generated by the dynamic hypothesis.

Administrative Data

The administrative sample included 4,771 households with children who entered homeless services in St. Louis City or County at least once between 2007-2012. Records were collected for a total of 5,624 stays. Details about the sample are displayed in Table 4.1. Households were overwhelmingly headed by unmarried, African American women in their 30s with approximately two children. Over the five-year study period, one in six families reentered services within two years of a prior exit. Families entered the homeless services system on average just over one time, although the number of entries ranged from one to five.

Table 4.1. Demographic characteristics of sample drawn from administrative (HMIS) records

		Mean(SD) or N(%)
Age at First Entry 2007-2012		33.56 (9.01)
Gender		
	Male	402 (8.4)
	Female	4369 (91.6)
Race/Ethnicity		
	Black	4276 (89.6)
	White	419 (8.8)
	Other	76 (1.6)
Number of Children		1.98 (1.16)

Spouse Present	531 (11.1)
Mental Health Problem	372 (7.8)
Disabling Health Condition	325 (6.8)
Number of Entries 2007-2012	1.18 (0.44)
First Entry Type	
Emergency shelter	1,294 (27.1)
Transitional Housing	277 (5.8)
Rapid Rehousing	182 (3.8)
Permanent Supportive Housing	114 (2.4)
Prevention	2,904 (60.9)
Ever Reentered	760 (15.6)

Group Model Building with Homeless Service Consumers and Providers

The sample for group model building sessions with consumers included 37 caregivers with children. They were overwhelmingly female (92%) and African American (87%), and two in three were first-time shelter clients (65%). The mean age was 39.6 (SD = 13.0) years, and caregivers had on average 2.5 children (SD = 1.8), although families ranged from 1 to 10 children. Households closely resembled those sampled in the HMIS dataset (Table 4.2). Heads of household were on average 34 years old, African American, female, and had 2 children. Compared to families from the HMIS records, heads of households from the GMB records were slightly older (t = 4.08), but did not differ significantly on other key demographic variables.

Table 4.2. Comparison of demographic characteristics between the GMB and HMIS samples

	HMIS	**GMB**	χ^2 or t
Age (*M/SD*)	33.56 (9.01)	39.65 (12.99)	4.079***
Female (*%*)	91.6	91.2	0.005
Race (*%*)			0.494
Black	89.6	86.5	

White	8.8	10.8	
Other	1.6	2.7	
Number of children (*M/SD*)	1.98 (1.16)	2.46(1.82)	2.494*

***p<0.01, *p < 0.05

Consumers participated in two group model building sessions each in order to contribute to development of a theoretical model (Table 4.3). The sessions centered on the following prompt: "What factors make it easier or harder to return to stable housing?" The purpose of group model building with staff members was to probe information elicited from clients in order to assess whether their perspectives converged on the same key themes and causal links. Staff participated in a one-time group model building session. Facilitators led participants in two scripts: graphs over time and initiating a causal loop diagram. Graphs over time were provided for key variables that had been elicited in client groups.

Table 4.3 Schedule of group model building scripts conducted with homeless consumers

Group	Site	Number of Participants	Session	Scripts	Duration
A	Gateway 180	12	Initial	• Variable elicitation • Initiating a CLD	• 20 min • 40 min
A	Gateway 180	8	Follow-up	• Causal mapping with seed structure	• 60 min
B	Gateway 180	6	Initial	• Variable elicitation • Initiating a CLD	• 20 min • 40 min
B	Gateway 180	14	Follow-up	• Causal mapping with seed structure	• 60 min
C	Room at the Inn	4	Initial	• Variable elicitation • Graphs over time	• 20 min • 40 min
C	Room at the Inn	3	Follow-up	• Causal mapping with seed structure	• 60 min
D	Loaves & Fishes	8	Initial	• Graphs over time • Initiating a CLD	• 30 min • 30 min
D	Loaves & Fishes	7	Follow-up	• Causal mapping with seed structure	• 60 min

Participants provided insights into variables driving key outcomes through the *variable elicitation* script (Figure 4.1), and trends in those variables over time in the *graphs over time* script (Figure 4.2). Variables were prioritized for final analyses if they 1) emerged in multiple GMB sessions, and 2) could be expressed as accumulations. Variables fell into three major themes that were identified by participants, members of the facilitation team, and consultation with key experts: *mental/emotional well-being*; *shelter conditions*; and *housing, services, and system policies*. (Table 4.4).

Table 4.4. Key themes and variables from group mode building sessions and key informant interviews

Key themes	Variables	Example Quotations
Mental/emotional well-being	Caregiver stress	"The emotional strain on you, the mental strain on you, the social strain on you - I don't know if I have what it takes to fight through everything." - *Caregiver* "It makes you crazy. You feel helpless. It's just never ending." - *Caregiver*
	Empowerment	"It's a sense of motivation, accomplishment, getting yourself out of a bad situation. Empowerment means 'moving forward.'" - *Caregiver* "When you think about empowerment, it's 'what lifts you up.'" - *Caregiver* "Either you're gonna become resilient, or you gonna fall and crumble." - *Caregiver*
	Child stress	"When I first got here me and my kids' stress level was really high. It's not really low but it's gone up and down some, but I'm still pretty stressed out and it's the same for my kids." - *Caregiver* "Moms are stressed, kids are stressed, staff is stressed." - *Caregiver* "Mom's stress affects the child's stress; it works both ways." – *Staff member*
	Child behavior	"When kids are stressed, they act out…very needy, looking for attention" – *Caregiver*

	Complexity of family's needs	"They want to discipline their kids, but we can't let them slap hit or kick the kids. We are mandated reporters. So parents get frustrated that they can't control their kids." – *Staff member* "[We] have very different needs and that makes it hard for caseworkers to provide for needs." – *Caregiver*
		"Length of stay depends on: how complicated are their needs, lack of motivation and self esteem, how many steps do they have to take." – *Staff member* "If I'm too comfortable I'll get lazy." – *Caregiver*
	"Getting comfortable"	"If they get everything without learning to use tools, then they get comfortable and won't be able to get housing." – *Staff member*
Shelter conditions	Crowding	"When it's more crowded, it's definitely more stressful, especially for the children." – *Staff member* "We're always full… We get hotline calls all day long. That forces us to move people as quickly as we can." – *Staff member*
	Strictness of shelter policies/rules	"We like them out in 90 days but some stay up to a year… If we have space, they can stay." – *Staff member* "Clients can push your buttons…it used to be, if a client were yelling or cussing you out, they'd be out. Now [with trauma-informed care], we can't be as punitive." – *Staff member*
	Caseworker support	"[T]hey tell you they have to ask your caseworker, but the caseworkers are never here." – *Caregiver*
Housing, Services, and System Policies	Available homeless services	"Lack of transitional housing means people stay longer – now we have permanent supportive housing, but that's mostly for chronic homeless." – *Staff member* "*We've* become the transitional housing." – *Staff member*
	Prioritization list/Referral procedures	"STL prioritizes chronic homelessness [for services], which is a bummer for us. Most of our families aren't chronic. The list is very slow-moving." – *Staff member* "Clients want to just put their names on any list, [they] don't necessarily know the criteria or realize how long the wait will be and that they shouldn't count on it." – *Staff member* "It's so hard to get [a housing voucher], but it's even harder to use it." – *Caregiver*
	Available housing resources	"We connect with landlords before sending clients there – can't just send people out; too many barriers to getting housing." – *Staff member*

	"You need to make 3x the rent in order to sign a lease…[that's] the reason people get involved with slumlords." – *Caregiver* "All of the affordable housing is in a rough neighborhood." – *Caregiver* "Childcare is a major barrier." – *Staff member*
Child care	"My biggest main goal that I'm focused on is getting a job and having someone to keep my kids while I'm working." – *Caregiver*
Transportation	'[My stress] started to go down once I got transportation. [People] donated bus tickets, and [shelter staff] also provide us transportation in the morning and evening." – *Caregiver*

Mental/Emotional Well-being

Caregivers emphasized the emotional strain they experienced during their shelter stay – one woman noted that if she were to rate her stress on a scale from one to 10, "I'm at a 12." There was consensus among the group that their individual stress levels immediately elevated upon entering the shelter and remained high throughout the duration of the stay.

One woman described the strain of being in the shelter:

> *It's like a system in here. The emotional strain on you, the mental strain on you, the social strain on you - I don't know if I have what it takes to fight through everything just to get back on my feet as an adult to get what everyone wants as an adult: to get your own place for you and your children.*

Caregivers also talked extensively about their own internal motivation, self-efficacy, and commitment to moving forward—captured in our model as *empowerment.* They felt a strong sense of responsibility to stay focused on moving forward and securing a stable future for their children. One woman explained, "[Empowerment] is a sense of motivation, accomplishment, getting yourself out of a bad situation… Empowerment means moving forward." Another

defined empowerment as: “A sense of ownership, owning up to your role in coming here. Deal with it, process it, move on.” In general, clients were open about their own roles in becoming homeless and the need to learn from their pasts; they expressed pragmatism in discussing the effort required to move forward. One young mother of a son with a physical disability said: “*I* had him. The state didn’t have him. So I have to take care of him. […]”

Another woman stated:

> *It falls on the shelter and also falls on us. It’s our mentality. It’s going to be how you want it to be. You’ve got to keep moving. Everybody is somebody and everybody feels differently about different things. It’s on me to make it what I want it to be.*

A different woman echoed this sense of personal responsibility for one’s mentality and commitment:

> *It’s what you make of it. You can take a bad thing, and work on it, process it. One of two things will happen: you’ll fix it, or you have to let it go and move onto something else.*

One caregiver noted the importance of a sense of personal responsibility in order to make progress in her current community: “As black people, we can’t expect things to come to us without putting anything in.”

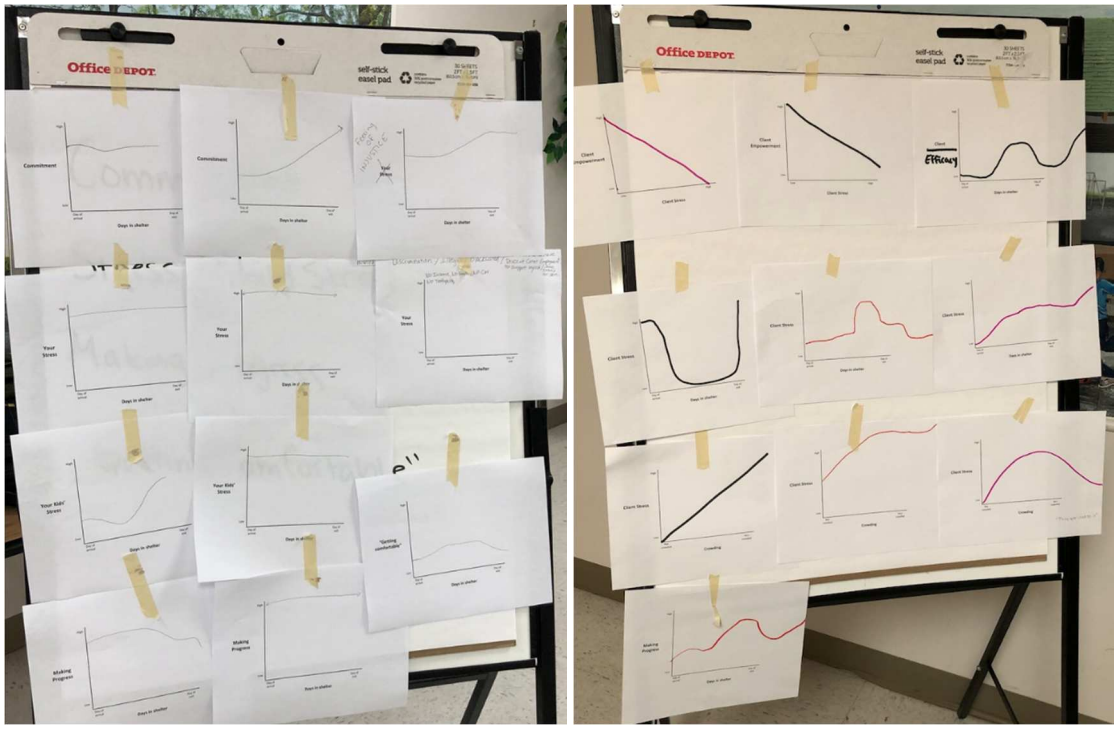


Figure 4.1. Output from "graphs over time" script with clients (left panel; Group C) and staff (right panel; Group D)

Caregivers provided insight into trends of their own stress, their children's stress, empowerment or "commitment," and a sense of "making progress" throughout their time in services (Figure 4.1). They generally felt that their stress was high throughout the duration of the homeless episode, while their kids' stress tended to increase over time as they became more aware of and frustrated by their surroundings; parents noted that children with special needs often had fluctuating levels of stress as they had fewer effective coping strategies. Clients also stated that a sense of motivation or commitment was generally high throughout the stay, but could decline as a result of experiencing repeated rejections from landlords or becoming fed up with their circumstances. In terms of "making progress," the clients felt that a sense of moving forward typically increased at first, and then stalled after a period of time in the shelter as rejections from landlords accumulated and frustration grew.

Some differences emerged between client and staff perspectives. While clients said that their stress levels had remained flat and high throughout the entire stay, staff offered a different view; while they agreed that clients were indeed stressed throughout their time in services, staff believed that stress increased over time – particularly as clients' goal exit dates approached and the prospect of having to leave the shelter became more "real" to them:

> *As soon as people walk in here, they want to know how long they can stay. When they approach that time, they start getting stressed. They start asking [other clients], 'How long have you been here? How long have you been here? Why do I have to leave?'*

Staff members also described feedback relationships between stress, length of stay, and the concept of "getting comfortable" described by clients:

> *If people stay longer and aren't making progress, their stress goes up. 'The longer I'm not making my goal, the more stressed I am because I'm stuck here.' People get comfortable, but even in that comfortability they get stressed because they see other people making progress.*

Staff confirmed the centrality of a sense of internal motivation, self-efficacy, and empowerment, but more strongly emphasized engagement with caseworkers and willingness to follow through on pre-determined goals.

Shelter Conditions

The crowding and lack of privacy that accompanied communal living was challenging for many caregivers when they entered shelters. Caregivers felt that the undesirable conditions in shelters both increased their motivation to find alternative, more comfortable accommodations, but also increased stress, making them feel less capable and more emotionally drained. Crowding also limited time with caseworkers and availability of resources, which made it more difficult to

make progress. Clients described the push-and-pull feeling of wanting to adapt to the shelter in order to feel more at home and reduce their stress, but also not wanting to let themselves "get comfortable," because they believed this would reduce their drive to make progress toward their goals. They agreed that the longer a family stayed in shelter, the more likely they were to acclimate to communal living, lose a sense of focus and urgency, and thus feel less capable of regaining independent housing quickly.

A father discussed how safety and stability were integral to his ability to make progress toward returning to housing:

> *The shelter should make you feel a sense of stability, because you're already so stressed. If I'm going for one chaotic situation to one that's even more chaotic, where am I going to have that sense of peace and understanding to hit my points?*

Families experienced a range of complex needs that made their stays longer and more challenging. Several caregivers noted their children had emotional, behavioral, or health problems that made it difficult to find appropriate care, posed challenges at school, and made it harder for the family to cope with being in the shelter. For example, one mother shared that her son had attention-deficit/hyperactivity disorder (ADHD), and that this made it hard for him to handle the shelter environment; he lacked coping skills, became bored easily, and acted out. Another mother shared that her child was bullied at school for being homeless, and that he had become withdrawn and irritable. Several mothers were caring for infants (less than age 1 year) and found it extremely stressful to manage sleep, feeding, and medical issues in the shelter environment. Families also noted that having more children made it difficult; the mean number of children among client participants was just over two, but some had as many as ten. Families with more children struggled with issues of childcare, transportation, and appropriate discipline

to manage behavioral problems. Overall, clients felt that families with more complex needs had a harder time following shelter policies and took longer to leave.

Parenting posed particular challenges in the shelter setting. Family size varied widely (1-10 children), which made it difficult for some parents to follow shelter rules that required them to remain outside the shelter all day as well as directly supervising all of their children at all times. Parents also felt disempowered to effectively discipline their children, who observed their parents being reprimanded by staff and were thus not motivated to respect parents' authority. Further, parents felt "under a microscope" and worried about being reported to Child Protective Services if they engaged in what parents believed to be appropriate disciplinary measures.

In regards to service delivery, resources, and shelter policy, participants felt that too much of service delivery applied a "one-size-fits-all" approach without acknowledging the complexity of families' circumstances and needs. In one agency, for example, clients were not allowed to enter the building between 8am and 4pm even if they worked evenings, lacked transportation to travel anywhere, or suffered from depression that made it difficult to motivate action.

Housing, Services, and System Policies

The third major theme that emerged was the available housing and other services along with system policies that helped or impeded families seeking stable housing. Caregivers noted key resources as childcare, mental health services, family support, transportation, and – most importantly – relevant, affordable housing options. For example, consumers felt that there were never enough realistic housing options because landlords required them to earn three times the rent in income, when many had very low or no incomes. The sense of competition for limited resources created strain for consumers and providers.

Shelters varied widely in services provided to consumers, which they felt were integral to their ability to make progress. In one agency, consumers felt that they rarely saw caseworkers and had little individualized attention. One caregiver said that when she needed something, "They tell you they have to ask your caseworker, but the caseworkers are never here." Another mother stated that her stress level was directly connected to the concrete resources available to her through the shelter, particularly transportation, which allowed her to make progress toward finding employment and attaining housing:

> *[My stress] was very high when I first got here…absolutely no income at all, not even transportation to get my son to and from school. My stress level was high. I've been here for two months. It started to go down once I got transportation. [People] donated bus tickets, and they also provide us transportation in the morning and evening.*

Overall, consumers emphasized the significance of internal motivation, commitment, and a sense of empowerment in concert with concrete resources and supports from the homeless services system as essential components of successful shelter exit. Most felt highly motivated to gain employment and find housing, but experienced stress and frustration at barriers along the way such as income requirements from landlords, inability to job hunt due to lack of child care or transportation, or repeated rejections of housing applications. Multiple consumers discussed the challenges of tight deadlines, confusing paperwork, and limited access to caseworkers that impeded their ability to find housing regardless of their motivation or commitment levels.

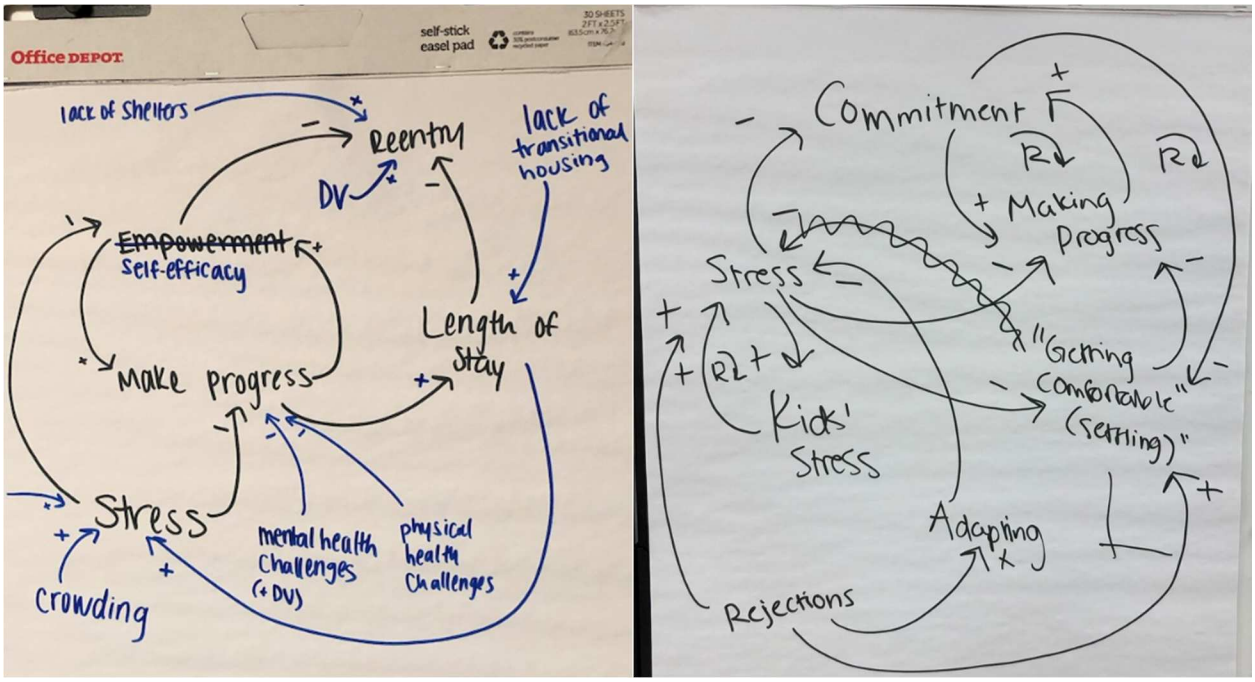


Figure 4.2. CLDs generated in group model building sessions with clients

In key informant interviews, availability of housing and the challenge of allocating scarce resources emerged prominently. All interviewees noted recent changes that had taken place due to HUD's recent implementation of Housing First. With this shift that began approximately 18 months prior to the study period, families seeking services were assessed and then assigned to a rapid rehousing, permanent supportive housing, or no housing intervention on a "prioritization list;" they waited in emergency shelter for a spot in one of these services to become available. According to staff, many clients did not acknowledge or understand the extremely limited nature of these services, however, and that it was still necessary to pursue "self-placement" housing options beyond those indicated by the PL. For some, the list skewed motivation. One staff member explained: "Clients want to just put their names on any list, and they don't necessarily know the criteria or realize how long the wait will be and that they shouldn't count on it." Another stated:

I do feel the PL [prioritization list] has messed things up a bit. […] St. Louis prioritizes chronic homelessness [for services], which is a bummer for us. Most of our families aren't chronic. The list is very slow-moving.

Discussing the shift in service availability in St. Louis, another staff member observed:

Lack of transitional housing means people stay longer. Now we have permanent supportive housing, but that's mostly for chronic homeless. […] It's hard to predict who will do well and who will struggle. Some people get lots of services and still come back. It's hard to change their behavior.

Key informants also noted the challenges of client involvement across multiple service systems. Staff explained that involvement with multiple service systems created stress and confusion for clients: "There are so many shared clients in this day and age across service systems. Things get messed up. It's too hard for clients to keep up with different service timelines." In particular, the state's Department of Social Services, which investigates allegations of child maltreatment and provides child welfare services, was flagged as a major presence in the lives of many shelter clients: "For many families, [Social Services] has already intervened." Staff noted challenges in coordinating with Social Services; they believed that some families were separated from their children by Social Services because of experiencing homelessness:

Some get separated before coming here due to homelessness. I've had to call [Social Services] to educate them about the shelter – that it is a place for families, [that] it's better than separating families. We reach out, but don't get much response. I think they don't have enough manpower, and they are overwhelmed.

Staff shared a strong sense of community-wide challenges in addressing family homelessness, both in terms of managing complex, unmet needs as well as coordinating with other agencies and

service systems. These insights, along with those from consumers, were combined so that a causal loop diagram was created for each group (Figure 4.3).

Key informants also provided insights into potential solutions for improving the efficiency of service delivery within the homeless system. Several believed that reversing the reduction in transitional housing would be a positive step. One staff member at an emergency shelter stated, "We need more 'next-step' beds. Everything would be in its proper queue. *We've* become the transitional housing." They believed that more accurate assessment and targeted referrals would reduce the burden on shelter providers, ease the bottleneck at system entry, and help families stabilize more quickly.

Causal Theory of Service Delivery

Insights from primary data collection were synthesized into a comprehensive causal theory of homeless service use among families with children. The theory was supported by primary qualitative data collected from participants in key informant interviews and group model building sessions, and compared against existing knowledge from prior literature.

Key Constructs

System capacity referred to the number of available units for families in the St. Louis City and County homeless services systems. The initial stock value was calculated according to the St. Louis City and County CoC (Continuum of Care) Housing Inventory Reports (HUD, 2007-2016). The model was calibrated using reports from 2007 for emergency shelter and transitional housing programs for families (defined as households with at least one adult and one child).

Families in services was calculated as the number of families reported to be in emergency shelter or transitional housing programs in starting in 2007 according to the St. Louis City and

County CoC (Continuum of Care) Homeless Populations and Subpopulations Reports (HUD, 2007).

Length of stay was calculated from HMIS administrative data for families who entered emergency shelter or transitional housing between 2007 and 2011. Records were collected from households who utilized homeless services within the St. Louis City or County CoCs at the time of service delivery.

Caregivers described a sense of *empowerment* as a key component of their ability to return to stable housing. This construct was described variably as: "self empowerment," "strong foundation," "sense of self," "commitment," and "focus," but all emphasized a commitment to remaining determined, believing in one's ability to make progress toward independence, and being a good parent. This quality was labeled *empowerment* in the model based on prior explorations of similar qualities and their relation to homeless mothers' perceived capabilities (Banyard & Braham-Bermann, 1995; Coady & Lehmann, 2016; Peterson, 2014).

Crowding existed as a function of the number of families in services relative to the spots available. Caseworkers and agency leadership uniformly stated that their agencies were always full or very nearly full, with overflow beds being added during periods of extreme weather. Staff members estimated that when the proportion of occupied spots exceeded 75-80% of total capacity, agencies began to "feel" overcrowded, affecting both staff and client stress levels.

Pressure on staff was elicited from both staff members and clients, who noted that caseworkers felt pressure from funders, agency policy, and overwhelming demand to move people through services as quickly as possible. Clients were allowed to stay beyond the typical timelines (30 days in shelter and 2 years in transitional housing) if they were thought to be

making progress; “progress” could be a somewhat subjective assessment, and pressure to move clients more quickly intensified when demand was greater.

Caregiver stress was conceptualized as the amount of stress caregivers experienced while in services. Caregivers were asked to describe their stress levels across their time in services on a scale of 0-10, which is a frequently used metric in system dynamics models to capture accumulations of psychological variables (Levine, 2000). The causal theory incorporated important feedback relationships identified by participants, and was supported by a combination of insights from key informant interviews and group model building sessions as well as existing literature examining homeless services and families’ experiences of shelters (*Table 4.5*). Key causal links were identified and reviewed by two researchers, as well as cross-checked against the dynamic hypothesis and existing research literature.

Table 4.5. Key causal links with sources

Causal link	**Source**
Crowding increases stress	GMB, key informant interview, Pable 2012; Evans & English, 2002
Length of stay increases stress	GMB, key informant interview
Stress erodes empowerment	GMB; Banyard & Graham-Bermann, 1995
Empowerment reduces length of stay	GMB, key informant interview
Length of stay erodes self-efficacy	GMB; Banyard & Graham-Bermann, 1995
Demand for services increases pressure on caseworkers	GMB; key informant interview
Importance of considering "empowerment" in service delivery	Tischler, Edwards, & Vostanis 2009
Reciprocal relationship between child risk and caregiver stress	GMB; key informant interview

Causal connections linked the key constructs according to participant insights and prior research. Key feedback loops detailed below explain system behavior as observed in reference modes.

Feedback Loops: Reinforcing

Four major reinforcing loops created vicious or virtuous cycles impacting the number of families in services, length of stay, and caregiver and child psychological well-being.

R1: "Crowding eroding empowerment"

The more families in services, the more crowding resulted. Caregivers, staff, and prior literature were in agreement that when more families entered the system and services became more crowded, client stress increased; this eroded empowerment. Families who were less empowered were less likely to make progress toward stable housing and move through services quickly, resulting in more families in services over time. Compared to R1 in the dynamic hypothesis' causal theory, this loop captured strain on clients rather than strain on providers as the main contributor to increased length of stay and ongoing crowding.

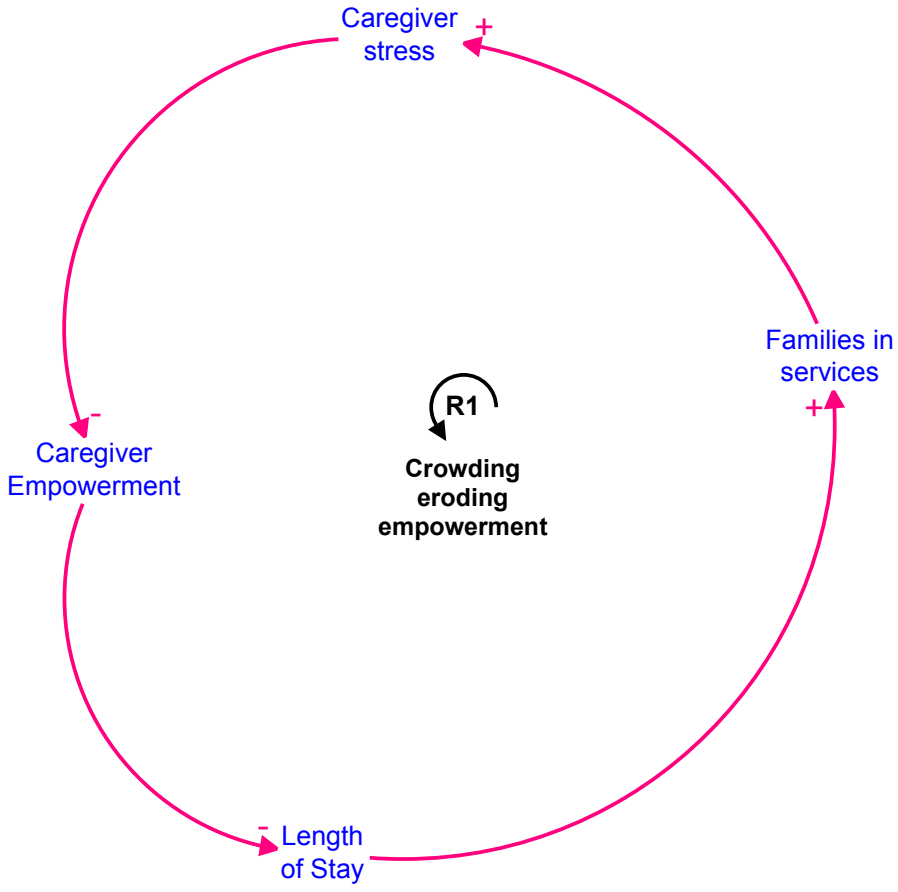


Figure 4.3. Reinforcing Loop 1: Crowding eroding empowerment

R2: "Stress impeding timely exit"

Caregivers agreed that longer stays in shelter increased their stress over

time, as the consistent lack of privacy and uncomfortable, unfamiliar conditions. This stress in turn reduced their sense of empowerment, which further contributed to longer stays.

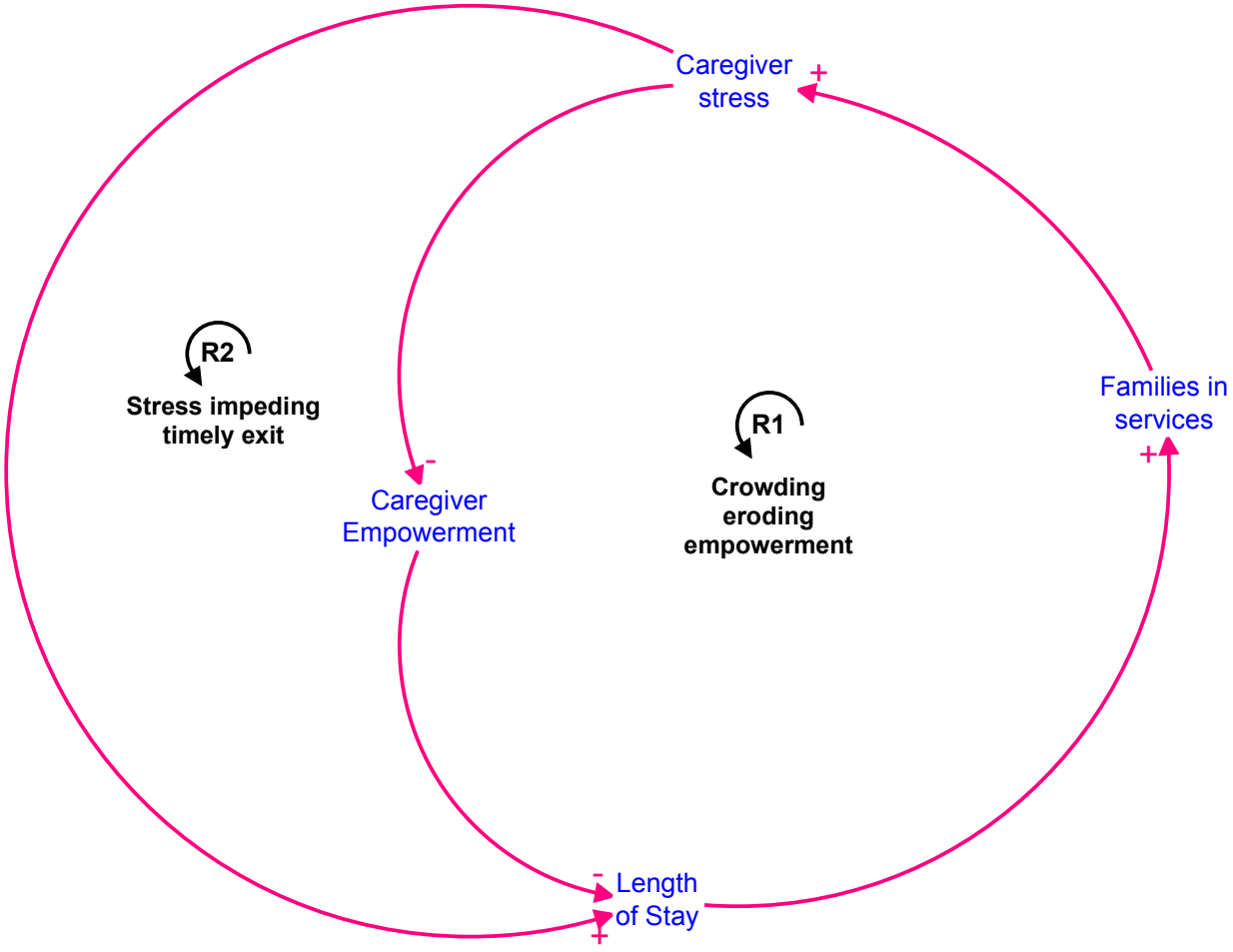


Figure 4.3.1. Reinforcing Loop 2: Stress impeding timely exit

R3: "'Getting comfortable'"

Caregivers described a process by which the longer a family stayed, the more likely they were to "settle in" at the agency; eventually, the shelter became a more manageable, desirable option compared to the effort required to overcome barriers and return to stable housing. Clients referred to this as "getting comfortable." Thus, when length of stay exceeded a certain duration, client empowerment was eroded such that it reinforced the increasing length of stay. The

hypothesized causal theory did not account for this process of "getting comfortable," but rather proposed that families conducted a cost-benefit analysis in regards to the shelter's desirability; in fact, clients stated that a sense of eroded empowerment increasing length of stay was the process by which families "chose" to stay in shelters.

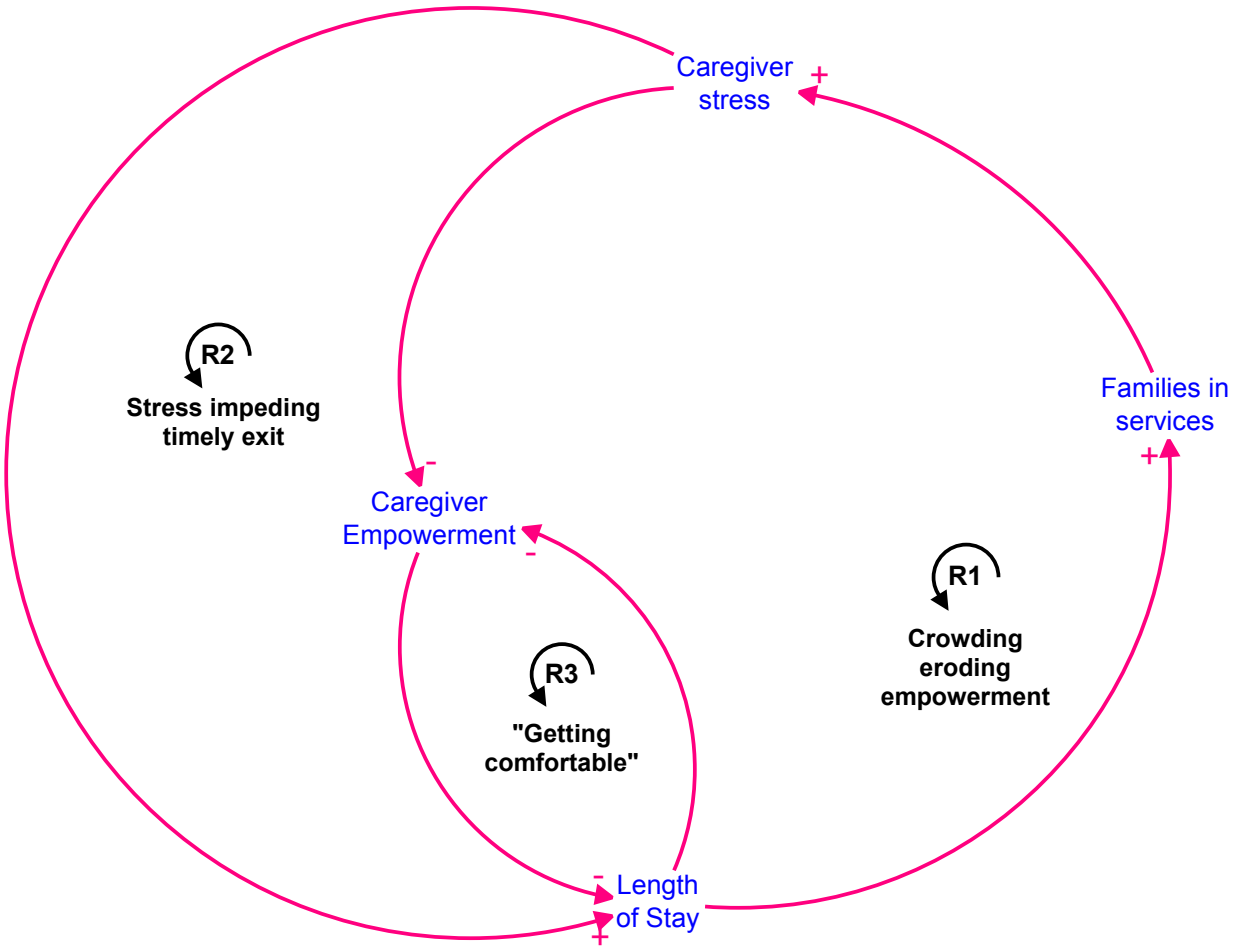


Figure 4.3.2. Reinforcing Loop 3: "Getting comfortable"

R4: "Child risk interacting with caregiver stress.

Caregivers described the impact their current circumstances placed on children, leading to greater stress and behavior problems. Almost uniformly, caregivers described feeling guilty

about putting their children in the position of being in a homeless shelter; furthermore, the daily experience of homelessness contributed to behavior issues that caregivers found difficult to manage in the structure of the shelter. The fear of sanction by shelter staff for disciplining children and their own mental health struggles created stress for caregivers.

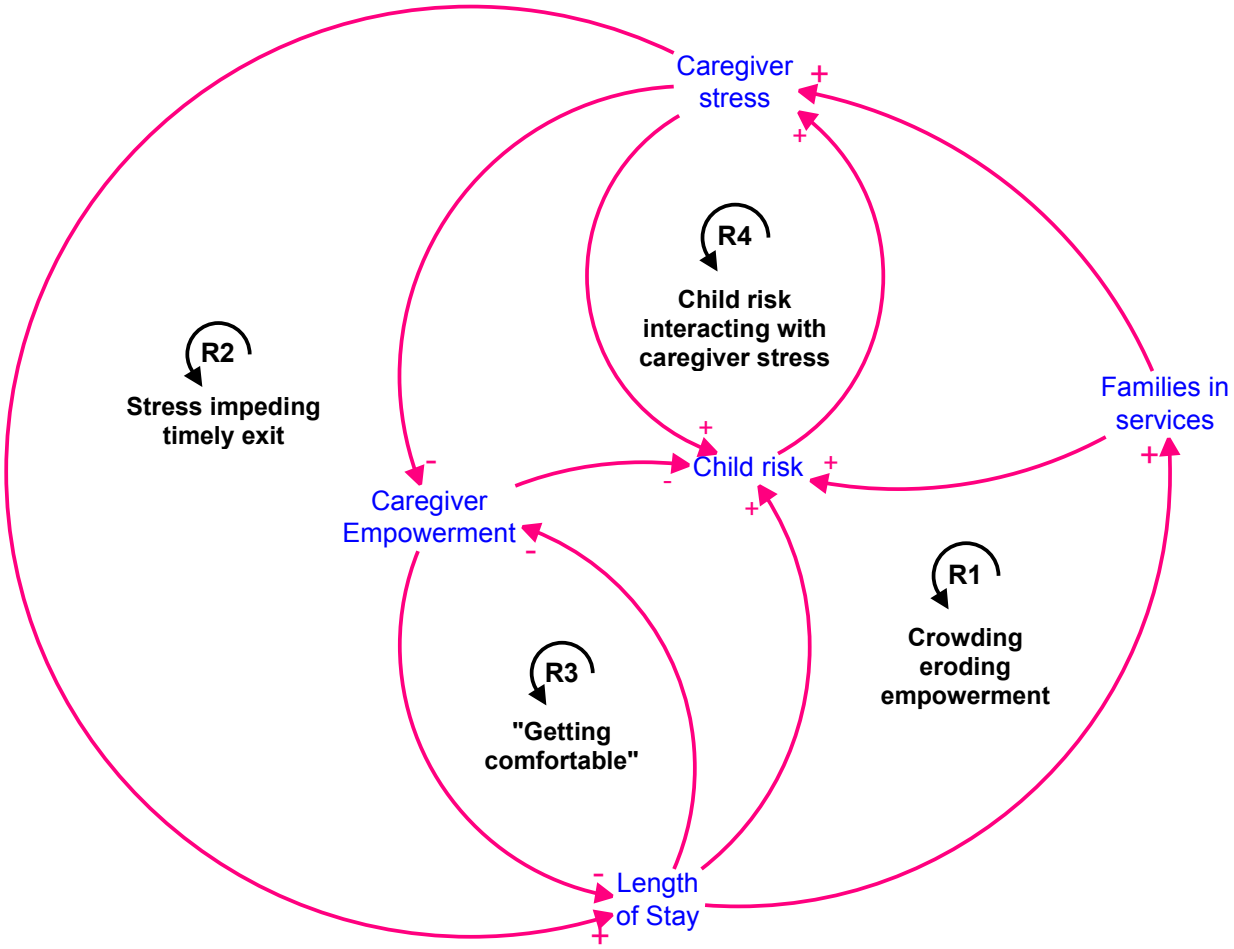


Figure 4.3.3. Reinforcing Loop 4: Child risk interacting with caregiver stress

Feedback Loops: Balancing

Two major balancing loops acted as checks on the reinforcing loops above. Limited service capacity as well as pressure on staff worked to counteract many of the processes that could have created runaway growth or decline over time.

B1: "Capacity constraints"

This loop is a simple story of supply and demand. The more families who enter services, the fewer services are left available for new families; thus fewer new families can enter or reenter. When families leave, in contrast, more services become available and more new families can subsequently enter services. This loop mirrored B2 in the hypothesized causal theory, suggesting service was determined in part by system capacity.

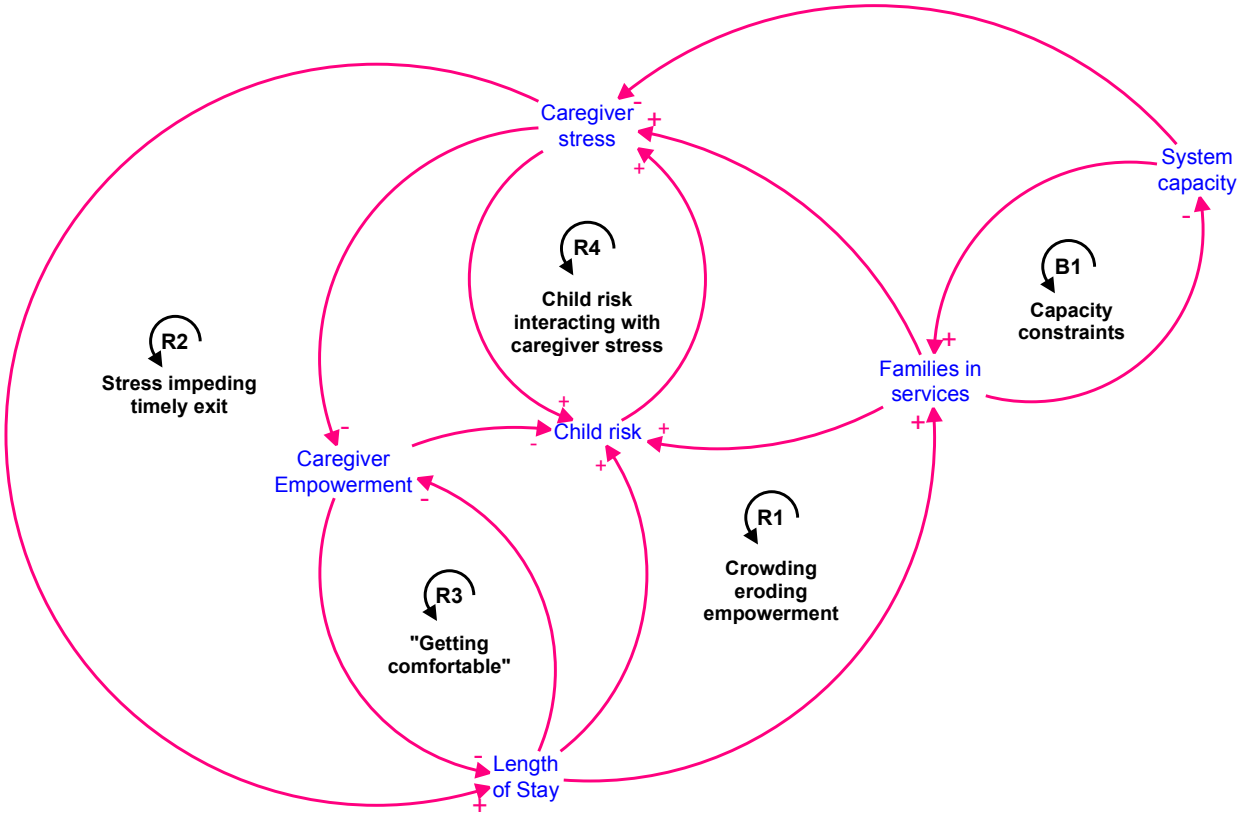


Figure 4.3.4. Balancing Loop 1: Capacity constraints

B2: “Pressure to move quickly”

With more families entering services, staff members are pressured both internally (by agency policy) and externally (by funders) to move families more quickly through services, reducing the average length of stay and thus reducing the number of families in services.

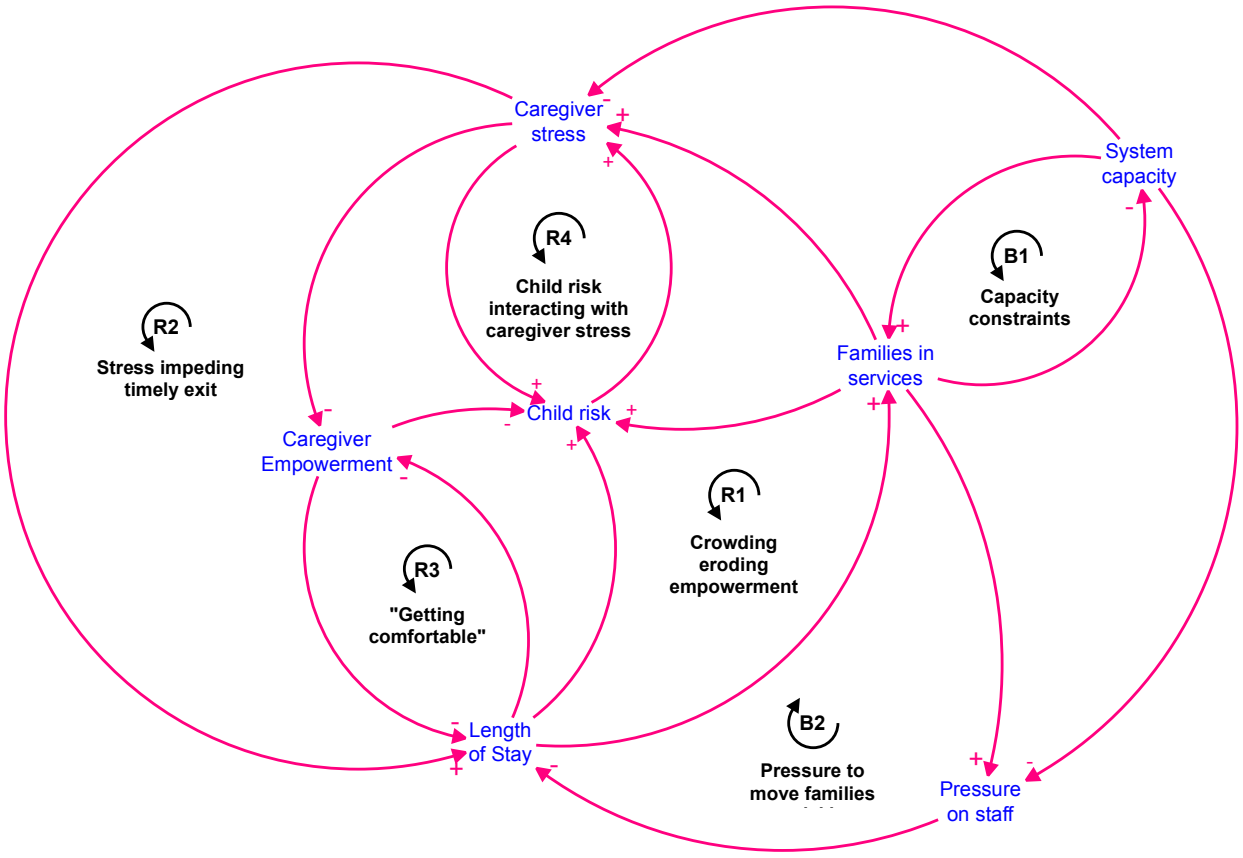


Figure 4.3.5. Balancing Loop 2: Pressure to move families

The model developed from group model building and key informant interviews supported the one developed for the dynamic hypothesis in key ways. First, availability of services was a

key feedback process; as more families entered and services became more crowded, families were less comfortable and more eager to leave quickly.

There were important differences between the models. In the dynamic hypothesis, crowding in shelters was believed to create strain on providers that eroded their abilities to meet clients' needs, thus increasing length of stay. Insights from interviews and group model building, however, indicated that crowding actually created pressure for providers to move families more quickly, thus *reducing* length of stay but not necessarily meeting consumer needs. Furthermore, caregiver stress and empowerment were not accounted for by the dynamic hypothesis, but emerged as major components of the causal theory based on insights from group model building.

Stock and Flow Model Structure

The above insights from group model building were then incorporated into a stock and flow structure adapted from the main "swamping insight" model (Ghaffarzadegan et al., 2011) to represent the family homeless system. In a stock and flow model, boxes or "stocks" represent accumulations, pipes represent transitions or "flows" between stocks, and clouds represent sources or sinks outside the model boundary. Auxiliary variables such as time constants, fractional rates, and effects impact the rate at which transitions between stocks occur. The present model also uses arrays, represented by stacked stocks – a structural shorthand to show multiple stocks and flows that share a basic structure.

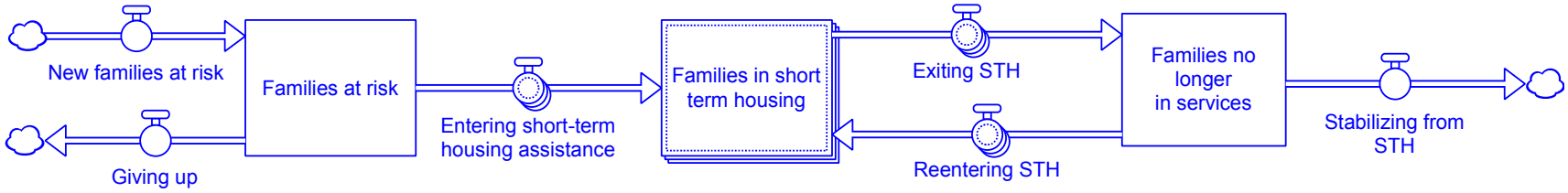
Service Use

The main model structure is adapted from a generic structure of service use (Ghaffarzadegan et al., 2011) representing people moving through a system. Families enter a stock of service users, and transition to a stock of former service users, at which point they can

either reenter services or successfully exit the system (not reentering within 2 years; Figure 4.4; HUD, 2016).

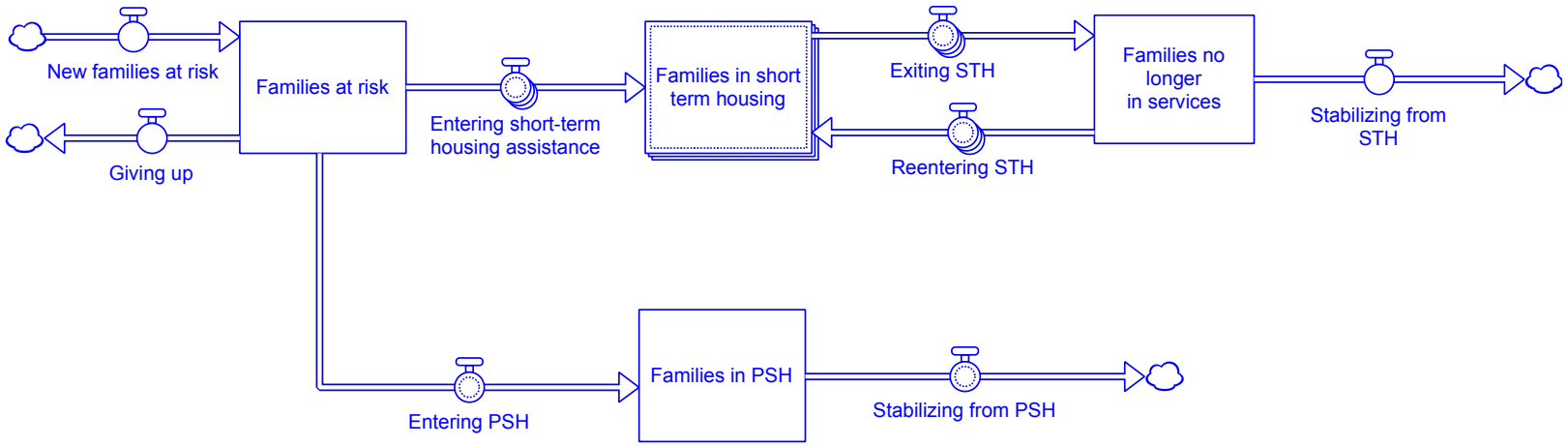
Short-term housing. The main structure included three types of "short-term housing" services: emergency shelter, transitional housing, and rapid rehousing. The stock of "Families at risk" represented those with housing problems seeking services; it was assumed that longer wait times made families more likely to "give up" and stop seeking services, and that approximately one-quarter of these families reentered the pool of "families at risk," or service seekers. When services became available, families at risk transitioned to one of three arrayed "Families in short-term housing" stocks (emergency shelter, transitional housing, or rapid rehousing – represented by the stacked boxes). After average length of services, families transitioned to "Families no longer in services," from which they could either stabilize (maintain independent housing for two years) or reenter short-term housing services.

Figure 4.4. Stock and flow structure of short-term housing service use



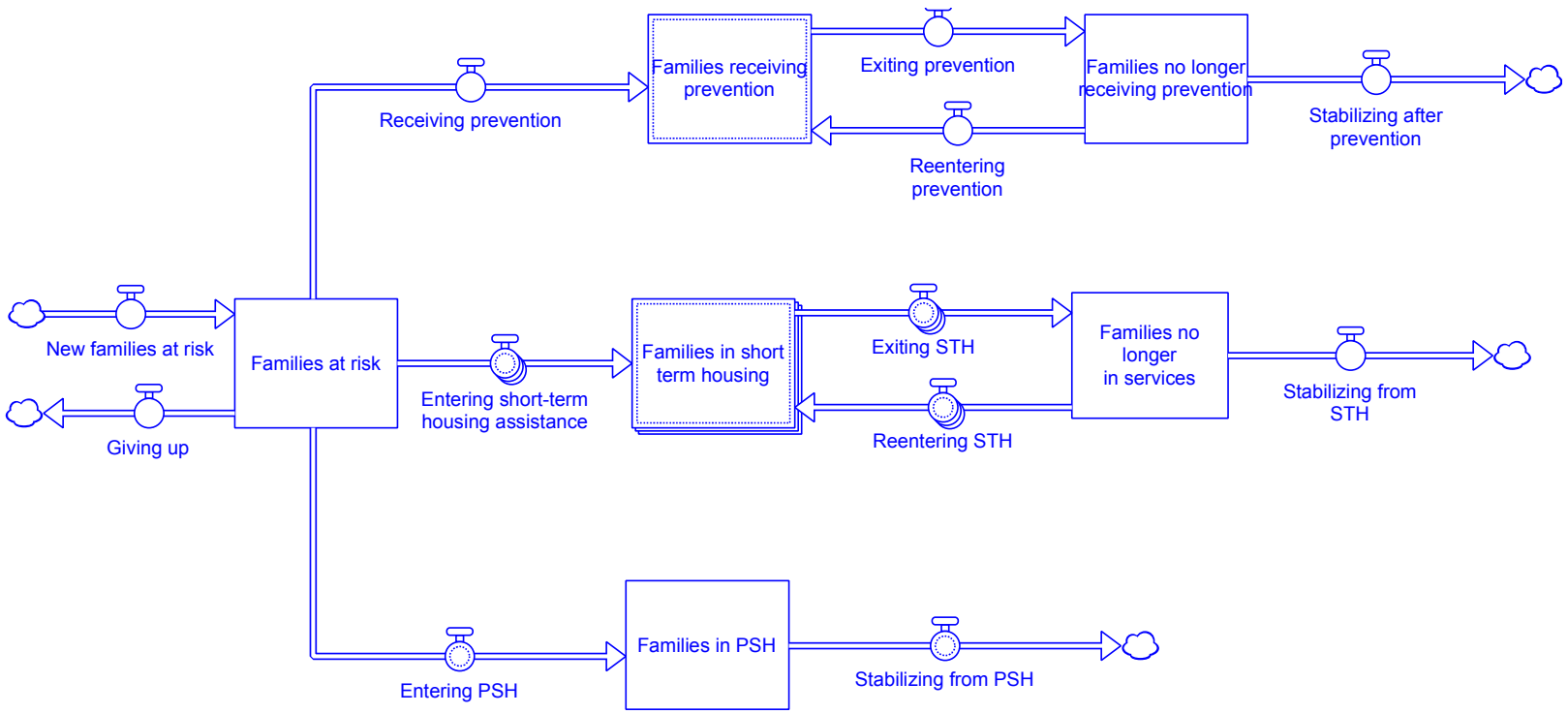
Permanent supportive housing. Families at risk could also enter permanent supportive housing (PSH; Figure 4.4.1) instead of short-term housing, depending on availability. Reentries to permanent supportive housing were rare (only two out of 114 families who initially entered PSH reentered within two years), so the model assumed all families stabilized from PSH after an average duration of 21 months. Given the long average length of stay in PSH (20 months), it is possible more families reentered with longer follow-up as the data were right-censored; however, prior literature suggests families who utilize PSH services have very low rates of reentry (Gubits et al., 2016).

Figure 4.4.1 Stock and flow structure of short-term housing and permanent supportive housing service use.



Prevention. Alternately, families at risk could receive prevention services rather than entering short-term housing or permanent supportive housing services (Figure 4.4.2). Lack of data gathered on prevention services creates uncertainty in the availability and utilization of these services, but estimates suggest more than half of families who entered the homeless services system in St. Louis City or County between 2007 and 2012 received prevention services, which included short-term rental or utility assistance for families at risk of losing their homes. After prevention services ended, approximately 12% of families reentered services within two years versus stabilizing.

Figure 4.4.2 Stock and flow structure of short-term housing, permanent supportive housing, and prevention service use.



System Capacity

A second structure captured service capacity by modeling available units based on HUD inventory reports (HUD, 2007-2016). Net change in availability was driven by families transitioning in and out of services (*Figure 4.4.3*).

Figure 4.4.3. Stock and flow structure of availability of housing services

Separate availability structures tracked emergency shelter, transitional housing, rapid rehousing, and permanent supportive housing services. For prevention services, availability was driven by annual funding; capacity of families served was calculated based on the average amount of spending per family receiving prevention services ($1,500 per family; HUD, 2015; Figure 4.4.4).

Figure 4.4.4 Stock and flow structure of availability of prevention services

Stress and Empowerment

Findings from group model building were incorporated into the model by tracking co-flows of stress and empowerment of families in services. Stocks represented accumulated stress and empowerment of families; flows allowed these to increase or decrease over time.

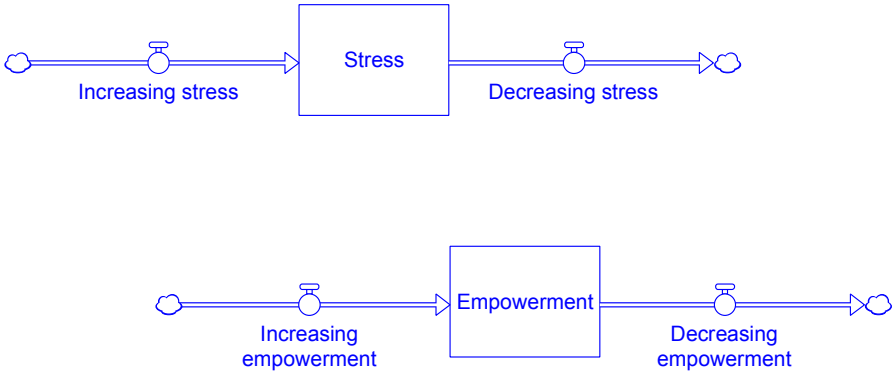


Figure 4.4.5 Stock and flow structures of caregiver stress/empowerment in homeless services

Unmet Need

A construct of *unmet need* was created to capture the gap between the services families needed and the services they actually received. First, the total *needed time in services* was calculated as the sum of waiting time and time in services for all families; total *actual time in services* was the total amount of time all families spent in services across the model time horizon. *Unmet need* was calculated as the difference between *needed time* and *actual time* (Figure 4.4.6).

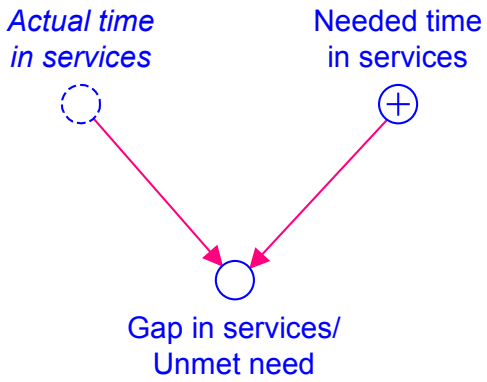


Figure 4.4.6 Stock and flow structure of unmet need.

Child Risk

Finally, a construct of *child risk* drew on the cumulative risk model to conceptualize the vulnerability children experienced during their time in homeless services. Risk was driven by exposure to stressful events and conditions, and could increase or decrease over time (Figure 4.4.7)

Figure 4.4.7. Stock and flow structure of child risk

The structures described above were connected through a series of feedback loops that captured dynamics elicited during group model building sessions. The full simulation model structure can be found in Appendix II.

Model Parameters and Calibration

The model was calibrated using three major sources: (1) administrative records from the Homeless Management Information System (HMIS) on families who had entered emergency shelters or transitional housing programs between January 1, 2007 and December 31, 2010; (2) HUD point-in-time counts of homelessness for the St. Louis City and County Continuums of Care in 2007; and (3) insights from group model building sessions and key informant interviews. The initial structure was calibrated using only HMIS records from emergency shelters and transitional housing programs as those receiving permanent supportive housing services were not captured in Point-in-Time counts (HUD, 2018). Initial stock values were based on the number of people in services in 2007 based on PIT counts, and transition rates (entering services, exiting services, reentering services, and permanently stabilizing) were calculated using average length of service use, time to reentry, and proportion of families who successfully exited services without reentering across two years (Appendix III).

Stress and Empowerment were calibrated on a 0-10 scale, with higher numbers indicating higher levels of each attribute. Initial stocks of each attribute were calibrated to trends elicited from group model building sessions – accounting for changes in the number of clients in services over time. For example, the model assumed each individual head of household in the model had his or her own stress level ranging from 0 to 10, with the "Stress in Services" stock value representing those individual scores multiplied by the total number of people in services; therefore, total stress changed as a function not only of individuals' stress levels increasing or decreasing while in services, but also as a function of people entering and exiting services and "bringing" their stress with them (Figure 3.6.5). Accumulations of stress and empowerment impacted other structures according to feedback processes documented above.

Key stocks in the main model structure were calculated as follows:

Equation 3:

$$Families\ in\ services = \int_0^{120} [New\ families\ entering(u) - Families\ leaving\ services(u) + Families\ reentering\ services]du + Families\ in\ services(0)$$

Equation 4:

$$Available\ units = \int_0^{120} [Net\ change\ in\ availability(u)]du + Available\ units(0)$$

Equation 5:

$$Stress\ in\ services = \int_0^{120} [Increasing\ stress(u) - Decreasing\ stress(u) + Change\ in\ stress\ when\ people\ enter\ or\ exit\ services]du + Stress\ in\ services(0)$$

Equation 6:

$$Empowerment\ in\ services = \int_0^{120} [Increasing\ Empowerment(u) - Decreasing\ Empowerment(u) + Change\ in\ empowerment\ when\ people\ enter\ or\ exit\ services]du + Empowerment\ in\ services(0)$$

Equations for Key Outcomes

Length of Stay. Length of stay in emergency shelters was influenced by caregiver stress, caregiver empowerment, and pressure on staff as a result of crowding:

*Average length of shelter stay = Initial average length of stay * Effect of empowerment * Effect of stress * Effect of pressure on staff*

Rate of reentry. Reentry was driven by average risk (initial fractional rate) and system capacity:

*Reentering services = Families no longer in services * FR of shelter reentry*

where

*FR of shelter reentry = [(Available emergency shelter units – Families in emergency shelter)/Available emergency shelter units] * Initial FR of shelter reentry*

Child Risk. Child risk was conceptualized as a stock that represented accumulated child risk attributable to the homeless service system via exposure. Increases in child risk were driven by increased length of stay, crowding, and unmet need. Caregiver empowerment contributed to decreasing child risk.

Rate of increasing risk = Initial rate of increasing risk + Effect of length of stay on risk + Effect of crowding on risk + Effect of unmet need on risk

and

*Rate of decreasing risk =Child risk * Initial average time to decrease risk*

where

*Average time to decrease risk = Initial average time to decrease risk * Effect of caregiver empowerment on reducing child risk*

Table 4.6. Equations for model effects

Effect	**Equation/Table Function**	**Explanation**
Effect of stress on length of stay	(0, 1.000) (1,1.000) (2,1.000) (3,1.000)(4,1.000)(5,1.000) (6,1.060) (7,1.210) (8,1.445) (9,1.605) (10,1.665)	As average caregiver stress increases, length of stay increases up to 66.5%
Effect of empowerment on length of stay	(0, 1.000) (1,1.000) (2,1.000) (3,1.000)(4,1.000)(5,1.000) (6,0.982) (7,0.738) (8,0.611) (9,0.587) (10,0.584)	As average caregiver empowerment increases, length of stay declines by up to 42%
Effect of pressure on staff on length of stay	Families in emergency shelter/Total emergency shelter capacity = (0,0.000) (0.1,1.000) (0.2,1.000) (0.3,1.000) (0.4,1.000) (0.5,1.037) (0.6,1.250) (0.7,1.521) (0.8,1.761) (0.9, 1.824) (1.0,1.835)	As the number of families in services approaches total capacity, pressure on staff increases by up to 83.5%
Effect of length of stay on child risk	(0.0,1.00) (0.6,1.01) (1.2,1.01) (1.8,1.10) (2.4,1.225) (3.0,1.345) (3.6,1.505) (4.2,1.650) (4.8,1.735) (5.4,1.780) (6.0,1.800)	As length of stay increases, child risk increases by up to 80%
Effect of crowding on child risk	Families in emergency shelter/Total emergency shelter capacity = (0.0,1.000)	As the number of families in services approaches total

	(0.1,1.000) (0.2, 1.011) (0.3,1.043) (0.4,1.106) (0.5,1.176) (0.6,1.261) (0.7,1.426) (0.8,1.691) (0.9,1.915) (1.0,1.947)	capacity, child risk increases by up to 94.7%
Effect of unmet need on child risk	(0,1.000) (15000,1.000) (30000,1.005) (45000,1.027) (60000,1.096) (75000,1.277) (90000,1.633) (105000,1.761) (120000,1.851) (135000,1.851)(150000,1.851)	As total unmet need increases, child risk increases by up to 8.1%
Effect of caregiver empowerment on reducing child risk	(0,1000) (100,1.000) (200,1.000) (300,0.973) (400,0.856) (500,0.580), (600,0.383), (700,0.197) (800,0.170), (900,0.170) (1000,0.176)	As caregiver empowerment increases, child risk declines by up to 82.4%

Note: The full set of equations for the simulation model can be found in Appendix IV.

"Business as Usual"

Initial simulation results tested whether the model structure could replicate reference modes of historical trends – a preliminary assessment of model validity. General patterns of behavior follow reference modes for key outcomes with known historical data. Simulated data for unmet need and child risk also tracked closely with hypothesized trends based on empirical data and theory.

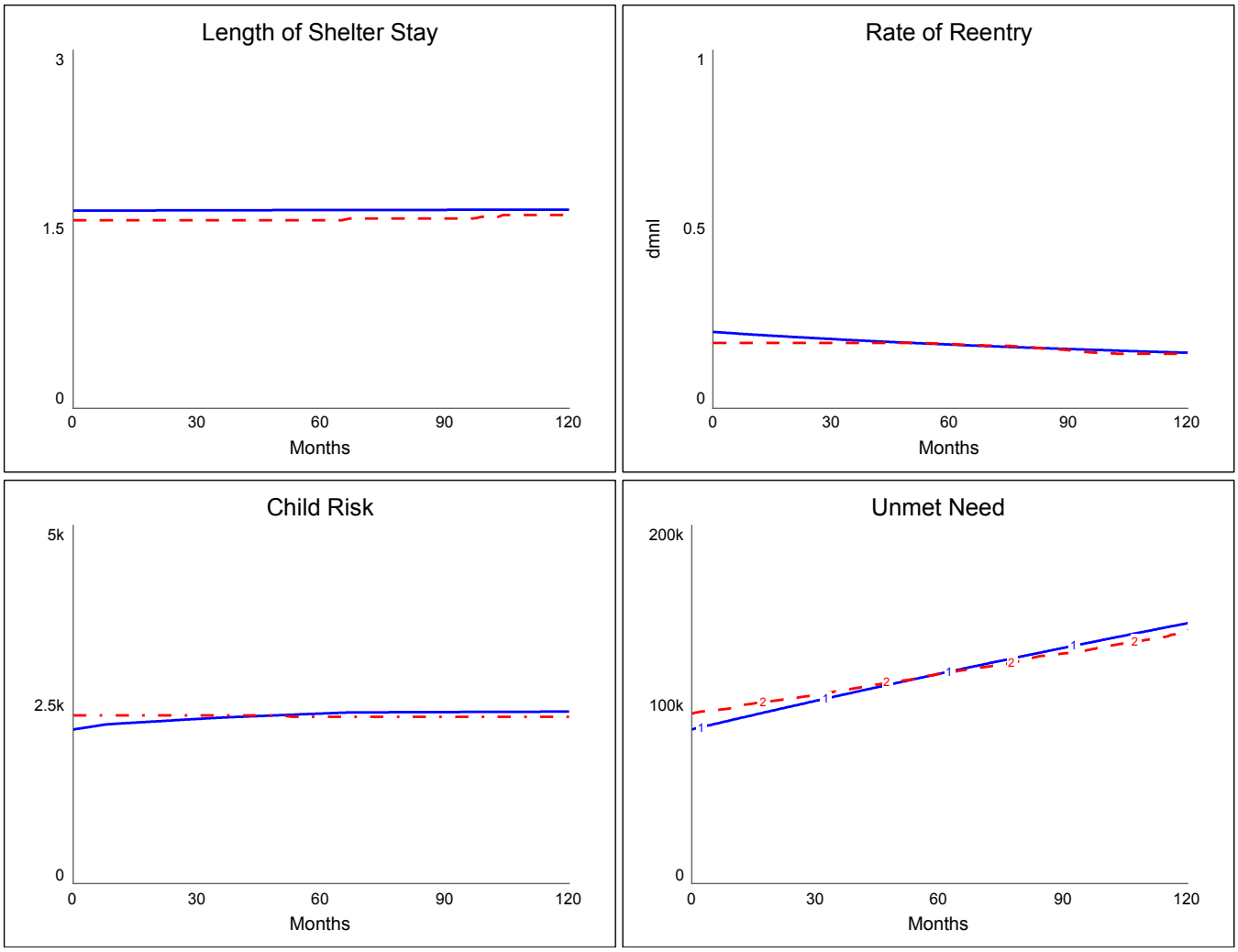


Figure 4.5. Results of "business as usual" run. Blue = simulated run. Red dashed = Reference mode.

V. Aim 3: Simulating Potential Interventions to Improve System Performance

Once the causal feedback theory was developed and incorporated into the generic stock and flow model, the final phase of analyses tested the impact of intervening at potential leverage points on key outcomes. This chapter presents findings from simulations testing potential interventions. Interventions were drawn from prior literature as well as group model building and key informant participants (Table 5.1). Run 1 for each experiment was "business as usual" or a historical reference mode that reflected actual system functioning over the five-year study period. Interventions began at Month 60, or halfway through the simulation. Interventions sought to promote timely, permanent exit for families from homeless services as well as reduce system-wide unmet need. First, experiments tested increased capacity of short-term housing services (emergency shelter, transitional housing, and rapid rehousing), and reallocation of services to allow for "step-down" transitions. Next, simulations tested recent policy shifts that 1) emphasize serving the highest risk households through investment in the most intensive services (permanent supportive housing programs), and 2) attempt to divert families from the homeless system altogether by providing prevention services.

Table 5.1. Experiments with source material and hypotheses

Experiment	Source	Hypotheses	Representation in Model
1) Increased short-term housing capacity	*Key informant interview:* - "We get hotline calls all day long." - "We're always full, every night."	↑ Length of stay ↑ Reentry ↓ Unmet need ↓ Child risk	Initial values of available emergency shelter, transitional housing, and rapid rehousing units multiplied by 2 via PULSE function
2) More "next-step" beds	*"Key informant interview:* - "We need more "next-step" beds... *We've* [emergency shelters] become the transitional housing." - "Lack of transitional housing means people stay longer."	↓ Length of stay ↓ Reentry ↓ Child risk	Initial value of available transitional housing units multiplied by 2 via PULSE function; new flow allowing transitions from emergency housing to transitional housing
3) Increased investment in permanent supportive housing.	*Key informant interview:* - "The list is very slow-moving. [There are] 1,700 families on the PL. There's not enough housing availability." - "We have permanent supportive housing, but that's mostly for chronic homeless." *Recent policy shift:* - HUD, 2017b; Fowler et al., 2019	↓ Length of stay ↓ Reentry ↓ Unmet need ↓ Child risk	Initial value of available PSH units multiplied by 2 via PULSE function; new flow allowed transitions from STH to PSH
4) Increased investment in prevention	*Implementation of Homeless Prevention and Rapid Rehousing Program (HPRP)* - HUD, 2016 *Empirical evidence suggesting promise for homelessness prevention:* - Fowler et al., 2019	↓ Reentry ↓ Unmet need ↓ Child risk	Initial value for monthly prevention funding multiplied by 2, then by 4 via STEP functions.
5) Stress reduction in shelters	*Group model building with consumers:* - "The shelter should make you feel a sense of stability, because you're already so stressed. If I'm going for one chaotic situation to one that's even more chaotic, where am I going to have the sense of peace and understanding to hit my points?"	↓ Length of stay ↓ Child risk	Average time to reduce stress reduced from 6 months to 1 month via STEP function

Experiment 1: Increased system capacity

Given the emphasis on crowding in services and inadequate supply to meet demand that emerged from key informant interviews and group model building sessions, the first experiment tested the impact of significant increasing the homeless system's capacity to serve families. It was hypothesized that because of the balancing effect of system capacity, increasing capacity would likewise increase average length of stay and rate of reentry; however, this would reduce the amount of time families waited for services, thus reducing child risk. Run 1 showed "business as usual," whereas Run 2 doubled the number of total units of each emergency shelter, transitional housing, and rapid rehousing via a pulse function – this created an influx of newly available units beginning at Month 60. Results showed length of shelter stay declined 4.6% (approximately 4 days), the proportion of families reentering services increased 10.7%. Child risk increased 15.0% and overall unmet need declined 10.4% after 60 months (Figure 5.1).

Results for rate of reentry and unmet need matched hypotheses. It was believed that length of stay would increase as a result of greater capacity due to less pressure on caseworkers to move families quickly, but in fact the opposite was observed; length of stay likely decreased via R2 wherein reduced crowding reduced stress, enabling families to make progress and leave shelter more quickly. Child risk also behaved contrary to hypotheses; reduced unmet need did not translate to reduced child risk, likely because greater shelter capacity created greater risk exposure for children.

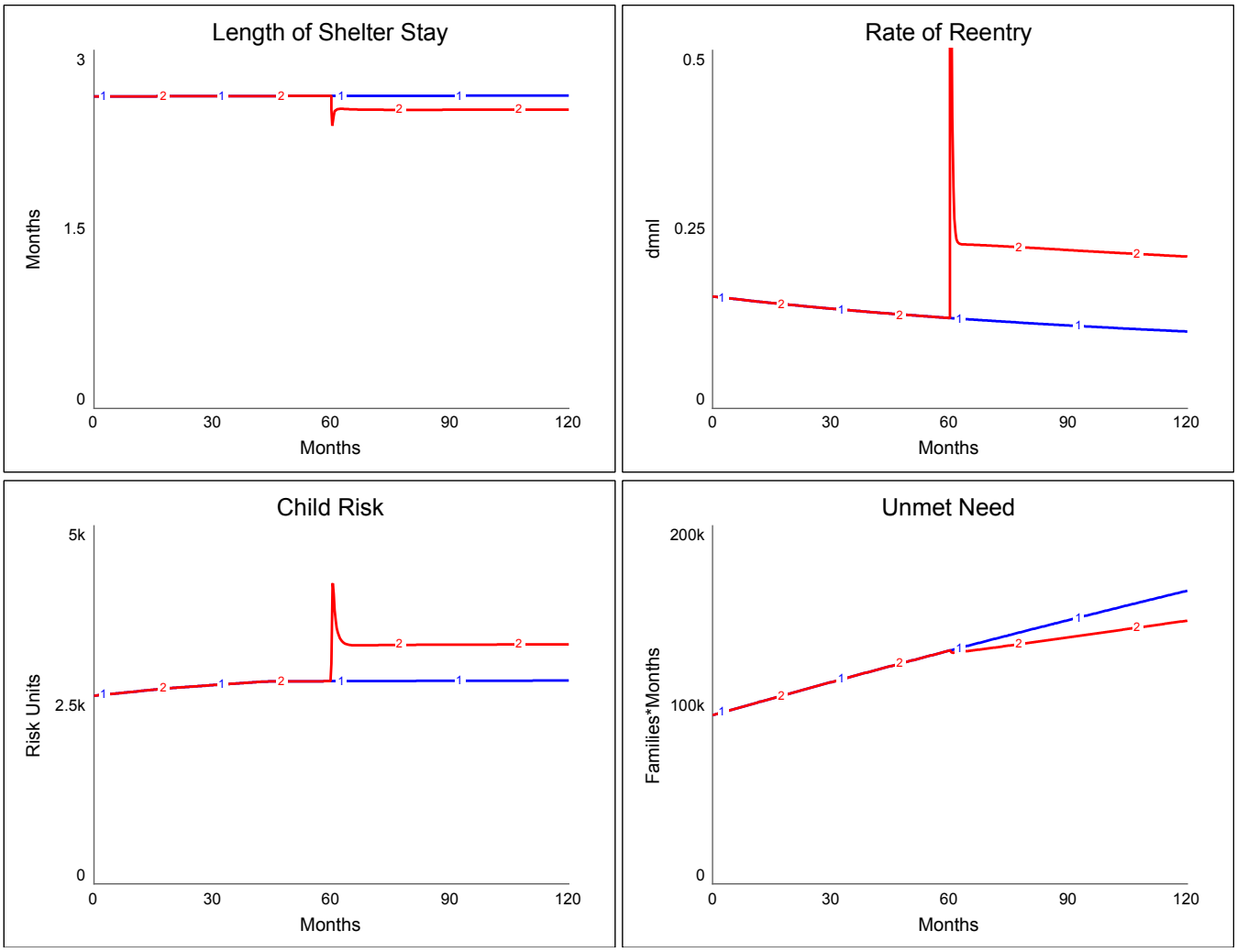


Figure 5.1. Simulation results from Experiment 1: Increased short-term housing capacity. *Run 1: "Business as usual." Run 2: Total number of short-term housing units doubled.*

Experiment 2: Implementing a "step-down" approach

Key informants indicated that lack of transitional housing, or "next-step beds," contributed to issues of crowding and delayed exits in emergency shelters. The next experiment therefore tested the impact of increasing availability of transitional housing and allowing families to move from shelter to transitional housing. This would theoretically allow families to move toward more independent living situations with a gradual withdrawal of supports; transitional housing programs yielded lower rates of

reentry than emergency shelters and consisted of less chaotic environments, thus contributing less to child risk. Because families' ability to enter services did not change, there was no hypothesized effect on unmet need. In fact, rate of reentry increased 1.5%; length of stay declined as hypothesized, but the magnitude of change was so small (0.08%) as to be practically insignificant. Child risk increased slightly 3.8%. As hypothesized, there was little impact on unmet need (1.8% decline).

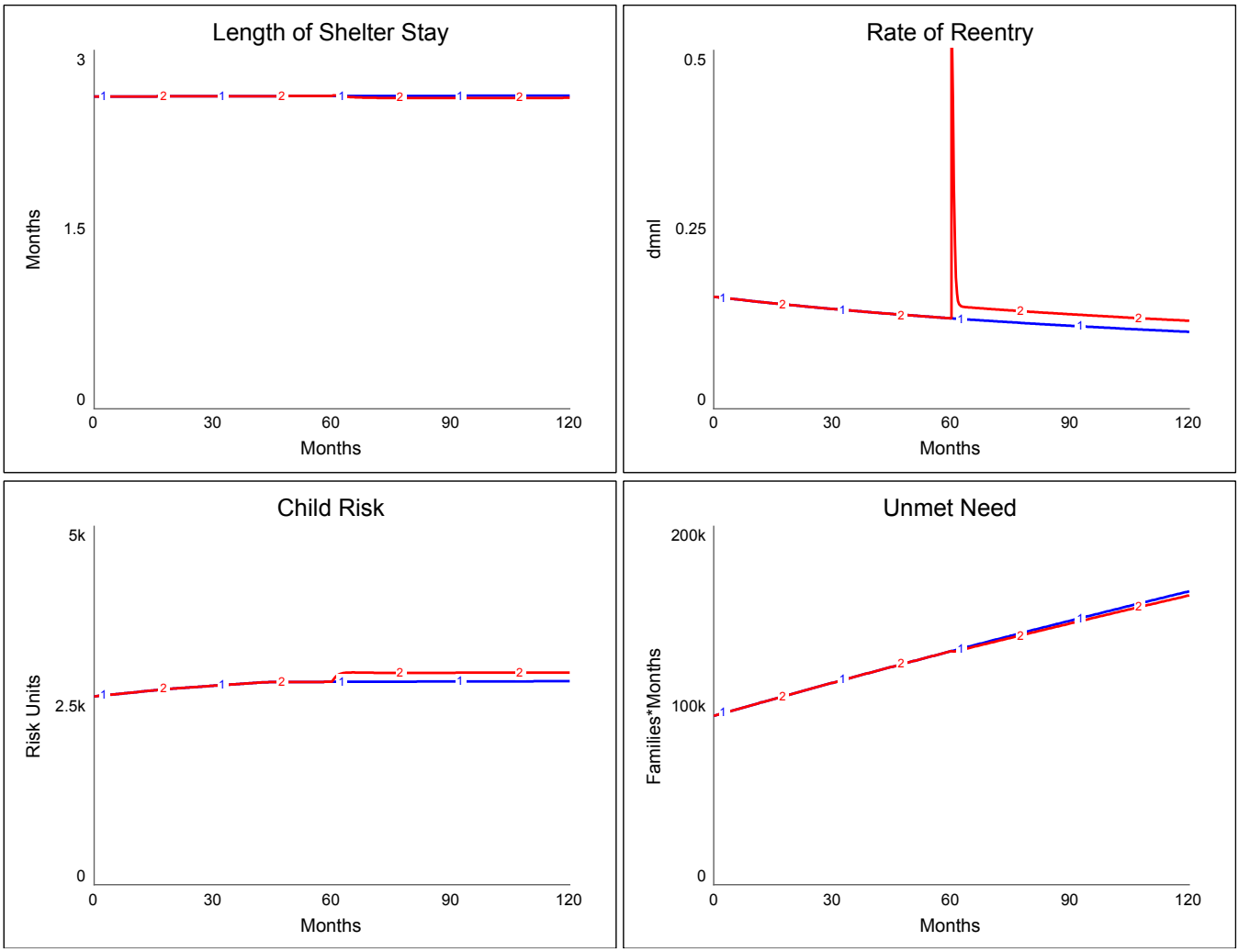


Figure 5.2. Simulation results from Experiment 2: Implementing a "step-down" approach.

Experiment 3: Increased investment in permanent supportive housing

Recent efforts have emphasized shifts toward more resource-intensive service models in order to serve the highest risk families (Fowler, Hovmand, Marcal, & Das, 2019); furthermore, permanent

supportive housing models have the most promising longtime outcomes (Gubits et al., 2016). Therefore, Experiment 3 tested the impact of increasing the number of available permanent supportive housing as well as allowing transitions from short-term housing to PSH. The initial number of available PSH units was doubled, and the structure was modified to allow families to transition from short-term housing to permanent supportive housing. Given prior empirical data and the potential to ease burden on short-term housing services, it was hypothesized that there was be reductions on all four outcomes; families would be able to exit shelter more easily and be less likely to reenter, all with less exposure to chaos. Results showed the rate of reentry initial spiked followed by a decline of 1.5%. Child risk declined 20%, while unmet need while unmet need decreased 3.7% (Figure 5.3).

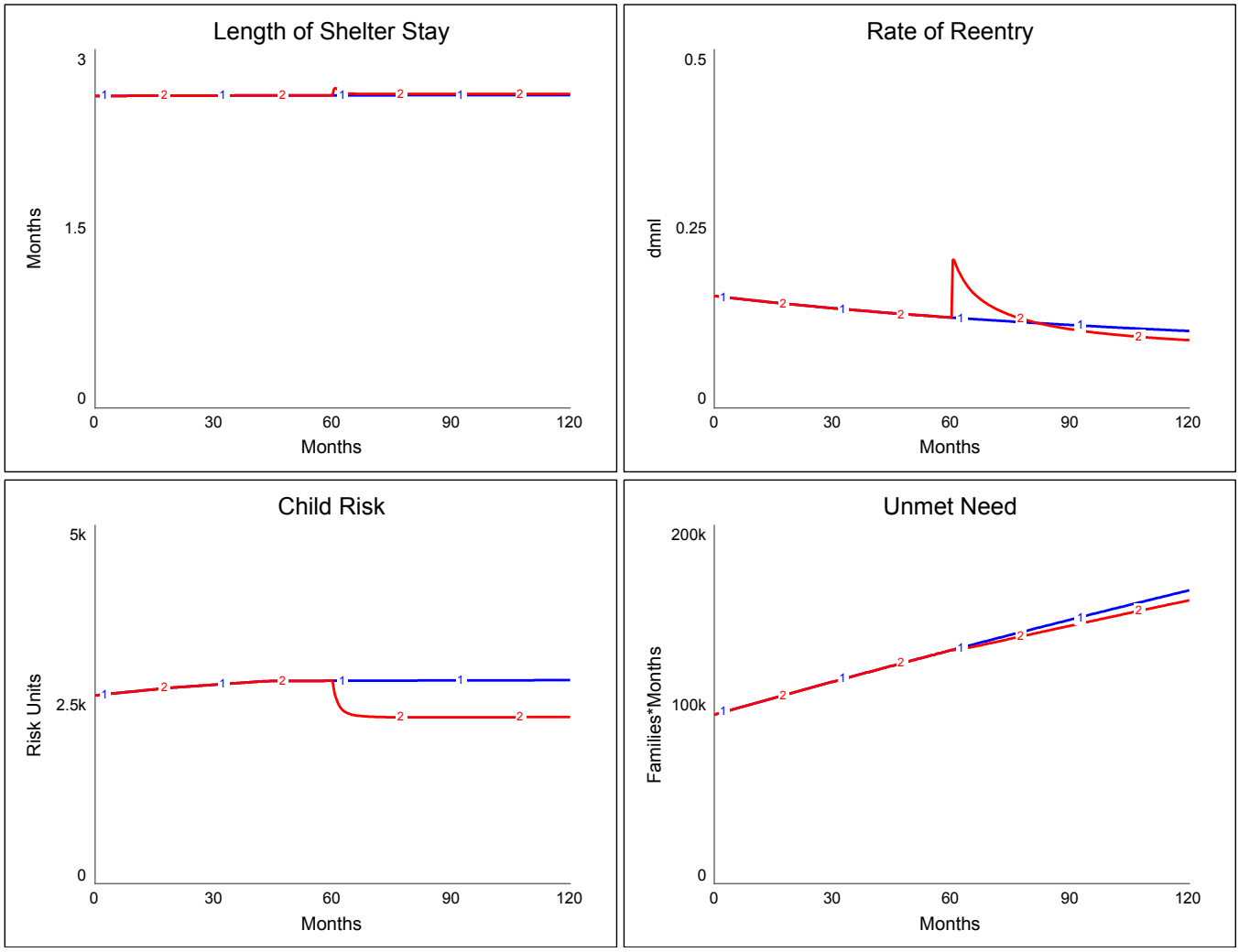


Figure 5.3. Simulation results from Experiment 3: Increased investment in permanent supportive housing interventions. Run 1: "Business as usual." Run 2: PSH capacity doubled, and 25% of families per month in short-term housing transitioning to PSH.

Experiment 4: Increased investment in prevention

Prior research suggests promise for investment in homelessness prevention. The Homelessness Prevention and Rapid Re-Housing Program (HPRP), established by HUD's 2009 Recovery Act, allocated funding for prevention assistance to families who would otherwise become homeless (HUD, 2016). However, evidence on outcomes associated with the program is limited. This experiment tested the impact of increases in funding for prevention services; Run 2 doubled monthly prevention funding while Run 3 quadrupled funding. It was hypothesized that diverting people from entering homeless services would reduce rate of reentry, as families were less likely to return to the system after receiving prevention services compared to other homeless services; additionally, this would reduce unmet need and child risk by reducing wait times and children's exposure to chaotic conditions. Simulation results showed no change in families using short-term housing services, despite large increases in the numbers of families receiving prevention services. The rate of reentry declined by 1.3% and 3.0% for Runs 2 and 3 respectively. Doubling prevention funding led to a decline in unmet need of 3.0%, while quadrupling funding led to a decline of 9.1% (Figure 5.4). As hypothesized, increased funding for prevention decreased rate of reentry and unmet need; however, no impact was seen on child risk.

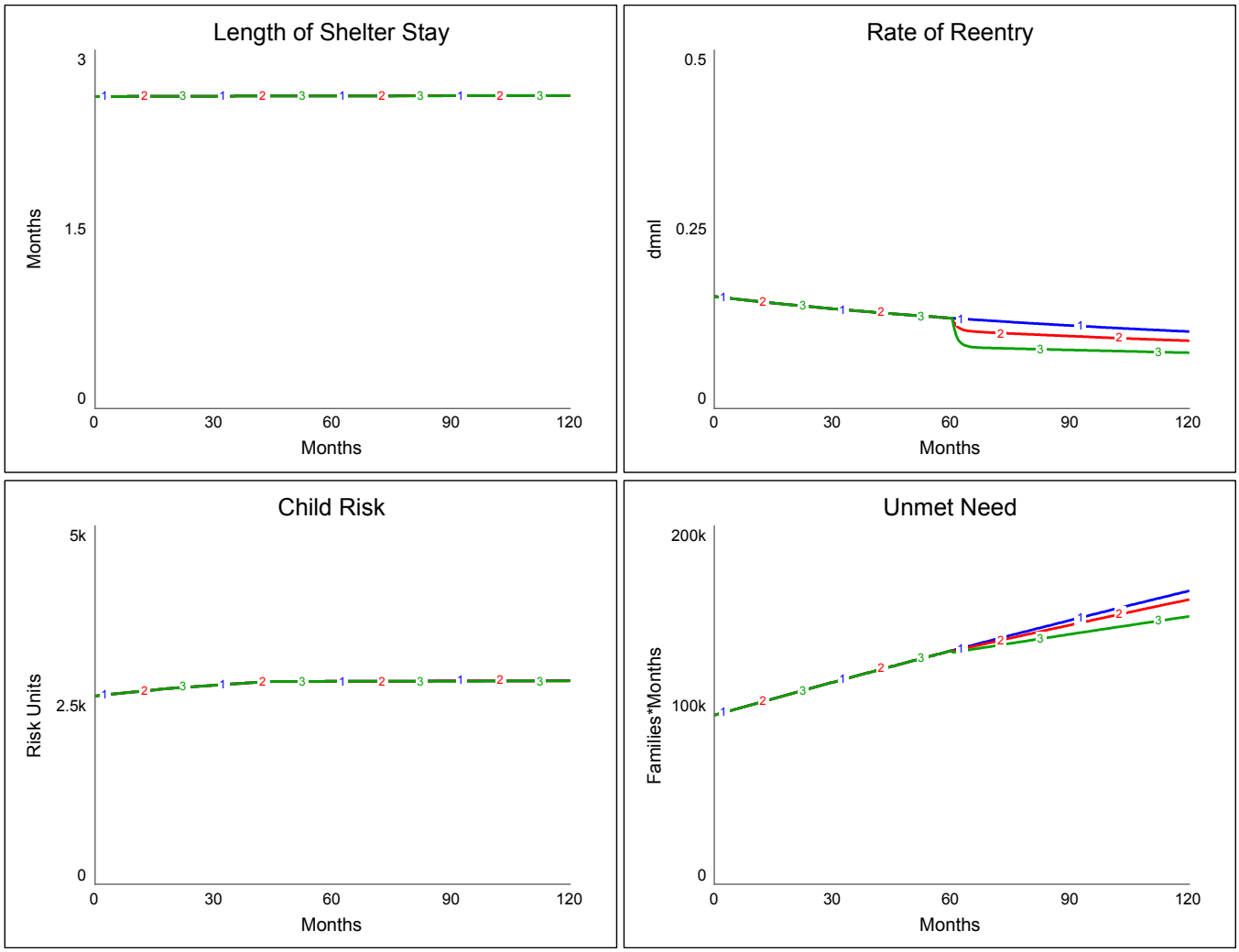


Figure 5.4 Simulation results from Experiment 4: Increased investment in prevention. *Run 1: "Business as usual." Run 2: Monthly prevention funding doubled. Run 3: Monthly prevention funding quadrupled.*

Experiment 5: Stress Reduction

Given the significance of interpersonal factors that emerged from group model building, Experiment 5 tested the impact of implementing a generic stress reduction intervention. This intervention functioned by reducing the amount of time caregivers experienced stress in the system; it was modeled by reducing "average time to reduce stress" from six months to one month, and the

immediate effect was reducing average stress in emergency shelter by 17%. Results indicated that average length of stay in emergency shelters 18.7% (just over two weeks) as hypothesized, but rate of reentry *increased* by 1.7%. Child risk declined 8.8% while a small improvement (approximately 1.8%) in unmet need was observed.

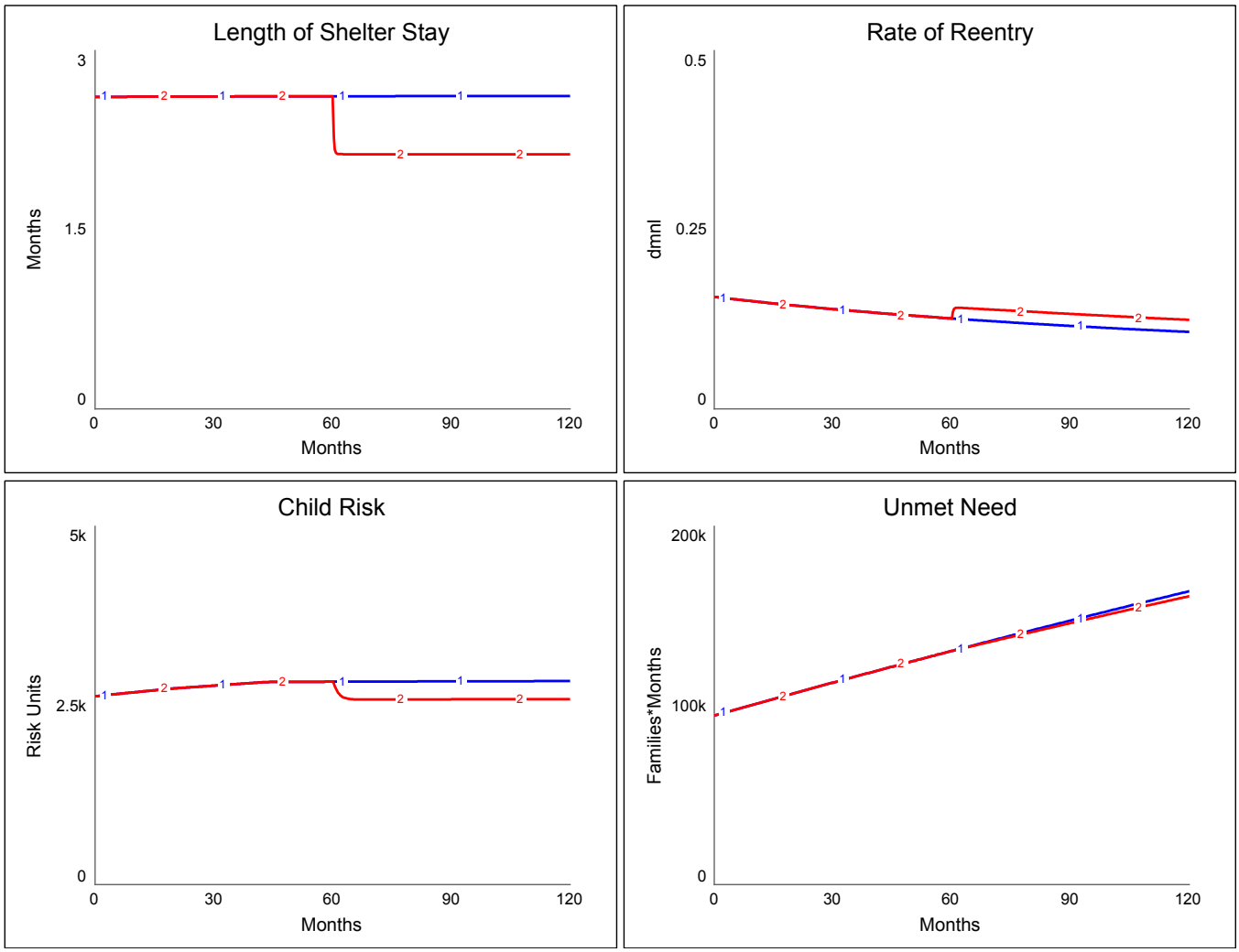


Figure 5.5 Simulation results from Experiment 5: Stress reduction. *Run 1: "Business as usual." Run 2: Average time to decrease stress reduced from six months to one month.*

Experiment 6: Combinations

Finally, a simulated tested the impact of a developmentally informed homeless system. In this approach, findings from individual interventions above were incorporated to 1) Reduce the number of

children entering homeless services, 2) Reduce length of stay, 3) Promote long-term stability. Thus, Experiment 6 included increased investment in prevention services, increased investment in permanent supportive housing, and stress reduction. This was designed to avoid increased exposure to chaos associated with increased shelter capacity (Experiment 1), and to leverage the most effective intervention types for reducing child risk and unmet need. Results showed reductions on all four key outcomes. Average length of stay declined by approximately 10 days, rate of reentry by 1.2%, child risk by 21.8%, and unmet need by 7.9% (Figure 5.6).

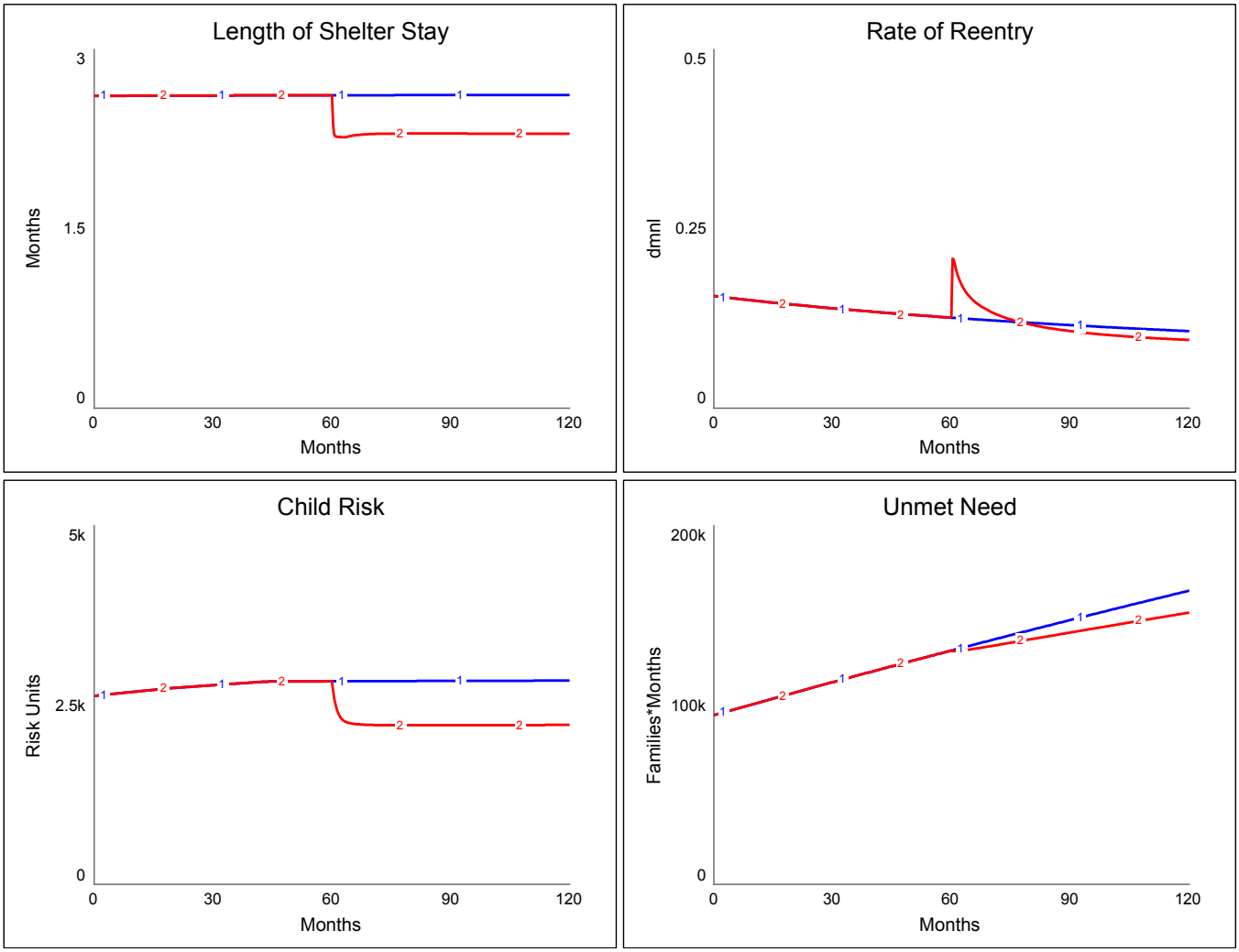


Figure 5.6 Simulation results from Experiment 6: Developmentally Informed System*. Run 1:*

"Business as usual." Run 2: Increased investment in prevention, increased investment in permanent supportive housing, and stress reduction.

Summary of Experiments

Experiments revealed mixed – sometimes unintuitive- results, highlighting the complexity of the system. Increasing short-term housing capacity reduced length of stay and unmet need, but increased reentries; when more units became available, more families were able to enter. The system simply swelled to meet demand. As a result, exposure to homeless shelters did not decline, and thus no improvements were seen in child risk. Increasing supportive housing and reducing caregiver stress were the only interventions that substantially reduced child risk. Addressing caregiver stress in successfully reduced average length of stay, which supported GMB participants' position that reducing stress would contribute to their ability to make progress and achieve independence more quickly; however, moderate stress reduction did not reduce length of stay sufficiently to reduce crowding. Furthermore, rate of reentry *increased*, suggesting families' needs were not being met sustainably in services despite seeming to achieve stability more quickly. Results suggested tradeoffs associated with different approaches, and reducing crowding or length of stay could contribute to increased risk for reentry later on. Emphasizing transitions to the most appropriate service type as well as mental health support appeared most effective at reducing unmet need.

Model Confidence Building

A number of strategies were used to build confidence in the model's validity and utility (Sterman, 2000). Model equations were reviewed for *dimensional consistency* such that units made both empirical and logical sense, as well as adequately represented the concept being modeled. For example, "stress" was conceptualized in "stress units," and calibrated based on participants' descriptions of stress as an accumulating entity that increased or decreased over time on a scale of 0-10. Equations linking

structures with different units incorporated effect sizes that converted between units. Additionally, equations for key effects were reviewed and documented in narrative form to review logic and decision-making rules (Table 4.6). Insights from participants, key informants, and key experts were reviewed to assess the appropriateness of the model boundaries. Given the sample and research questions were limited to involvement in the homeless services system, for example, experiences outside of services were excluded. Initial causes of homelessness were considered exogenous, while reentries were considered as an endogenous indicator of system performance according to theory and the generic "swamping insights" model (Ghaffarzadegan et al., 2011).

Parameter sensitivity analyses tested key variables (particularly those that were assumed rather than based on empirical data) across a wide range of values in order to assess the model's robustness to parameter changes (Appendix VI). The model was sensitive to the assumed parameter "initial families at risk;" when new demand was eliminated, unmet need declined substantially while rate of reentry increased sharply. Results suggest the model may create divergent patterns of behavior in communities with very little demand for homeless services. Additional analyses probed results of experiments, particularly the impact of different interventions in a community with little to no new demand (Figure 5.7). Run 1 represented "business as usual," Run 2 represented "business as usual" (no experiments) with initial families at risk declining from 150 to 0 families per month via a STEP function at Month 60, and Runs 3-6 represented Experiments 1-5 respectively under the new condition of no new demand. Results indicated that when new demand was eliminated, length of stay, child risk, and unmet need declined, suggesting that these outcomes were sensitive to community-level need. Rate of reentry increased as new demand declined; fewer new families competing for services meant that prior served families were more likely to return.

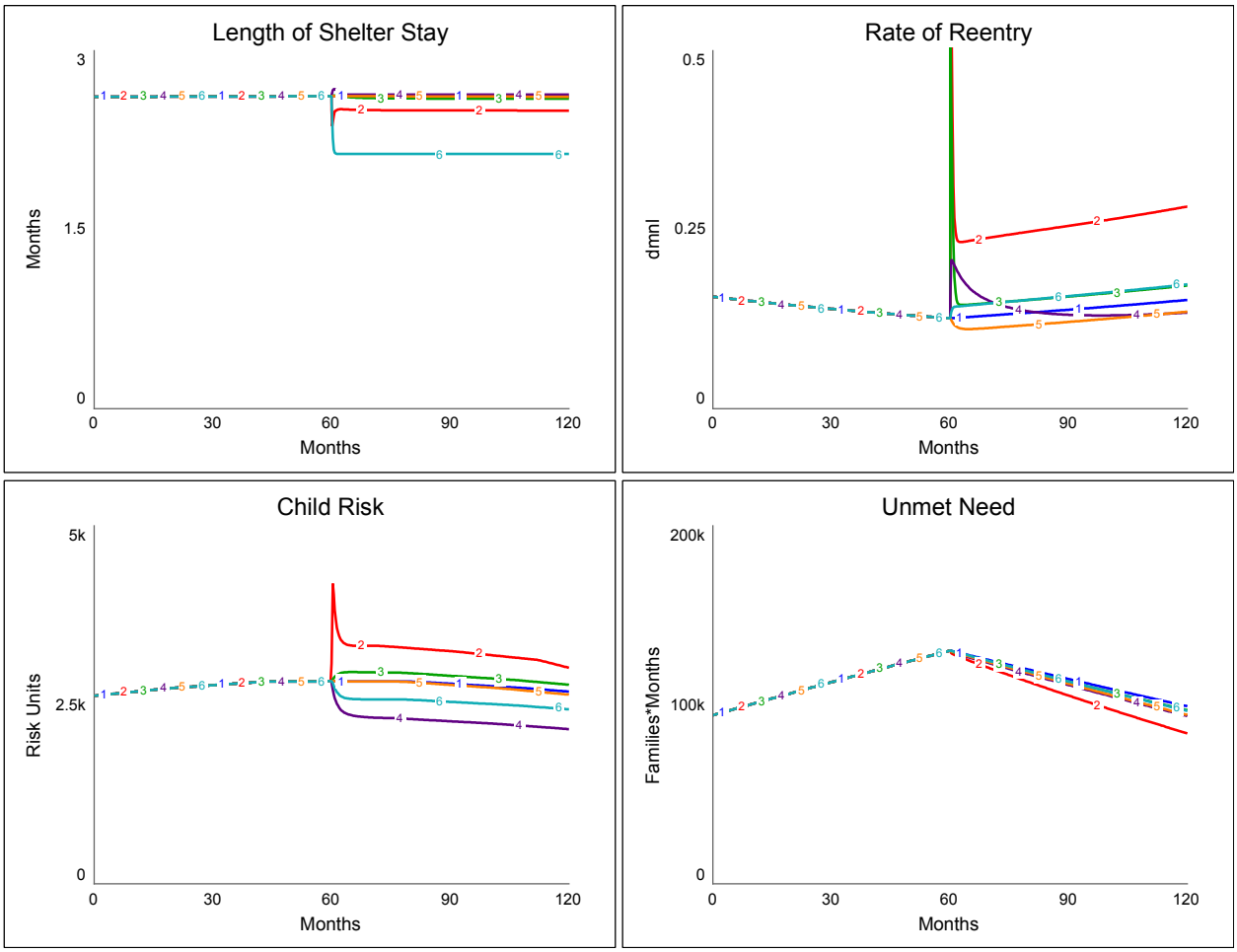


Figure 5.7. *Results of sensitivity test eliminating new demand for homeless services.*

Next, a structural test probed the lack of findings related to increased investment in prevention services, given promising recent empirical and theoretical evidence (Fowler et al., 2019). Prevention services are most effective when delivered early enough, and for appropriate families who do not require more intensive intervention; therefore, a new set of simulations tested whether more accurate screening and referral of families to prevention versus other homeless services would improve system performance. The model structure first assumed families were referred based on random chance (Run 1); fractional rates of entering prevention versus other homeless services were set at 0.5. Run 2 assumed nearly perfect screening where 100% of families with low needs were referred to prevention services per month, whereas high need families were referred to prevention services at a fractional rate of only 0.01.

Run 3 replicated the fractional rates of Run 2 but increased available prevention services five-fold, whereas Run 4 also increased capacity of the homeless services system (Figure 5.8). Results showed that improved screening led to a slight increase in the proportion of families exiting the system successfully (e.g. having their needs met and not reentering within two years). However, more accurate screening slowed down service delivery such that a bottleneck occurred at the entrance to the system; the number of families waiting to enter services accumulated substantially until Run 4, which substantially increased capacity of both prevention and homeless services. Results suggest that inaccurate screening contributes part of the story; like all other interventions, tradeoffs exist whereby nearly perfect screening and referral procedures increase wait times for services, compounding unmet need.

Overall, the model proved largely robust to parameter and structural sensitivity testing, producing consistent behavior even when key parameters and model assumptions were allowed to vary. Future iterations should consider altering model boundaries to incorporate insights from providers and clients outside the homeless services system, as well as probing assumptions and new hypotheses that emerged during the simulation process.

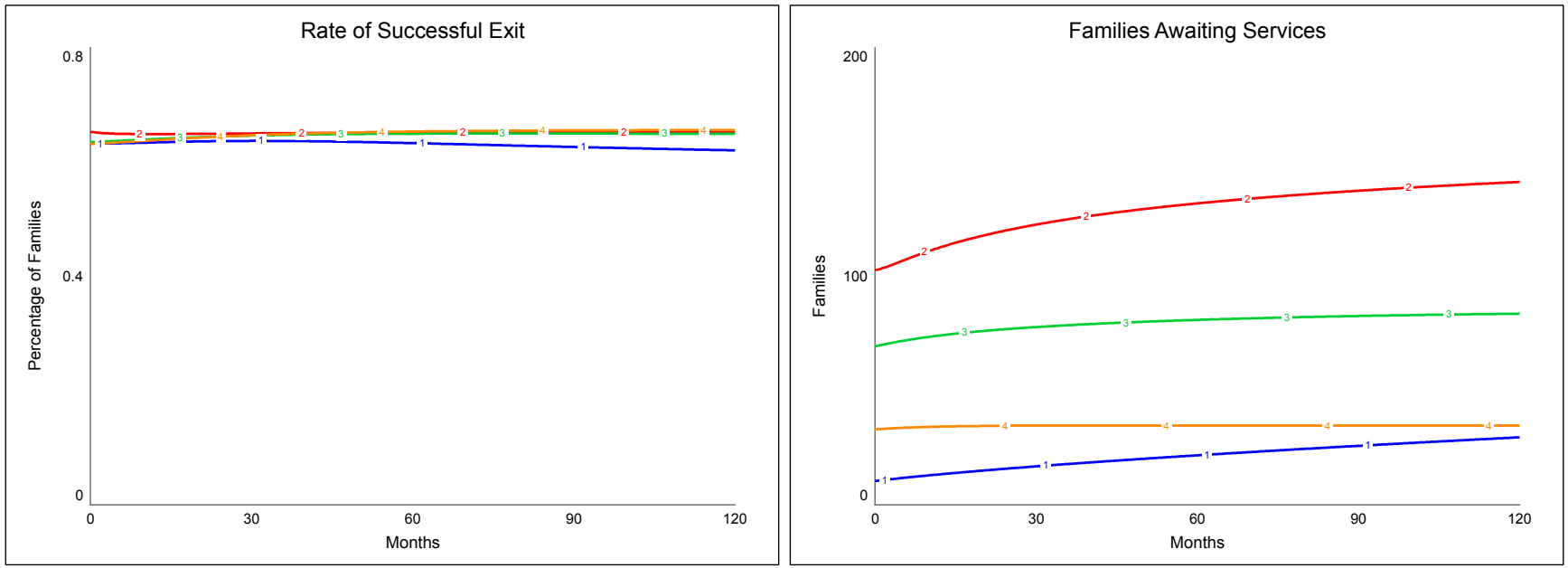


Figure 5.8. Results of simulations testing improved screening for prevention services. Run 1: Referrals based on random chance. Run 2: Referrals based on nearly perfect screening of family needs. Run 3: Nearly perfect screening and prevention capacity increased 5x. Run 4: Nearly perfect screening, prevention capacity increased 5x, homeless system capacity increased 5x.

VI. Discussion

Summary of Findings

The present study aimed to explore and understand drivers of service use patterns among families with children in the homeless services system. The mixed methods, community-based system dynamics approach probed facilitators and barriers to successful system exit, drivers of length of stay and reentry, and the internal experiences of families utilizing services with the aim of finding leverage to intervene and improve overall system performance. Qualitative group model building sessions and interviews with key stakeholders informed a quantitative simulation model calibrated using administrative homeless service use data. The mixed methods approach allowed for nuanced exploration of complex processes that have proven resistant to policy efforts to end homelessness for families with children.

Processes driving system behavior. Group model building yielded important insights into drivers of stagnant rates of homeless service use among families over time. First, elements of the system structure itself reinforce patterns of service use. With emergency shelters constantly full to capacity, both staff and clients reported that overcrowding increases client stress and erodes the empowerment and self-efficacy needed to make progress and return to stable housing. This can delay shelter exit as families' needs are compounded by the stress caused by shelter conditions. A counterintuitive insight that emerged from group model building is that crowding can also *accelerate* client exit, via increased pressure on staff members in light of limited capacity. Thus, length of stay is impacted both positively and negatively by crowding, contributing to the pattern of equilibrium observed over time.

Second, group model building participants and key informants discussed how staying in shelters erodes self-efficacy and contributes to longer stays through a process of "getting comfortable." Clients described "getting comfortable" as a vicious cycle by which they become more dependent on services

and less able to make progress toward self-sufficiency; a tendency toward this dependence is accelerated by the crowded, high-stress shelter environment. Key informants theorized that this process has been further compounded by the implementation of Coordinated Entry and the prioritization system, because clients feel less incentivized to seek housing on their own and more reliant on the prioritization list. In two sessions, clients were also clear to draw a distinction between "getting comfortable" as a negative process of *settling,* versus *adapting* to the shelter conditions in order to cope in the short-term. The push and pull clients feel over resisting dependence on services versus making the best of their living situations for their children in the meantime creates internal dissonance that contributes to their stress.

The centrality of stress and its implications for mental health, parenting, and return to stable housing emerged in every group model building session and key informant interview. Clients described feeling crippled by stress – the sources of which included crowded living conditions, demands from children, paperwork and requirements for housing programs, job searches, lack of child care, lack of transportation, and conflicts with other clients or staff members. Although not formally assessed, mental health problems figured prominently into discussions of the shelter experience, with several participants disclosing diagnoses of depression, anxiety, bipolar disorder, schizoaffectic disorder, and post-traumatic stress disorder – a pattern supported by prior literature of the mental health of mothers experiencing homelessness (Marcal, 2018). Caregivers reported guilt and shame over their homelessness that impeded their ability to be self-sufficient as parents and seek stable housing. Findings support prior research suggesting homelessness and entrance into homeless services pose significant barriers to the routines of positive parenting, interfering with caregiver autonomy and parent-child attachment; this puts caregivers in the difficult situation of having to manage both their own and their children's complex mental health needs (Bradley et al., 2018; Mayberry et al., 2014; Utrzan et al., 2017). Both clients and staff felt

underequipped to manage the challenges posed by prevalent depression and anxiety among shelter populations, and felt that these posed concrete obstacles to efficient return to stable housing.

Testing interventions to improve system performance. Simulation modeling likewise yielded important insights into system behaviors. With agencies reporting being consistently full and clients waiting substantial amounts of time to access services, this suggests supply of services has not been meeting demand; therefore, the number of families being served at any given time has been largely dictated by capacity constraints rather than family need. Results from Experiment 1 provide some insight into this unmet demand, as newly available services are immediately filled.

Simulation results also indicate the strength of the balancing effect of capacity constraints. Despite several reinforcing processes that could have created exponential growth in service use and length of stay (e.g. "getting comfortable", crowding eroding empowerment, and stress impeding timely exit), many system behaviors are simply limited by lack of space for families. The dominance of this balancing feedback process is supported by providers' strategies of accelerating rate of exit when services are overcrowded. Furthermore, this suggests that families outside services employ coping strategies to avoid shelter (Rufa & Fowler, 2018), or are diverted to other services systems (e.g. health care or mental health care, schools, incarceration; Culhane et al., 2011), all of which result in stagnant rates of service use that calibrate to meet supply.

Finally, simulations demonstrate tradeoffs in interventions. Increasing capacity, a logical response to the findings above, allows more families to be served but also allows more families to reenter services, exacerbating the problem of families "churning" through services and children's exposure to ongoing chaos. Additionally, investing in permanent supportive housing may reduce exposure to the chaos of short-term housing services, but the costly nature of PSH may reduce the total number of families who could benefit; furthermore, this risks "over-serving" lower-risk families who

may only need short-term assistance to stabilize (Fowler et al., 2019; Shinn et al., 2001). Similarly, diverting families to prevention services may help them avoid shelters and reduce costs, but risks underserving needier families who would benefit from more intensive housing services. Policies and practices must consider the consequences of these tradeoffs, and improve efforts to tailor service pathways to families' specific circumstances.

Homeless Services as a Complex Adaptive System

Findings from the present study support the application of complex adaptive systems theory for understanding and improving homeless services for families with children. Simulations yielded counterintuitive, nonlinear outputs resulting from complex feedback relationships among key variables. First, increasing access to services made system performance appear *worse;* when capacity of needed short-term housing services was expanded, rate of reentry and child risk increased. When the system was allowed to serve more people, more children were exposed to adverse conditions. Similarly, reducing stress among caregivers allowed them to leave services more quickly, but they were more likely to return. Furthermore, analyses found the homeless system to be an adaptive or learning system. For example, providers calibrate their behavior to match available resources; in this context of scarcity, patterns of service use driven in part by capacity constraints rather than client need. The study's mixed methods approach revealed multiple interacting feedback loops driving unexpected system behaviors that could not have been elicited from a single data source.

Implications for Policy and Practice

Findings reveal several opportunities for policy and practice improvements. Agencies may need to consider hard decisions about whether to maximize clients served, or optimize quality of services for a limited population. Although the Coordinated Entry process relies upon timely and accurate assessment and referral, there exists limited empirical support for current practices (Brown, Cummings,

Lyons, Carrion, & Watson, 2018; DeCandia, Bassuk, & Richard, 2017). Key informants expressed frustration that it was difficult to predict which clients would stabilize quickly and which clients would struggle, and that this contributed to the backlog of families waiting for appropriate services. Improved accuracy of assessment and referral processes would minimize the number of families in inappropriate services (e.g. the problems of "underserving" or "over-serving"). Additionally, accuracy and timeliness of referrals are dependent on available outside services. Providers offering case management services in under-resourced communities are hindered by limited referral options, which may impact homeless system performance measures; when fewer outside systems are able to meet needs, the homeless system bears a greater portion of the burden for serving vulnerable families. Furthermore, agency policies and staff workloads should be examined to avoid the risk of moving families too soon in response to strained capacity. One key informant stated that because her shelter was constantly receiving hotline calls, "That forces us to move people as quickly as we can." A scarcity mindset may allow factors other than client need to drive decisions about cases; greater staff training and greater service capacity could counter this process. Finally, homeless services should emphasize mental health promotion, not only due to high rates of mental disorder among consumers, but because improved emotional well-being can accelerate return to stable housing and protect children from further adversity.

Limitations

Findings from the present study must be considered in light of a number of limitations. First, administrative records were only available from a five-year period during and immediately following the Great Recession, limiting the scope and generalizability of the sample. Rates of family homelessness and housing instability increased nationally during this period, compounding existing strains on services (Sard, 2009). It is possible that were data available over a longer period of time, different trends in service use may have emerged. Similarly, the study was conducted in a medium-sized metropolitan area

in the Midwestern United States; it is possible that dynamics of agency and CoC policies, along with client and staff experiences, differ in larger urban or more sparsely populated rural areas. Nonetheless, the population of families experiencing homelessness in St. Louis closely resembled demographic trends nationally, making it a useful starting point to explore dynamics. Future research should employ a systems perspective in diverse settings.

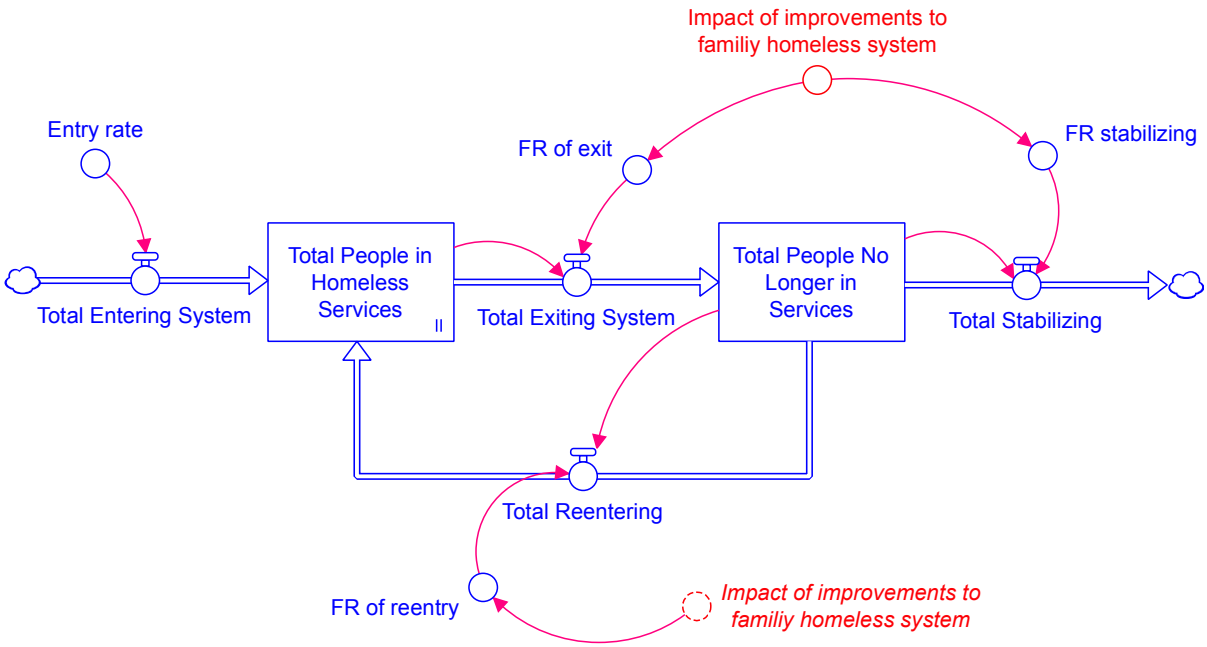
Next, qualitative data collection was limited to agencies that provided emergency shelter and transitional housing services. While the majority of families who enter the homeless system do utilize these types of short-term housing services, the study lacks perspectives of families receiving permanent supportive housing or prevention services. Similarly, perspectives of families who had successfully stabilized (exited services and never returned) were not collected, which would have provided an important comparison to those currently in services. This would have offered an opportunity to understand strategies families use to avoid entering the homeless system, which acts as a balancing force on the number of families in services in additional to capacity constraints.

Finally, qualitative data collection focused on a snapshot in time and did not capture the full range of experiences and outcomes of group model building participants. The study collected only limited demographic information, leading to an incomplete picture of the families and their experiences before, during, and after the homeless episode. Furthermore, no longitudinal indicators were tracked; thus, it was not known how long participants' current shelter stays would last, or whether they would reenter services within two years. These outcomes would be important for testing some hypotheses generated from group model building sessions against trends observed in administrative data, as well as determining comparability between the samples. Additionally, longitudinal measures would enable future research to assess impacts of natural experiments resulting from policy changes or test effects of systems-level interventions.

Future Directions

There are a number of areas of future research that would shed greater light on strategies to promote child well-being by addressing homelessness efficiently and sustainably. The application of a systems perspective offers opportunities to consider existing evidence in a new context. For example, the implementation of Coordinated Entry has changed policies and practices among clients and staff that are still unfolding. Staff key informants reported that the prioritization list had altered incentives for clients to "self-place," but clients disagreed with this assessment. The impact of Coordinated Entry on agency formal and informal policies is an important area of future study. Additionally, the family homeless system comprises one component of the larger homeless system. Making one part of a system more efficient may benefit the broader system, but also diverts resources from other subsystems; in a context of finite resources, prioritizing subgroups within the homeless population can force difficult decisions about where money and effort are best spent. Future research should examine how interventions supporting families with children impact homeless services more broadly (Figure 6.1).

Figure 6.1 Concept model of the impact of improving services for homeless families on the broader homeless services system



Additional qualitative data collection would provide insights into the coping strategies caregivers employ to manage their children's and their own behavioral health needs in the context of constrained resources, and how these affect the dynamics of service-related decision-making. Inclusion of families in other service types such as permanent supportive housing or prevention, as well as families who have exited services successfully, in data collection would allow researchers to test additional hypotheses about stakeholders' decision-making and priorities. A promising future area of research probes how to predict which families benefit most from more intensive services versus "lighter-touch" preventative services (Fowler et al., 2019; Shinn et al., 2013), and how improved accuracy and efficiency of targeting services can promote system functioning. This could be explored with qualitative perspectives from providers, policymakers, and clients about the complex tradeoffs associated with assessing and referring families for different service types in combination with further simulation modeling.

Another area of future research would more explicitly test impacts of system behavior and systems change on caregiver and child mental health. Although the risk for mental disorder among children who experience homelessness is well established, less is known about how the environments of services and transitions between service systems contribute to or protect against this risk (Bassuk et al., 2015; Haskett et al., 2015; Marcal, 2016). Agent-based modeling could be used to take an individual-level approach, testing the behaviors of individual actors in response to systems trends. The complexity of service delivery, provider decision-making, and client needs make homelessness research an area of great opportunity for systems approaches.

Research in this area would also benefit from greater understanding of strategies to engage vulnerable populations in systems thinking. Group model building has been noted as a promising implementation strategy (Powell et al., 2017), but lack of trust, limited literacy, and distrust between clients and staff created barriers for the present study. An initial concept model based on observations

and assumptions from the current study demonstrates the dynamics of building or eroding trust in group model building (Figure 6.2). This model conceptualizes a gap between the goals of researchers and participants as a driver of reducing trust; when goals are aligned, trust is slower to decline. Similarly, high trust can promote collaboration that reduces the goal gap. A challenge that emerges in working with marginalized groups is building trust where none has previously existed; this is demonstrated in the concept model through the causal link from the stock of "participant trust" to the flow "increasing trust." Some initial trust is needed on which to build; otherwise if the stock is empty, the inflow stops. In the current study, this emerged as a barrier in agencies where the research team collaborated with agency leadership, but relations between staff and clients were strained. Clients then distrusted the research team by association and were less likely to be forthcoming in sessions. Understanding processes that build and drain trust has implications for research and practice with vulnerable populations, and could be leveraged to improve the quality of services for families experiencing homelessness.

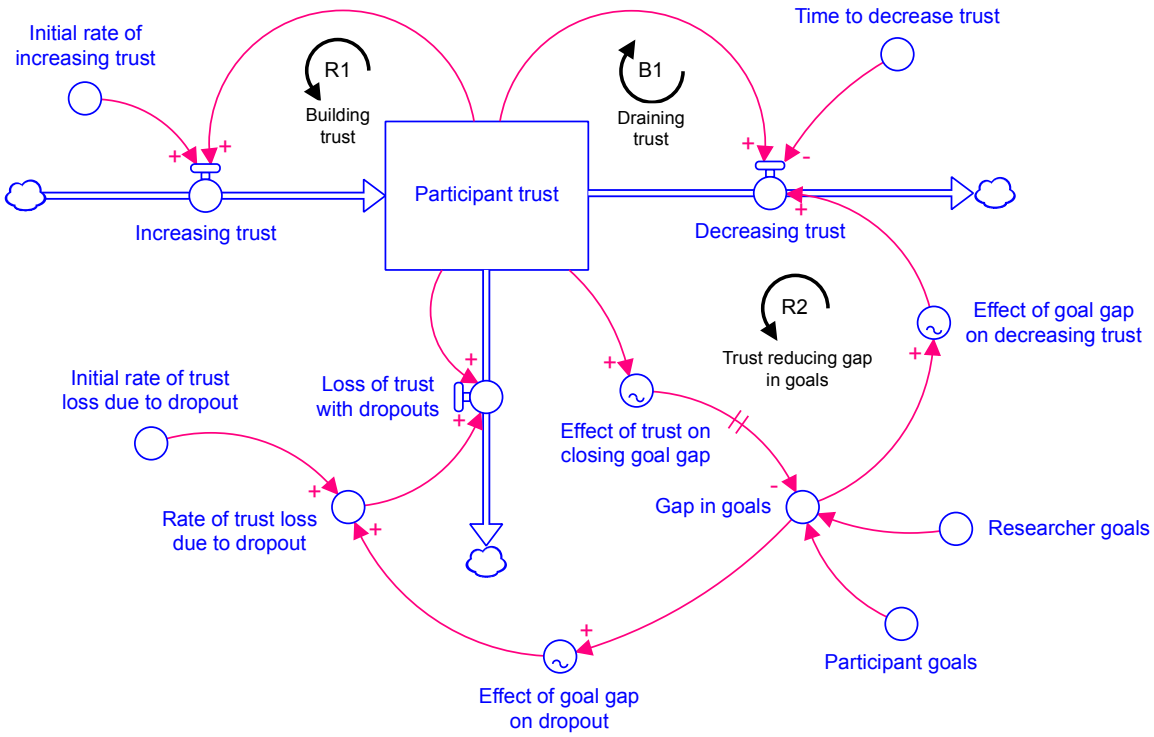


Figure 6.2 **Concept model of building and draining trust among participants in a research study.**

Conclusions

The present study fills important gaps in our understanding of the processes underlying patterns of service use among families experiencing homelessness. This is one of the first studies to apply a complex systems perspective in this area, improving our understanding of homelessness and how it poses ongoing threats to family and child well-being. The application of community-based systems dynamics allows for more complex understanding of the dynamics experienced by families in homeless services than achieved in prior research. Engagement with multiple stakeholders including clients as well as staff members in a variety of roles throughout agencies increases the range of perspectives incorporated into modeling and bolsters validity of findings.

Considering the effectiveness of service types in isolation overlooks the importance of the system as a whole, undermining efforts to promote sustainable housing stability. For example, merely emphasizing rapid return to independent housing can contribute to increased rates of reentry; similarly, focusing entirely on reducing the number of families in services can compound unmet need. The study fills an important gap by establishing a baseline understanding of client and provider decision-making and interpersonal processes that underlie stagnant rates of homeless service use among families with children. This provides a crucial foundation for future efforts to disrupt the current policy-resistance of homelessness and adopt more efficient approaches to stabilizing families.

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APPENDIX I: Qualitative Data Collection Tools

Key Informant Interview Guide

Basic Demographics/Background Info

Average family size, demographics, etc?

How long on average do families stay?

Reentry

How likely is it that families return for ***repeat stays***? Are you able to predict which families those will be?

- If so, how?
- If not, what would you need to know to be able to predict?

Do families typically return directly to their own housing, or some type of transitional or supportive housing program as an interim residence?

Crowding

How full is the shelter typically? (beds or percentage-wise)

- Is there a point at which it ***start to FEEL too crowded***? (e.g. 80% full, 90% full, etc)
- ***What does this feel like?*** increased stress? More drama? Less time with clients/longer stays? People try to leave faster?
- What are the ***effects of crowding on the community***? Does more crowding lead to more stress among staff and/or clients? Is there a sense of community among clients when they have more people to share experiences with/kids have more playmates?
- How much ***time is needed per client***? (per day, per week, total, any estimate)
- How much time do you actually get per client? Too much/too little/about right?

Motivation, Self-Efficacy, Stress

Clients talked about needing both a sense of motivation/self-efficacy PLUS relevant resources/support to leave shelter quickly. Do you agree/disagree? Is this missing anything?

What causes ***client*** stress to increase/decrease? How much? (a little/lot, 1-10)

What causes ***client*** self-efficacy to increase/decrease?

What causes ***your*** stress to increase/decrease?

Length of Stay/"Getting Comfortable"

What affects how long families stay?

- Families talked about this push/pull process where they see the shelter as a safe place to stay

(better than the alternative they're coming from), but also they miss privacy, having their own home, etc. which increases motivation to leave quickly…how do you see this working?

Clients also described a push-pull process where: staying longer increases stress and motivation leave, but staying longer can also increase a sense of "getting comfortable" and not wanting to leave. How do you see this working?

Complexity of Family Needs

How much variation is there in the types/complexity of families' needs? How do you manage that complexity in terms of providing them support in Gateway, as well as connecting them to the right outside services?

Parenting, Managing Child Behavior

Parents also talked about the challenges of managing child needs and child behavior problems while receiving services. How do you see this playing out?

Parents felt a lack of self-efficacy in parenting – they were dependent on services, so how can they make their kids listen to/respect them as authority figures?

How do children cope with experiencing homelessness? What kinds of behaviors do you see? How do they manage stress/uncertainty?

Strengths/Challenges

What is/are the most ***important factor/s for families to succeed***?

What are the ***biggest challenges for families*** to stabilize?

What are the ***biggest challenges for you*** in doing your job? (High demand, complexity, structural issues, something else?)

System Redesign

If you could design an ideal service system for the families you see, what would that look like? (e.g. what components? Shelters, transitional housing, step-down approach, more counseling, etc?)

Facilitation Manual I: Clients Session 1

Overview	
July 17, 2018 July 19, 2018 October 29, 2018 December 7, 2018	**Duration:** 1 hour
Participants: 3-15 participants	
Materials: • Flip chart • Markers • Painter's Tape • Printer Paper • Key question written on flipchart	

Introduction	
Time required: 5 minutes	**Follow-up Time:** 0 minutes
Facilitating: Kate • Have markers and paper on the tables • Informed consent intro from Kate	

Variable Elicitation	
Time required: 20 minutes	**Follow-up Time:** 0 minutes
Materials: • Markers • Stacks of white paper • Painter's tape	

• Key question written on flipchart	
Roles: • Kate facilitating • Jess/Katie wall-building	
Key question: What factors make it easier or harder to return to stable housing? *Probes:* Things that you're considering while you're making that decision.. when you're thinking about leaving the shelter what factors are you considering? What makes it hard to get your own place? What makes it easier?	
Steps:	1. The facilitator gives each participant sheets of blank paper and markers. 2. The facilitator writes a task-focusing question "What are factors that make it easier or harder to return to stable housing?" on flipchart. 3. The facilitator asks participants to write as many problem-related variables as they can on the sheets of paper. Participants are given a few minutes to work individually on their lists. 4. Once they have finished the individual exercise, the facilitator uses the same process used in the "Hopes and Fears" script to put all individual variables on the board. When a variable name is open to several interpretations, the facilitator asks for a brief description or definition of the variable, including the units in which the variable can be measured. 5. The facilitator writes the variable name on the board, including any additional information in parenthesis. 6. The facilitator makes a summary of the variables on the board, while the recorder captures the products of the process either photographically or in a word processor. 7. The facilitator suggests which variables can be considered stocks as they are mentioned. If the participants agree, the facilitator can add the words "level of" to these variables.

Initiating a CLD	
Time required: 20 minutes	**Follow-up Time:** 20 minutes

Materials:

- Flipchart paper for each group or large whiteboard/chalkboard (e.g., approximately 5 feet of horizontal space per group)
- Markers

Inputs: List of variables

Outputs:

- Interim output/product: increased consensus on dynamic hypothesis, or a possible structural explanation for observed behavior
- Deliverable: a causal loop diagram which may be described either in a report (in the case that only a qualitative model is built), or be used as a dynamic hypothesis on the basis of which formal modeling starts

Roles:

- Facilitator/modeler with experience in drawing causal loop diagrams, and preferably with experience in building formal models

Key question: What makes it easier or harder to exit services and return to stable housing?
What things could the homeless service system (i.e. your caseworker) do to help you stay in stable housing?
What could the shelter do to help you return to stable housing?
What might make you likely to return to the shelter?

Steps:

1. Remind the group of the list of variables elicited before. Place the list of variables in such a way that it is visible to the group of participants. Write the **problem variable [barriers to leaving the shelter]** in the center of the white board.
2. Build the model by following steps a, b, and c below:
    - (a) Ask participants which variable from the collected list is a cause for changes in the problem variable. When someone makes a suggestion, include this in the drawing of the model in order to visualize what is meant. Then check to see if everyone agrees with the proposed relation. If someone disagrees, ask for clarification and try to determine what the group thinks the relationship should be. If a discussion goes on too long, you can choose to temporarily 'park' this item and continue with another

	part of the model. Hopefully, there will not only be variables that have a direct relationship with the problem variable, but you will also build a few logical chains of reasoning (via intermediate variables) into the model. In addition, check the polarity (positive or negative) of the relationship. • (b) After spending some time doing this, proceed to the consequences of changes in the problem variable. • (c) At the point where a feedback chain becomes closed, check with the entire group to see if the chain as a whole is correct. Check again to see if a loop is positive or negative. The "Ratio Exercise" script may be used to draw out loops. 3. In the last part of the session, analyze the model by checking the feedback loops one more time. Before you close the group session, make sure you do the following: • If there is a list of 'parked' issues, go through them. • State once more what has been done and what will happen with the final products. • Formulate a few concise conclusions. As Andersen and Richardson (1997) say: "End with a bang!" • Make sure that all the information which is necessary for the report has been noted.
Evaluation criteria: Participants created a rich causal loop diagram (CLD) based on their thoughts and stories; Set of CLDs	

Wrap-Up
Facilitator: Kate or Jess --Reflections on CLD & debrief --Next session?

Facilitation Manual II: Clients Session 2

Overview	
July 25, 2018 July 26, 2018 November 4, 2018 January 16, 2019	**Duration:** 1 hour
Participants: 3-15 participants	
Materials: • Flip chart • Markers • Painter's Tape • Printer Paper • Key variables written on flipchart • Graphs over time templates	

Graphs Over Time	
Time required: 30 minutes	**Follow-up Time:** 0 minutes
Roles: • Kate facilitating • Jess wall-building/taking notes **Materials**: • Markers • Graph over time templates • Variables from last week written on flipchart	

Key Question: How do the key variables change over time during a shelter stay? (motivation, stress, "making progress," etc.

Steps:

1. Review key variables identified in last session
2. Pass out graph over time templates and explain that participants should think about how each one varies over their time in the shelter (either in their own experience or what they observe in others)
3. Have the participants spend ~10 min filling in the graphs individually
4. Reconvene the group and go through each variable. Have each participant share their graph and explain the story. Invite others to discuss convergent/divergent ideas
5. Hang the graphs up on the wall/display for the group to see during the activity

Causal Mapping with Seed Structure	
Time required: 30 minutes	**Follow-up Time:** 0 minutes

Roles:

- Kate facilitating
- Jess wall-building/taking notes

Materials:

- Markers
- Variables from last week written on flipchart

Key Question: How are key variables related to each other to explain length of stay and reentry patterns?

Steps:

1. Review key variables identified in last session and trends from Graphs Over Time activity (see above)
2. Explain that variables should be linked causally – e.g. stress directly decreases motivation. Have participants take turns providing suggestions for links.
3. If there is disagreement, elicit feedback from the rest of the group

4. When there is consensus, draw causal links between variables
5. Identify any feedback loops that emerge and point them out to the group

Wrap-Up (5 min)
Facilitator: Kate or Jess --Reflections on graphs, CLD, & debrief

Facilitation Manual III: Staff

Overview	
November 28	**Duration:** 1 hour
Participants: 3-5 participants	
Materials: • Flip chart • Markers • Painter's Tape • Printer Paper • Blank graphs printed out for everyone • Key question written on flipchart	

Introduction	
Time required: 5 minutes	**Follow-up Time:** 0 minutes
Facilitating: Kate • Have markers and paper on the tables • Study details and informed consent intro from Kate	

Graphs over Time	
Time required: 25 minutes	**Follow-up Time:** 0 minutes
Materials: • Markers • Stacks of white paper • Painter's tape • Blank graphs	

- Key question written on flipchart

Roles:

- Kate facilitating
- Jess writing variables/wall-building

Key question: What are facilitators/barriers to returning to stable housing?

Provide participants with blank graphs (some have variables filled in, some blank). Ask them to track trends over time of variables over time/relationships between variables.

Steps:

1. The facilitator gives each participant blank graphs. Some will have variables filled in, some will be blank.
2. The facilitator writes a task-focusing question “What are facilitators and barriers to returning to stable housing?” on flipchart.
3. The facilitator asks participants to sketch variables over time or relationships between variables.
4. Once they have finished the individual exercise, the facilitator uses the same process used in the "Hopes and Fears" script to put all individual variables on the board. When a variable name is open to several interpretations, the facilitator asks for a brief description or definition of the variable, including the units in which the variable can be measured.
5. The facilitator makes a summary of the variables on the board, while the recorder captures the products of the process either photographically or in a word processor.

Initiating a CLD

Time required: 25 minutes

Materials:

- Flipchart paper for each group or large whiteboard/chalkboard (e.g., approximately 5 feet of horizontal space per group)
- Markers

Inputs: List of variables

Outputs:

- Interim output/product: increased consensus on dynamic hypothesis, or a possible structural explanation for observed behavior
- Deliverable: a causal loop diagram which may be described either in a report (in the case that only a qualitative model is built), or be used as a dynamic hypothesis on the basis of which formal modeling starts

Roles:

- Facilitator/modeler with experience in drawing causal loop diagrams, and preferably with experience in building formal models

Key questions: What makes it hard to leave the shelter?
What could the shelter or other services do to help clients return to stable housing faster?
What might make clients more/less likely to return to the shelter after leaving?
What increases/decreases stress/motivation/empowerment/self efficacy to return to stable housing?

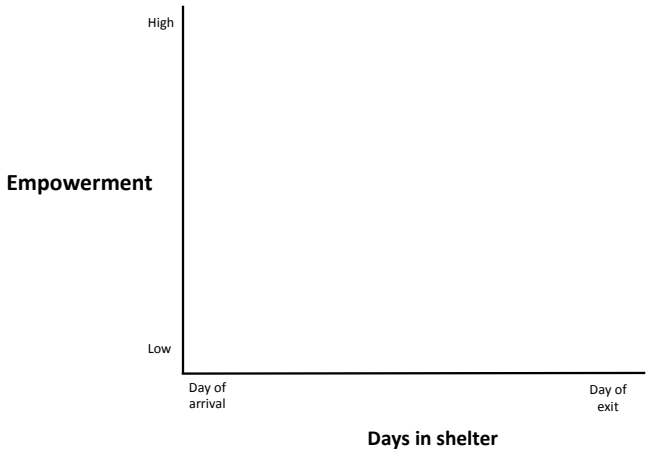
Steps:

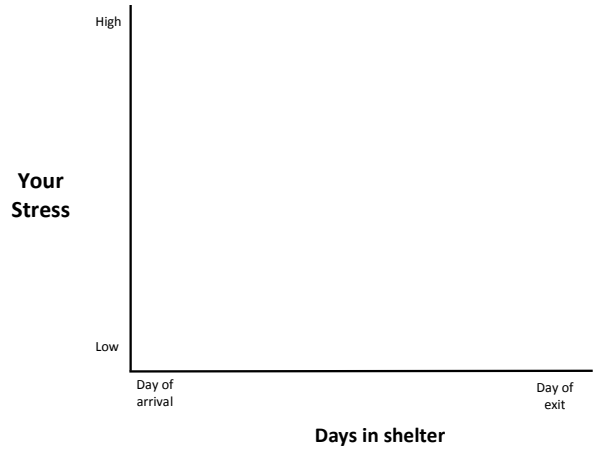
1. Remind the group of the list of variables elicited before. Place the list of variables in such a way that it is visible to the group of participants. Write the **problem variable [barriers to returning to stable housing]** in the center of the white board.
2. Present an example feedback loop (don't use this language…just present as virtuous/vicious cycle or other laymen's terms)
3. Model building can start from scratch, or build on example provided above if relevant enough. Build the model by following steps a, b, and c below:
    - (a) Ask participants which variable from the collected list is a cause for changes in the problem variable. When someone makes a suggestion, include this in the drawing of the model in order to visualize what is meant. Then check to see if everyone agrees with the proposed relation. If someone disagrees, ask for clarification and try to determine what the group thinks the relationship should be. If a discussion goes on too long, you can choose to temporarily 'park' this item and continue with another part of the model. Hopefully, there will not only be variables that have a direct relationship with the problem variable, but you will also build a few logical chains of reasoning (via intermediate variables) into the model. In addition, check the polarity (positive or negative) of the relationship.

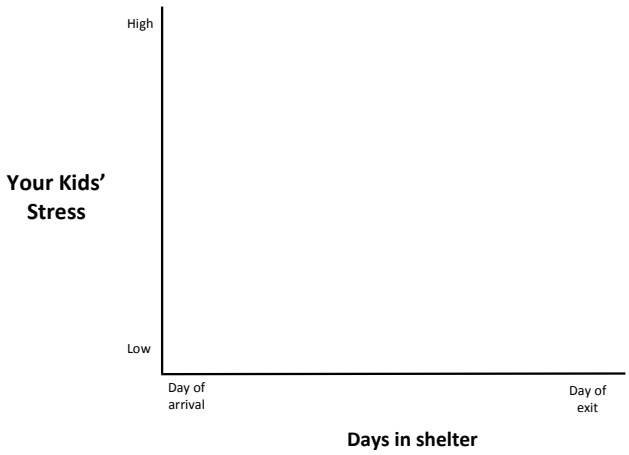
	• (b) After spending some time doing this, proceed to the consequences of changes in the problem variable. • (c) At the point where a feedback chain becomes closed, check with the entire group to see if the chain as a whole is correct. Check again to see if a loop is positive or negative. The "Ratio Exercise" script may be used to draw out loops. 4. In the last part of the session, analyze the model by checking the feedback loops one more time. Before you close the group session, make sure you do the following: • If there is a list of 'parked' issues, go through them. • State once more what has been done and what will happen with the final products. • Formulate a few concise conclusions. As Andersen and Richardson (1997) say: "End with a bang!" • Make sure that all the information which is necessary for the report has been noted.
Evaluation criteria: Participants created a rich causal loop diagram (CLD) based on their thoughts and stories; Set of CLDs	

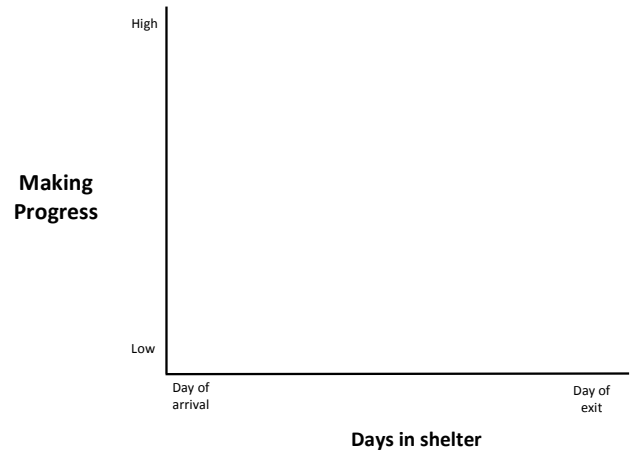
Wrap-Up (5 min)
Facilitator: Kate or Jess --Reflections on CLD & debrief --Next session?

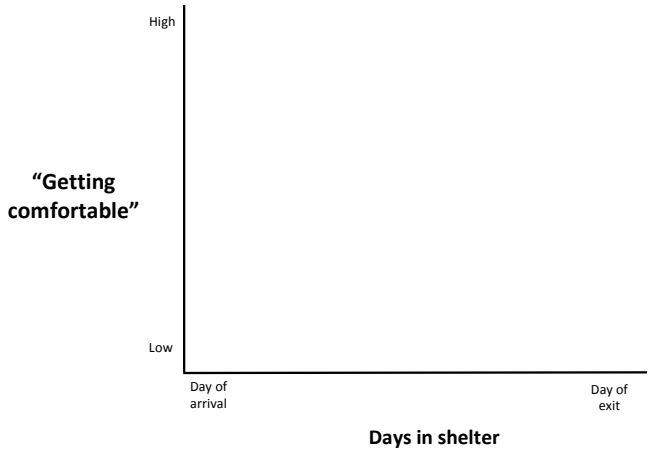
Templates for "Graphs Over Time" Script with Clients



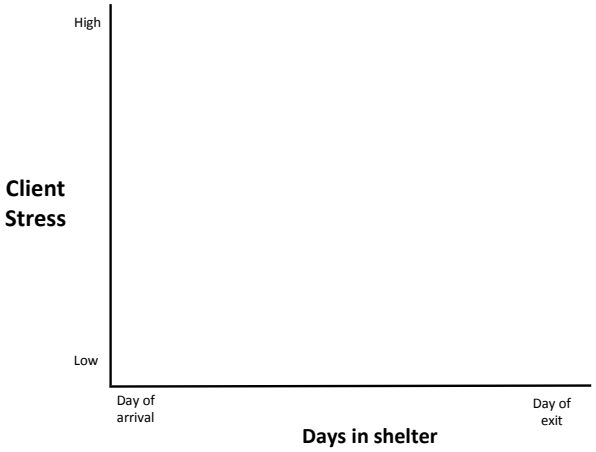


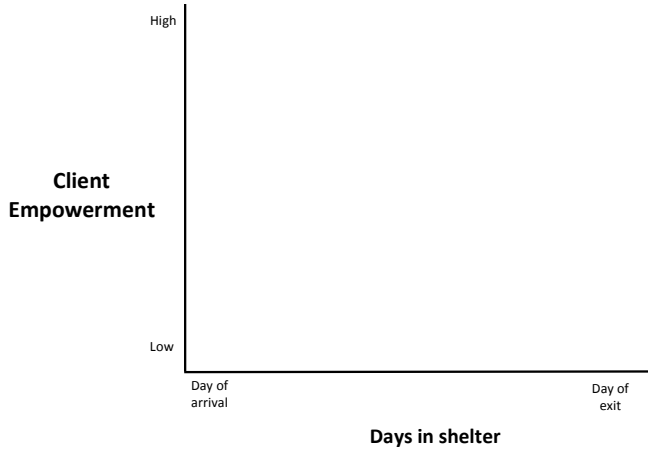


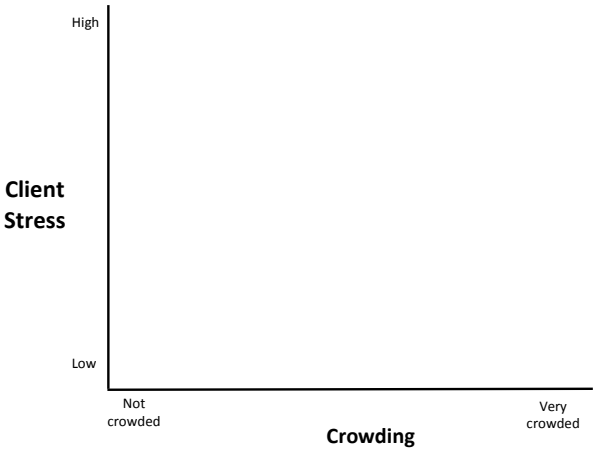


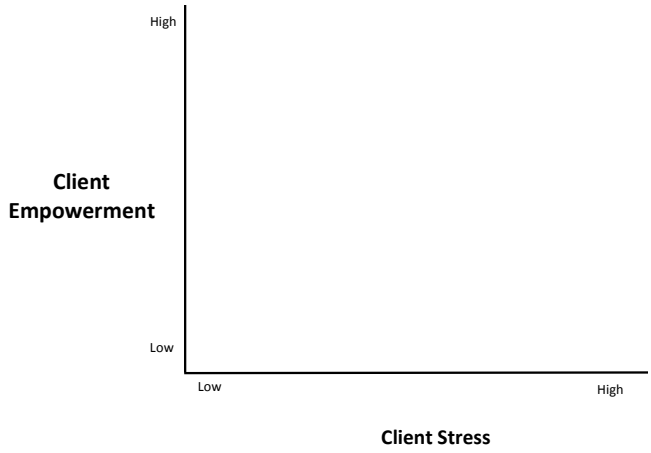

High
"Getting comfortable"
Low
Day of arrival
Day of exit
Days in shelter

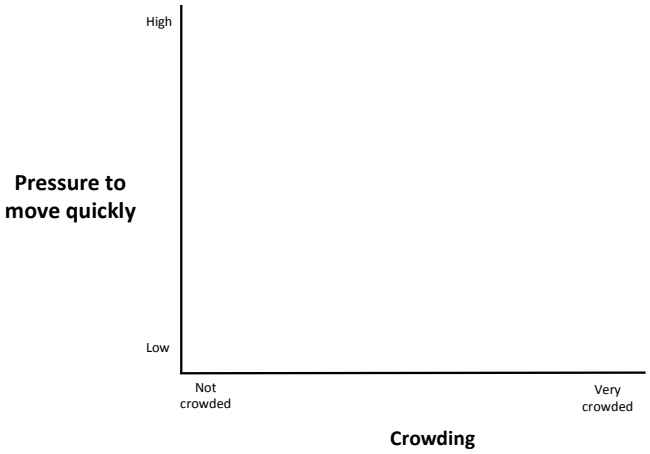
Templates for "Graphs Over Time" Script with Staff

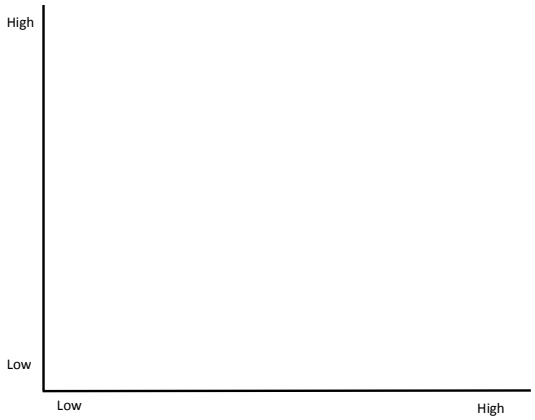









High
Pressure to move quickly
Low
Not crowded
Very crowded
Crowding


High
Low
Low
High

APPENDIX II: Simulation Model Structure

Figure A1. Service use structure

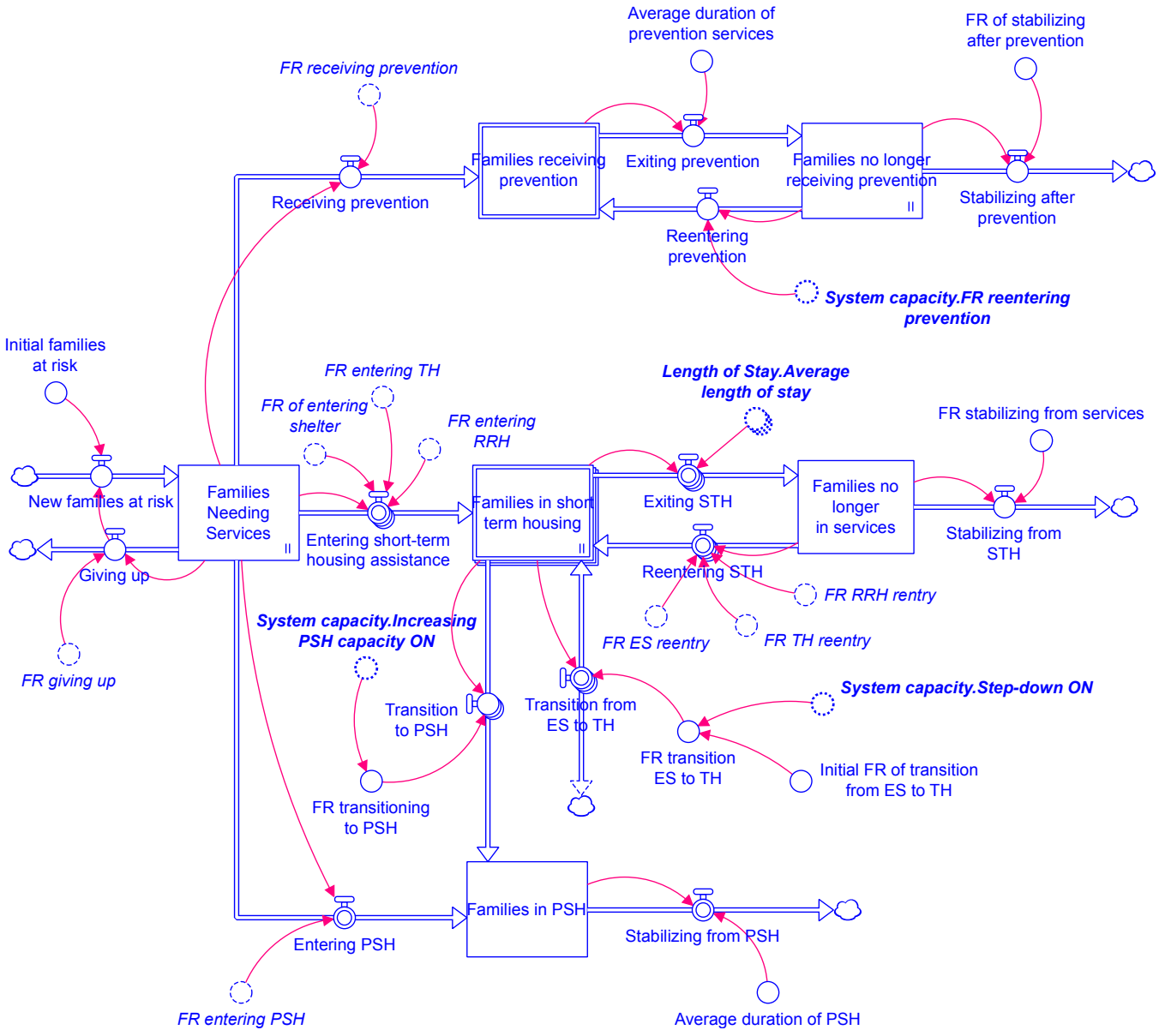


Figure A2. Fractional rates of service entry, reentry, and giving up

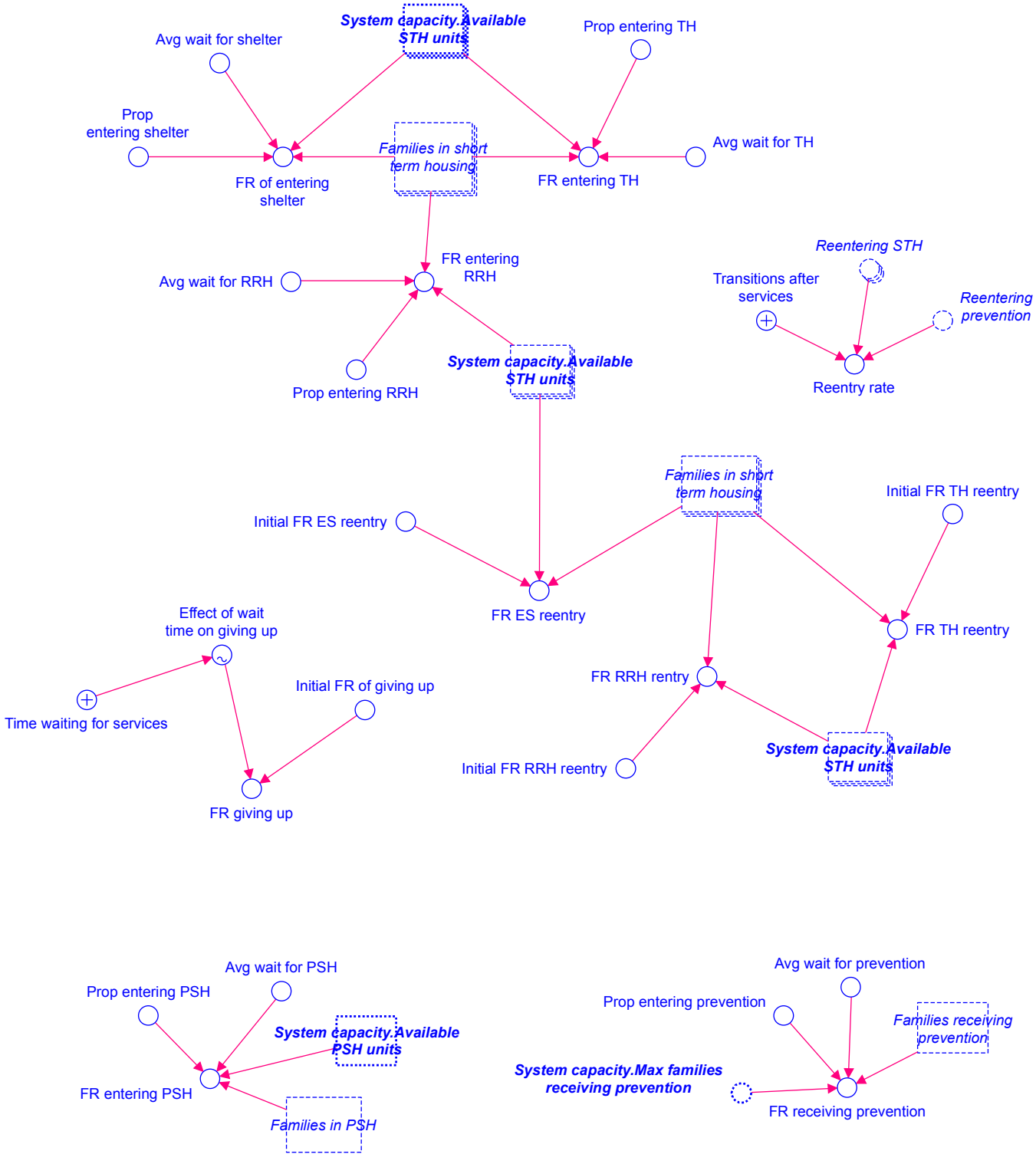


Figure A3. System capacity

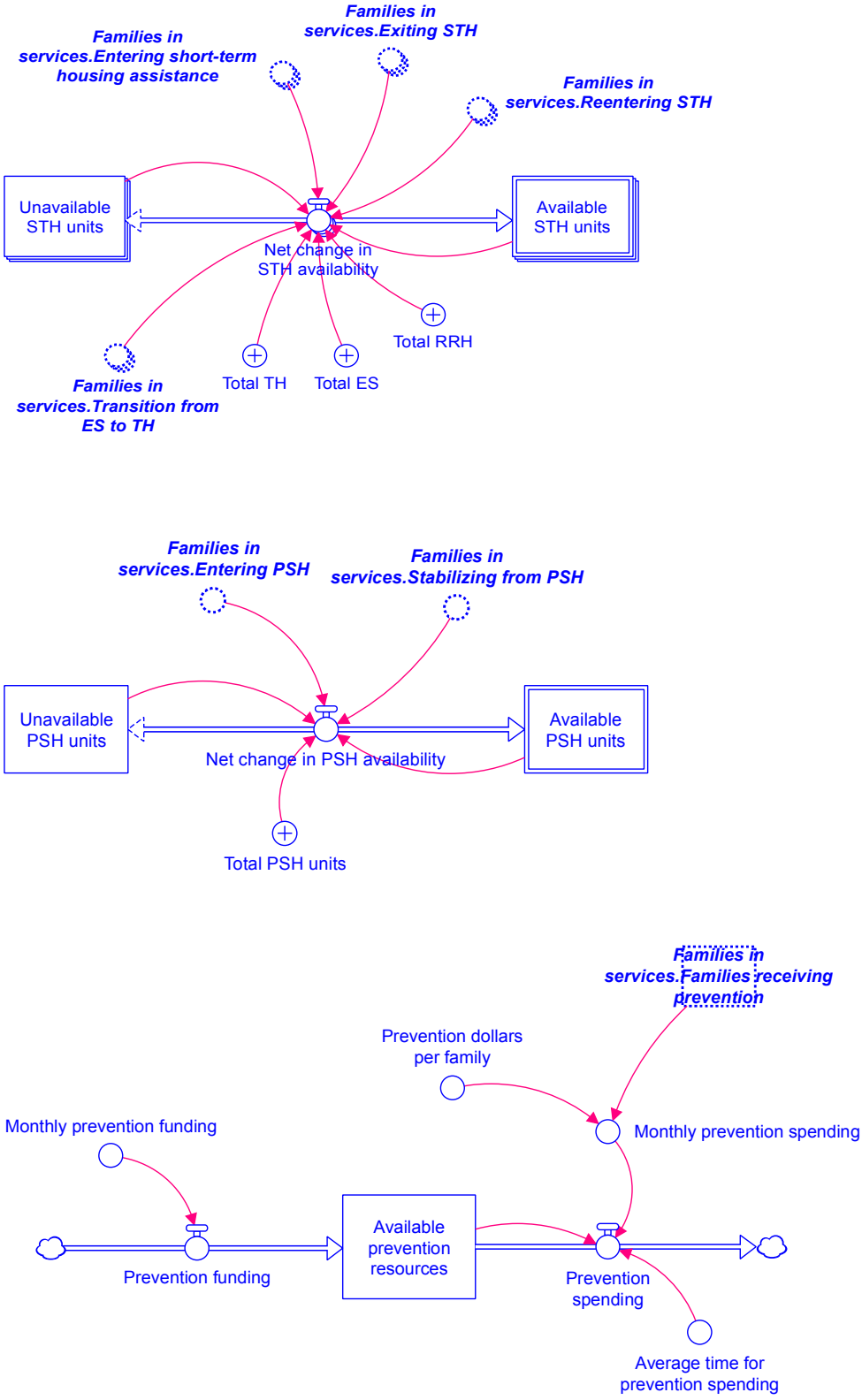


Figure A4. Caregiver stress

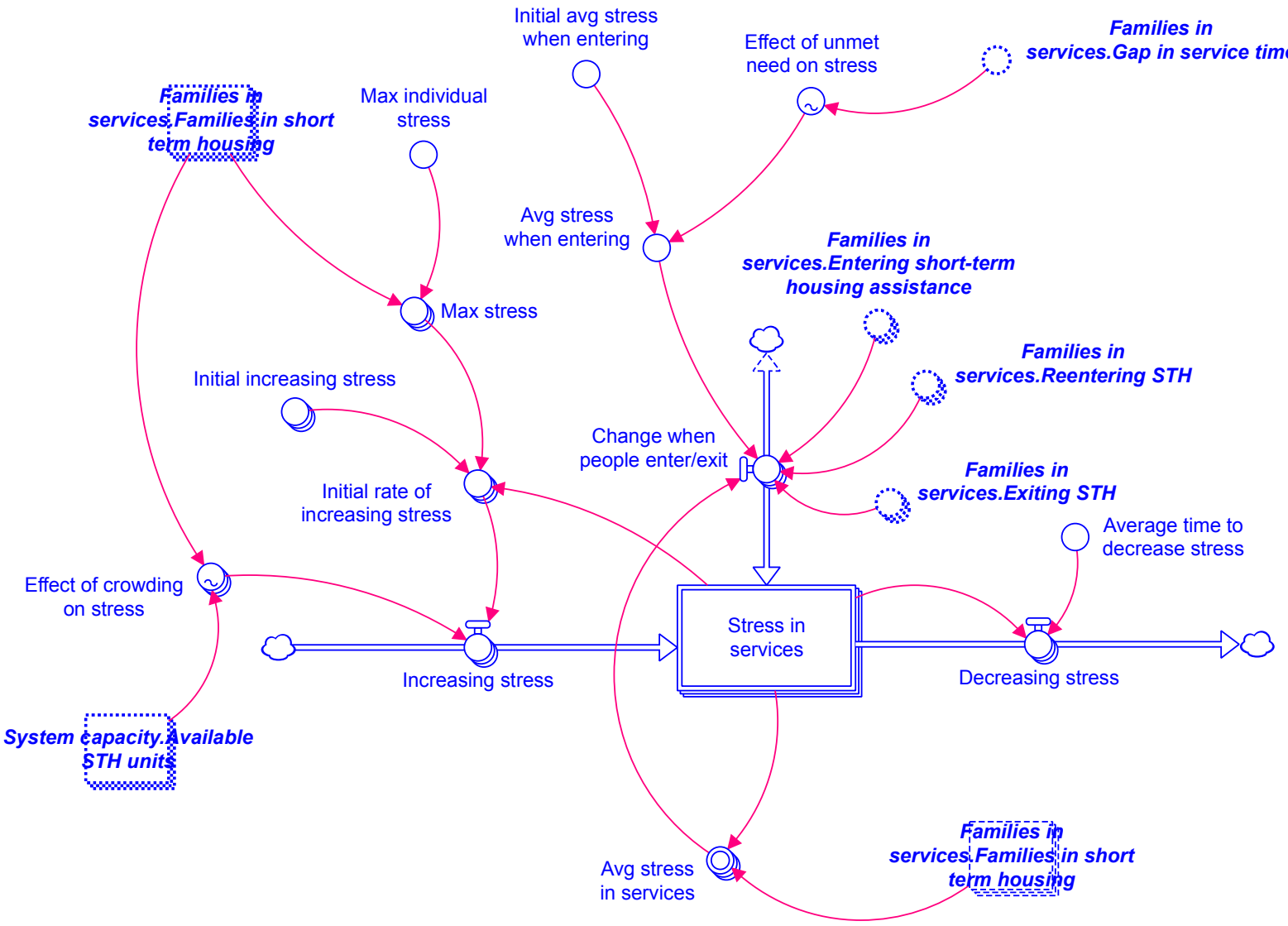


Figure A5. Empowerment

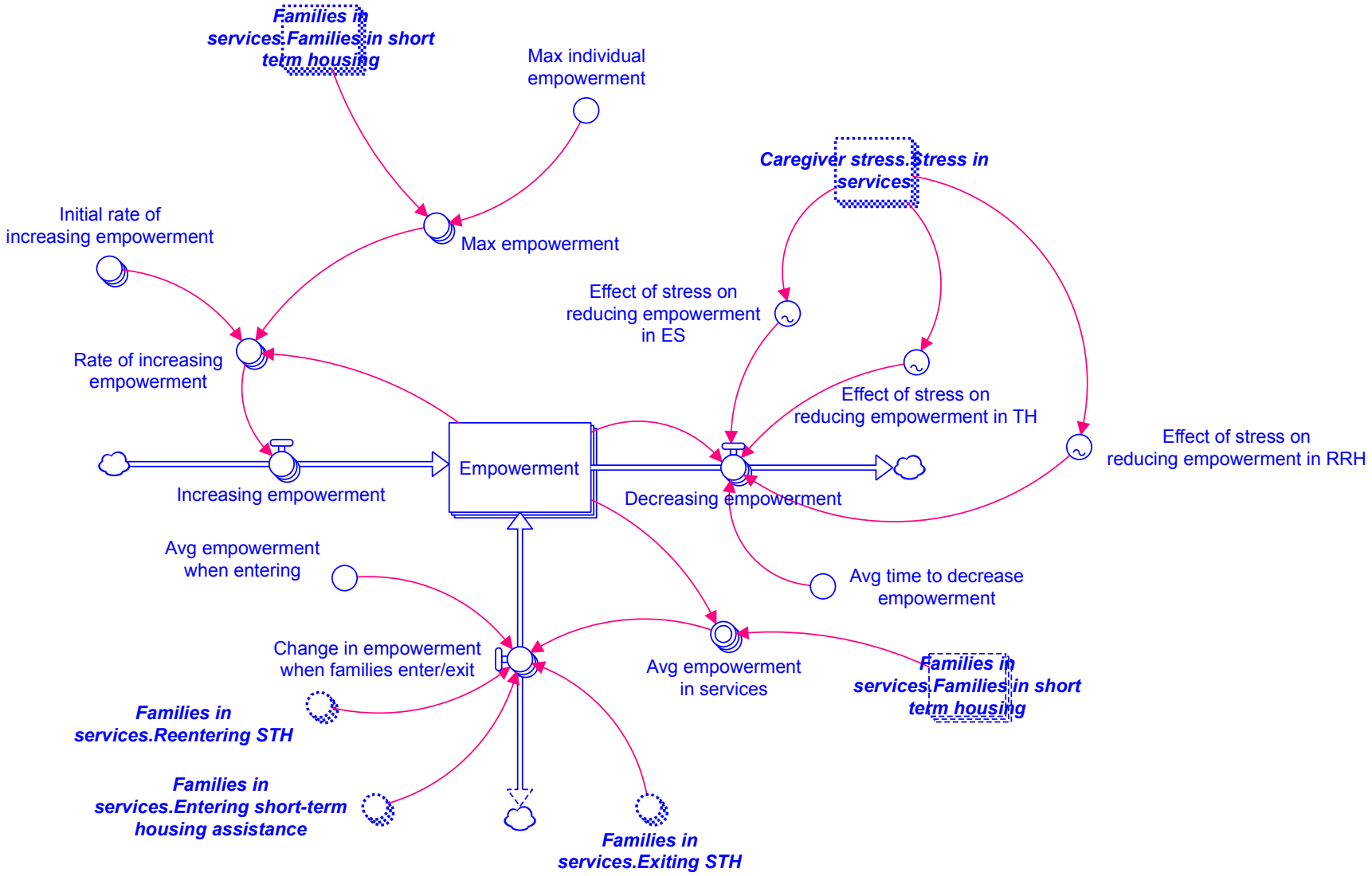


Figure A6. Length of stay

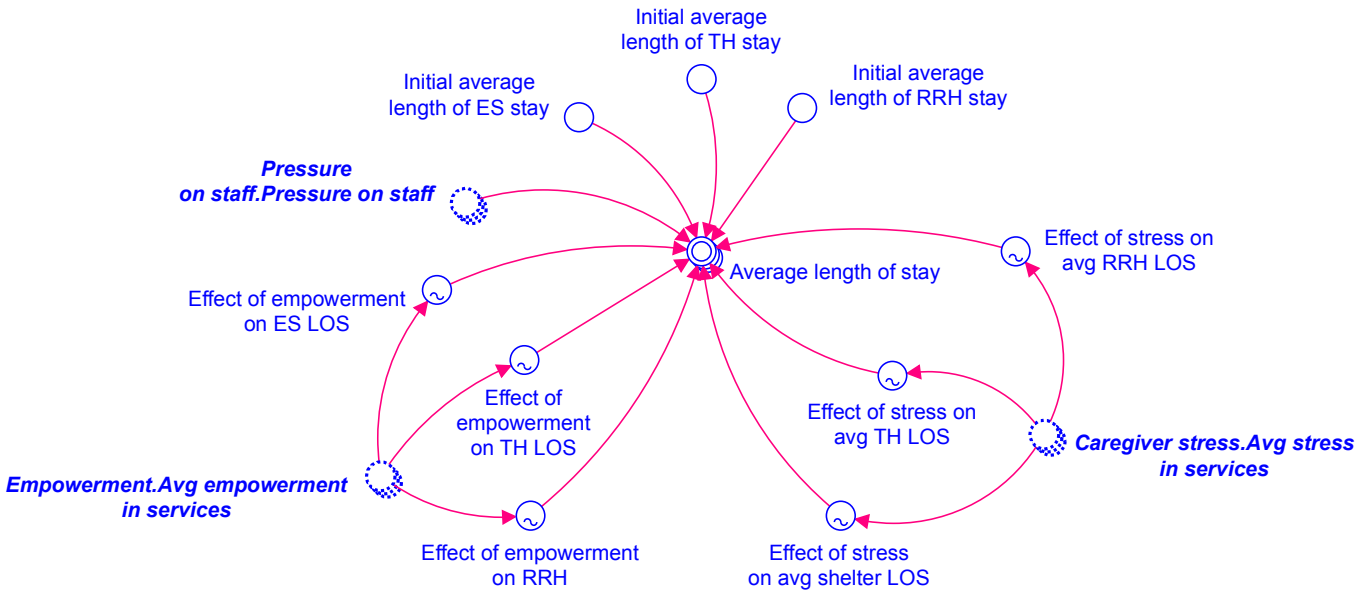


Figure A7. Child risk

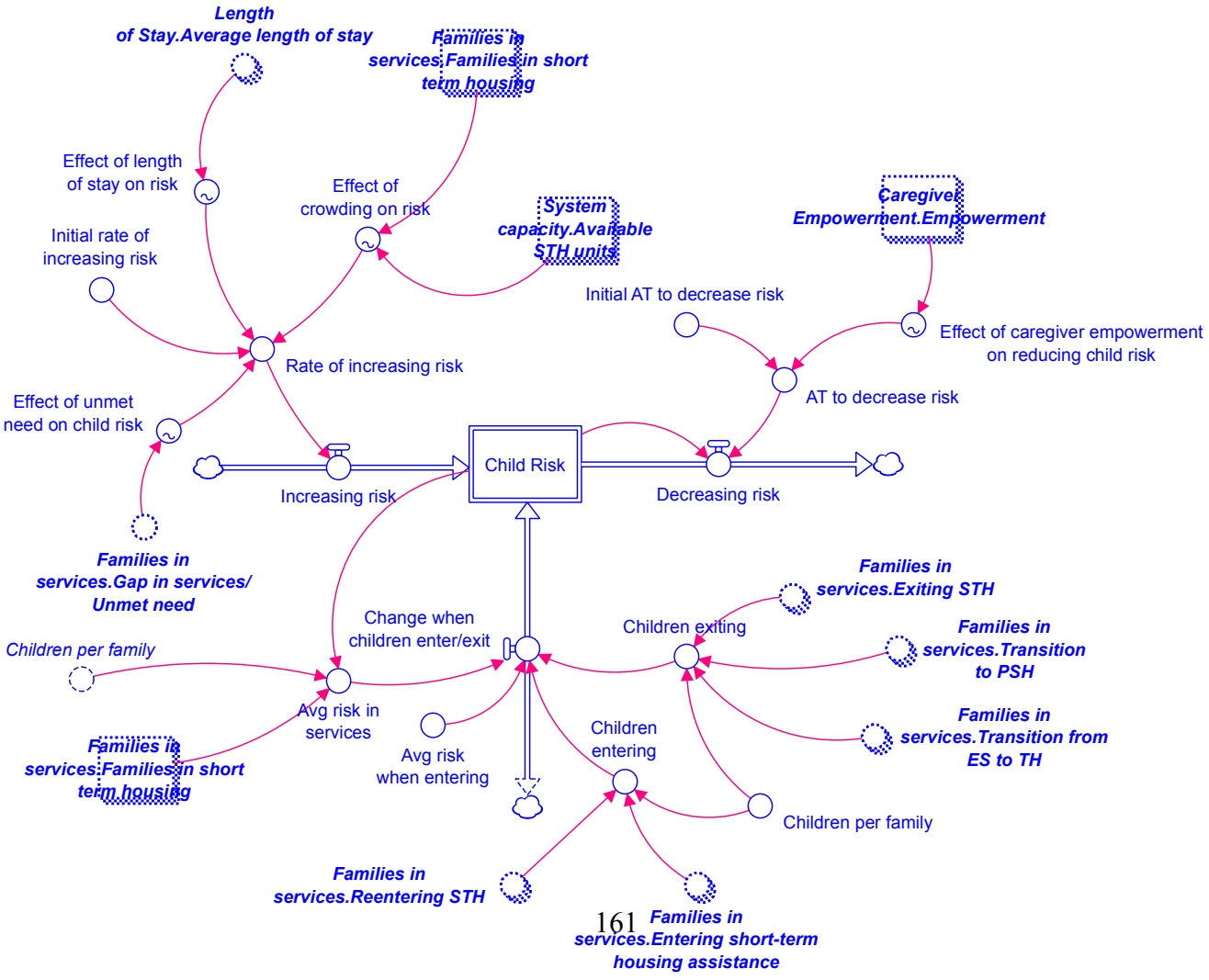
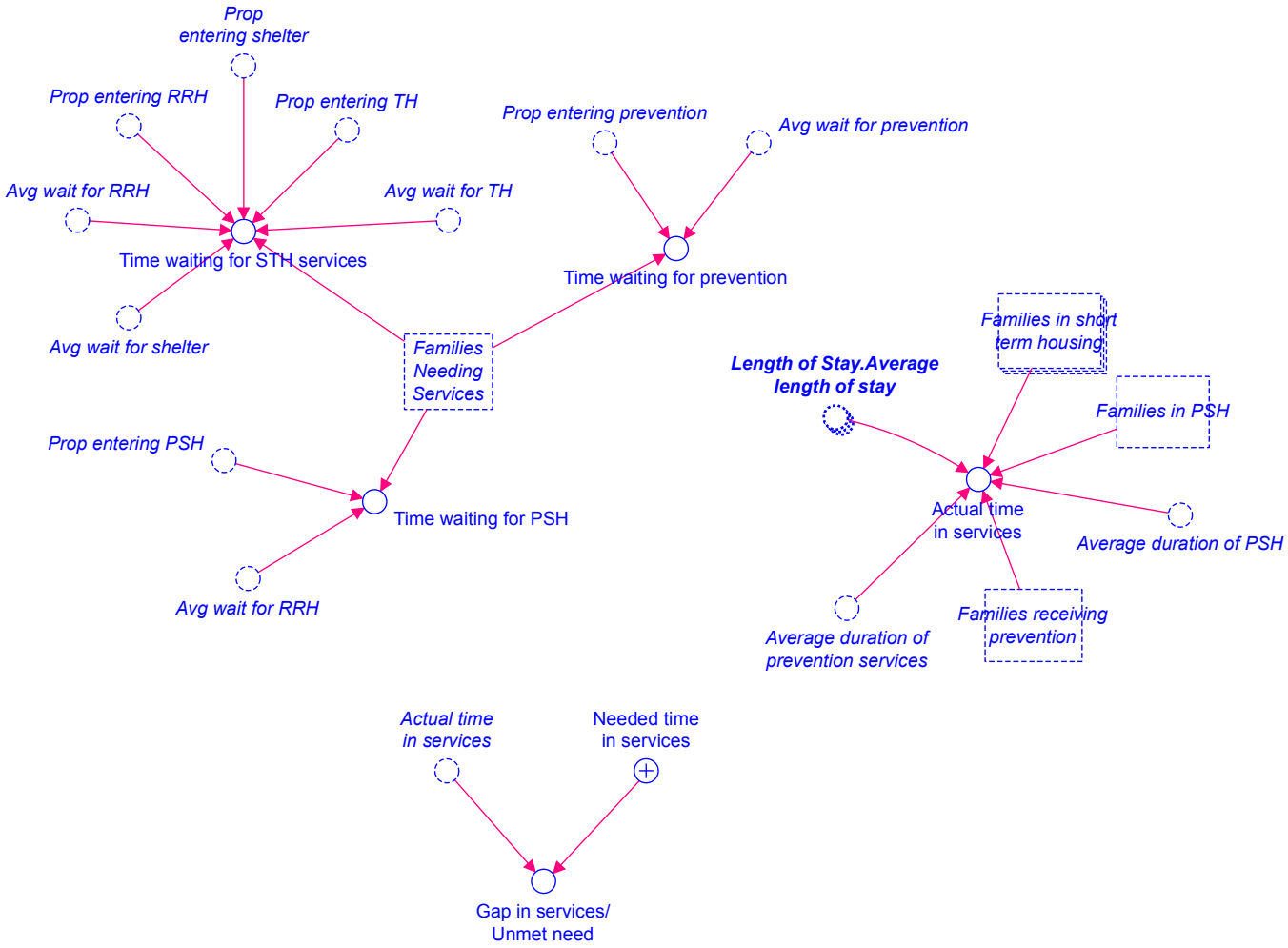


Figure A8. Unmet need



APPENDIX III: Initial Values

s for stock and flow simulation model by module

	Type	Initial Value/Equation	Units	Source
sk	Rate	150	Families/Months	Assumed
ervices	Stock	1000	Families	Assumed
mergency shelter	Time constant	6	Months	Calculated (HMIS)
g emergency shelter	Proportion	0.27	Dimensionless	Calculated (HMIS)
ansitional housing	Time constant	3	Months	Calculated (HMIS)
g transitional housing	Proportion	0.06	Dimensionless	Calculated (HMIS)
apid rehousing	Time constant	3	Months	Calculated (HMIS)
g rapid rehousing	Proportion	0.038	Dimensionless	Calculated (HMIS)
ermanent supportive				
	Time constant	9	Months	Calculated (HMIS)
g permanent				
	Proportion	0.024	Dimensionless	Calculated (HMIS)
revention	Time constant	9	Months	Calculated (HMIS)
g prevention	Proportion	0.61	Dimensionless	Calculated (HMIS)
p	Fractional rate	0.001	1/Months	Assumed
erm housing				
]	Stock	120	Families	HUD Exchange PIT reports

System Capacity	Families in short-term housing [transitional housing]	Stock	135	Families	HUD Exchange PIT reports
	Families in short-term housing [rapid rehousing]	Stock	30	Families	HUD Exchange PIT reports
	Families receiving prevention	Stock	50	Families	Assumed
	Initial average length of ES stay	Time constant	1.5	Months	Calculated (HMIS)
	Initial average length of TH stay	Time constant	7	Months	Calculated (HMIS)
	Initial average length of RRH stay	Time constant	5	Months	Calculated (HMIS)
	Families no longer receiving services	Stock	500	Families	Assumed
	Families in PSH	Stock	200	Families	HUD Exchange PIT reports
	Initial FR of ES reentry	Fractional rate	0.1	1/Months	Calculated (HMIS)
	Initial FR of TH reentry	Fractional rate	0.075	1/Months	Calculated (HMIS)
	Initial FR of RRH reentry	Fractional rate	0.075	1/Months	Calculated (HMIS)
	FR stabilizing from STH services	Fractional rate	0.03	1/Months	Calculated (HMIS)
	Average duration of PSH	Time constant	21	Months	Calculated (HMIS)
	Initial FR reentering prevention	Fractional rate	0.01	1/Months	Calculated (HMIS)
	FR stabilizing after prevention	Fractional rate	0.75	1/Months	Calculated (HMIS)
	Unavailable STH units [emergency shelter]	Stock	120	Families	HUD Exchange HIC reports
	Unavailable STH units [transitional housing]	Stock	135	Families	HUD Exchange HIC reports
	Unavailable STH units [rapid rehousing]	Stock	34	Families	HUD Exchange HIC reports
	Available STH units [emergency shelter]	Stock	80	Families	HUD Exchange HIC

					reports
	Available STH units [transitional housing]	Stock	67	Families	HUD Exchange HIC reports
	Available STH units [rapid rehousing]	Stock	34	Families	HUD Exchange HIC reports
	Unavailable PSH units	Stock	200	Families	HUD Exchange HIC reports
	Available PSH units	Stock	100	Families	HUD Exchange HIC reports
	Monthly prevention funding	Rate	8300	Dollars/Months	HUD HPRP 3-Year Summary
	Available prevention resources	Stock	2,000,000	Dollars	HUD HPRP 3-Year Summary
	Prevention dollars per family	Rate	1500	Dollars/Families/ Months	HUD HPRP 3-Year Summary
Caregiver Stress	Stress in services [emergency shelter]	Stock	6*120	Stress units	Assumed/calculated (HMIS; families in services multiplied by average stress)
	Stress in services [transitional housing]	Stock	6*135	Stress units	Assumed/calculated (HMIS; families in services multiplied by average stress)
	Stress in services [rapid rehousing]	Stock	6*34	Stress units	Assumed/Calculated

					(HMIS; families in services multiplied by average stress)
	Initial increasing stress [emergency shelter]	Rate	1000	Stress units/ Months	Assumed/Calculated to achieve dynamic equilibrium
	Initial increasing stress [transitional housing]	Rate	1000	Stress units/ Months	Assumed/Calculated to achieve dynamic equilibrium
	Initial increasing stress [rapid rehousing]	Rate	1000	Stress units/ Months	Assumed/Calculated to achieve dynamic equilibrium
	Max individual stress	Constant	10	Stress units/ Families	Assumed (Levine, 2000)
	Initial average stress when entering	Constant	6	Stress units/ Families	GMB
	Average time to decrease stress	Time constant	6	Months	GMB
Empowerment	Empowerment in services [emergency shelter]	Stock	3*120	Empowerment units	Assumed/Calculated (HMIS; families in services multiplied by average empowerment)
	Empowerment in services [transitional housing]	Stock	3*135	Empowerment units	Assumed/Calculated (HMIS; families in services multiplied by average

				empowerment)
Empowerment in services [rapid rehousing]	Stock	3*34	Empowerment units	Assumed/Calculated (HMIS; families in services multiplied by average empowerment)
Initial increasing empowerment [emergency shelter]	Rate	1000	Empowerment units/Months	Assumed/Calculated to achieve dynamic equilibrium
Initial increasing empowerment [transitional housing]	Rate	1000	Empowerment units/Months	Assumed/Calculated to achieve dynamic equilibrium
Initial increasing empowerment [rapid rehousing]	Rate	1000	Empowerment units/Months	Assumed/Calculated to achieve dynamic equilibrium
Max individual empowerment	Constant	10	Empowerment units/Families	Assumed (Levine, 2000)
Initial average empowerment when entering	Constant	3	Empowerment units/Families	GMB
Average time to decrease empowerment	Time constant	1	Months	GMB

APPENDIX IV: Model Equations

Top-Level Model:

Caregiver_stress:

Stress_in_services[Emergency_shelter](t) = Stress_in_services[Emergency_shelter](t - dt) + (Increasing_stress[Emergency_shelter] + "Change_when_people_enter/exit"[Emergency_shelter] - Decreasing_stress[Emergency_shelter]) * dt {NON-NEGATIVE}

INIT Stress_in_services[Emergency_shelter] = 6*120 UNITS: Stress units

Stress_in_services[Transitional_housing](t) = Stress_in_services[Transitional_housing](t - dt) + (Increasing_stress[Transitional_housing] + "Change_when_people_enter/exit"[Transitional_housing] - Decreasing_stress[Transitional_housing]) * dt {NON-NEGATIVE}

INIT Stress_in_services[Transitional_housing] = 6*135 UNITS: Stress units

Stress_in_services[Rapid_rehousing](t) = Stress_in_services[Rapid_rehousing](t - dt) + (Increasing_stress[Rapid_rehousing] + "Change_when_people_enter/exit"[Rapid_rehousing] - Decreasing_stress[Rapid_rehousing]) * dt {NON-NEGATIVE}

INIT Stress_in_services[Rapid_rehousing] = 6*34 UNITS: Stress units

INFLOWS:

Increasing_stress[Short_term_housing] = Initial_rate_of_increasing_stress*Effect_of_crowding_on_stress {UNIFLOW} UNITS: Stress units/Months

"Change_when_people_enter/exit"[Short_term_housing] = (Families_in_services."Entering_short-term_housing_assistance"+Families_in_services.Reentering_STH)*Avg_stress_when_entering - Families_in_services.Exiting_STH*Avg_stress_in_services UNITS: Stress units/Months

OUTFLOWS:

Decreasing_stress[Short_term_housing] = Stress_in_services/Average_time_to_decrease_stress {UNIFLOW} UNITS: Stress units/Months

Average_time_to_decrease_stress = 6-STEP(5*Stress_reduction_ON, 60) UNITS: Months

Avg_stress_in_services[Short_term_housing] = Stress_in_services/Families_in_services.Families_in_short_term_housing UNITS: Stress units/Families

Avg_stress_when_entering = Initial_avg_stress_when_entering*Effect_of_unmet_need_on_stress UNITS: Stress units/Families

Effect_of_crowding_on_stress[Short_term_housing] = GRAPH(Families_in_services.Families_in_short_term_housing/System_capacity.Available_STH_units) (0.000, 1.000), (0.100, 1.000), (0.200, 1.023), (0.300, 1.065), (0.400, 1.168), (0.500, 1.424), (0.600, 1.622), (0.700, 1.866), (0.800, 1.954), (0.900, 2.000), (1.000, 2.000) UNITS: dmnl

Effect_of_unmet_need_on_stress = GRAPH(Families_in_services."Gap_in_services/_Unmet_need") (0, 1.0050), (7500, 1.0550), (15000, 1.1125), (22500, 1.1575), (30000, 1.1975), (37500, 1.2250), (45000, 1.2400), (52500, 1.2500), (60000, 1.2600), (67500, 1.2600), (75000, 1.2600) UNITS: dmnl

Initial_avg_stress_when_entering = 6 UNITS: Stress units/Families
Initial_increasing_stress[Short_term_housing] = 1000 UNITS: Stress units/Months
Initial_rate_of_increasing_stress[Short_term_housing] = ((Max_stress-Stress_in_services)/Max_stress)*
Initial_increasing_stress UNITS: Stress units/Months
Max_individual_stress = 10 UNITS: Stress units/Families
Max_stress[Emergency_shelter] =
Families_in_services.Families_in_short_term_housing[Emergency_shelter]*Max_individual_stress UNITS: Stress units
Max_stress[Transitional_housing] =
Families_in_services.Families_in_short_term_housing[Transitional_housing]*Max_individual_stress UNITS: Stress units
Max_stress[Rapid_rehousing] =
Families_in_services.Families_in_short_term_housing[Rapid_rehousing]*Max_individual_stress UNITS: Stress units
Stress_reduction_ON = 0 UNITS: dmnl

Empowerment:
 Empowerment[Emergency_shelter](t) = Empowerment[Emergency_shelter](t - dt) +
(Increasing_empowerment[Emergency_shelter] +
"Change_in_empowerment_when_families_enter/exit"[Emergency_shelter] -
Decreasing_empowerment[Emergency_shelter]) * dt {NON-NEGATIVE}
  INIT Empowerment[Emergency_shelter] = 3*120 UNITS: Empowerment units
Empowerment[Transitional_housing](t) = Empowerment[Transitional_housing](t - dt) +
(Increasing_empowerment[Transitional_housing] +
"Change_in_empowerment_when_families_enter/exit"[Transitional_housing] -
Decreasing_empowerment[Transitional_housing]) * dt {NON-NEGATIVE}
  INIT Empowerment[Transitional_housing] = 3*135 UNITS: Empowerment units
Empowerment[Rapid_rehousing](t) = Empowerment[Rapid_rehousing](t - dt) +
(Increasing_empowerment[Rapid_rehousing] +
"Change_in_empowerment_when_families_enter/exit"[Rapid_rehousing] -
Decreasing_empowerment[Rapid_rehousing]) * dt {NON-NEGATIVE}
  INIT Empowerment[Rapid_rehousing] = 3*30 UNITS: Empowerment units
  INFLOWS:
    Increasing_empowerment[Short_term_housing] = Rate_of_increasing_empowerment {UNIFLOW}
UNITS: Empowerment units/Months
    "Change_in_empowerment_when_families_enter/exit"[Short_term_housing] =
(Families_in_services."Entering_short-

term_housing_assistance"+Families_in_services.Reentering_STH)*Avg_empowerment_when_entering-(Families_in_services.Exiting_STH*Avg_empowerment_in_services)

UNITS: Empowerment units/Months OUTFLOWS:

Decreasing_empowerment[Emergency_shelter] = (Empowerment[Emergency_shelter]/Avg_time_to_decrease_empowerment)*Effect_of_stress_on_reducing_empowerment_in_ES {UNIFLOW} UNITS: Empowerment units/Months

Decreasing_empowerment[Transitional_housing] = (Empowerment[Transitional_housing]/Avg_time_to_decrease_empowerment)*Effect_of_stress_on_reducing_empowerment_in_TH {UNIFLOW} UNITS: Empowerment units/Months

Decreasing_empowerment[Rapid_rehousing] = (Empowerment[Rapid_rehousing]/Avg_time_to_decrease_empowerment)*Effect_of_stress_on_reducing_empowerment_in_RRH {UNIFLOW} UNITS: Empowerment units/Months

Avg_empowerment_in_services[Short_term_housing] = Empowerment/Families_in_services.Families_in_short_term_housing UNITS: Empowerment units/Families

Avg_empowerment_when_entering = 3 UNITS: Empowerment units/Families

Avg_time_to_decrease_empowerment = 1 UNITS: Months

Effect_of_stress_on_reducing_empowerment_in_ES = GRAPH(Caregiver_stress.Avg_stress_in_services[Emergency_shelter])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.000), (6.00, 1.326), (7.00, 1.639), (8.00, 1.779), (9.00, 1.866), (10.00, 1.881) UNITS: dmnl

Effect_of_stress_on_reducing_empowerment_in_RRH = GRAPH(Caregiver_stress.Avg_stress_in_services[Rapid_rehousing])
(0.00, 1.002), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.000), (6.00, 1.634), (7.00, 1.799), (8.00, 1.878), (9.00, 1.903), (10.00, 1.910) UNITS: dmnl

Effect_of_stress_on_reducing_empowerment_in_TH = GRAPH(Caregiver_stress.Avg_stress_in_services[Transitional_housing])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.000), (6.00, 1.731), (7.00, 1.803), (8.00, 1.866), (9.00, 1.891), (10.00, 1.891) UNITS: dmnl

Initial_rate_of_increasing_empowerment[Short_term_housing] = 1000 UNITS: Empowerment units/Months

Max_empowerment[Short_term_housing] = Families_in_services.Families_in_short_term_housing*Max_individual_empowerment UNITS: Empowerment units

Max_individual_empowerment = 10 UNITS: Empowerment units/Families

Rate_of_increasing_empowerment[Short_term_housing] = ((Max_empowerment-Empowerment)/Max_empowerment)*Initial_rate_of_increasing_empowerment UNITS: Empowerment units/Months

Families_in_services:
Families_in_PSH(t) = Families_in_PSH(t - dt) + (Entering_PSH + Transition_to_PSH[Emergency_shelter] + Transition_to_PSH[Transitional_housing] + Transition_to_PSH[Rapid_rehousing] - Stabilizing_from_PSH) * dt {NON-NEGATIVE}
INIT Families_in_PSH = 200 UNITS: Families
INFLOWS:
Entering_PSH = Families_Needing_Services*FR_entering_PSH {UNIFLOW} UNITS: Families/Months
Transition_to_PSH[Emergency_shelter] = Families_in_short_term_housing*FR_transitioning_to_PSH {UNIFLOW} UNITS: Families/Months
Transition_to_PSH[Transitional_housing] = Families_in_short_term_housing*FR_transitioning_to_PSH {UNIFLOW} UNITS: Families/Months
Transition_to_PSH[Rapid_rehousing] = Families_in_short_term_housing*FR_transitioning_to_PSH {UNIFLOW} UNITS: Families/Months
OUTFLOWS:
Stabilizing_from_PSH = Families_in_PSH/Average_duration_of_PSH {UNIFLOW} UNITS: Families/Months
Families_in_short_term_housing[Emergency_shelter](t) = Families_in_short_term_housing[Emergency_shelter](t - dt) + ("Entering_short-term_housing_assistance"[Emergency_shelter] + Reentering_STH[Emergency_shelter] + Transition_from_ES_to_TH[Emergency_shelter] - Exiting_STH[Emergency_shelter] - Transition_to_PSH[Emergency_shelter]) * dt {NON-NEGATIVE}
INIT Families_in_short_term_housing[Emergency_shelter] = 120 UNITS: Families
Families_in_short_term_housing[Transitional_housing](t) = Families_in_short_term_housing[Transitional_housing](t - dt) + ("Entering_short-term_housing_assistance"[Transitional_housing] + Reentering_STH[Transitional_housing] + Transition_from_ES_to_TH[Transitional_housing] - Exiting_STH[Transitional_housing] - Transition_to_PSH[Transitional_housing]) * dt {NON-NEGATIVE}
INIT Families_in_short_term_housing[Transitional_housing] = 135 UNITS: Families
Families_in_short_term_housing[Rapid_rehousing](t) = Families_in_short_term_housing[Rapid_rehousing](t - dt) + ("Entering_short-term_housing_assistance"[Rapid_rehousing] + Reentering_STH[Rapid_rehousing] + Transition_from_ES_to_TH[Rapid_rehousing] - Exiting_STH[Rapid_rehousing] - Transition_to_PSH[Rapid_rehousing]) * dt {NON-NEGATIVE}
INIT Families_in_short_term_housing[Rapid_rehousing] = 30 UNITS: Families
INFLOWS:
"Entering_short-term_housing_assistance"[Emergency_shelter] = Families_Needing_Services*FR_of_entering_shelter {UNIFLOW} UNITS: Families/Months
"Entering_short-term_housing_assistance"[Transitional_housing] = Families_Needing_Services*FR_entering_TH {UNIFLOW} UNITS: Families/Months

"Entering_short-term_housing_assistance"[Rapid_rehousing] = Families_Needing_Services*FR_entering_RRH {UNIFLOW} UNITS: Families/Months

Reentering_STH[Emergency_shelter] = Families_no_longer_in_services*FR_ES_reentry {UNIFLOW} UNITS: Families/Months

Reentering_STH[Transitional_housing] = Families_no_longer_in_services*FR_TH_reentry {UNIFLOW} UNITS: Families/Months

Reentering_STH[Rapid_rehousing] = Families_no_longer_in_services*FR_RRH_rentry {UNIFLOW} UNITS: Families/Months

Transition_from_ES_to_TH[Emergency_shelter] = -Families_in_short_term_housing[Emergency_shelter]*FR_transition_ES_to_TH UNITS: Families/Months

Transition_from_ES_to_TH[Transitional_housing] = Families_in_short_term_housing[Emergency_shelter]*FR_transition_ES_to_TH UNITS: Families/Months

Transition_from_ES_to_TH[Rapid_rehousing] = 0 UNITS: Families/Months

OUTFLOWS:

Exiting_STH[Emergency_shelter] = Families_in_short_term_housing[Emergency_shelter]/Length_of_Stay.Average_length_of_stay[Emergency_shelter] {UNIFLOW} UNITS: Families/Months

Exiting_STH[Transitional_housing] = Families_in_short_term_housing[Transitional_housing]/Length_of_Stay.Average_length_of_stay[Transitional_housing] {UNIFLOW} UNITS: Families/Months

Exiting_STH[Rapid_rehousing] = Families_in_short_term_housing[Rapid_rehousing]/Length_of_Stay.Average_length_of_stay[Rapid_rehousing] {UNIFLOW} UNITS: Families/Months

Transition_to_PSH[Short_term_housing] = Families_in_short_term_housing*FR_transitioning_to_PSH {UNIFLOW} UNITS: Families/Months

Families_Needing_Services(t) = Families_Needing_Services(t - dt) + (New_families_at_risk - "Entering_short-term_housing_assistance"[Emergency_shelter] - "Entering_short-term_housing_assistance"[Transitional_housing] - "Entering_short-term_housing_assistance"[Rapid_rehousing] - Receiving_prevention - Entering_PSH - Giving_up) * dt {NON-NEGATIVE}

INIT Families_Needing_Services = 1000 UNITS: Families

INFLOWS:

New_families_at_risk = Initial_families_at_risk+(Giving_up*.25) {UNIFLOW} UNITS: Families/Months

OUTFLOWS:

"Entering_short-term_housing_assistance"[Emergency_shelter] = Families_Needing_Services*FR_of_entering_shelter {UNIFLOW} UNITS: Families/Months

"Entering_short-term_housing_assistance"[Transitional_housing] = Families_Needing_Services*FR_entering_TH {UNIFLOW} UNITS: Families/Months

"Entering_short-term_housing_assistance"[Rapid_rehousing] = Families_Needing_Services*FR_entering_RRH {UNIFLOW} UNITS: Families/Months

Receiving_prevention = Families_Needing_Services*FR_receiving_prevention {UNIFLOW} UNITS: Families/Months

Entering_PSH = Families_Needing_Services*FR_entering_PSH {UNIFLOW} UNITS: Families/Months

Giving_up = Families_Needing_Services*FR_giving_up {UNIFLOW} UNITS: Families/Months

Families_no_longer_in_services(t) = Families_no_longer_in_services(t - dt) + (Exiting_STH[Emergency_shelter] + Exiting_STH[Transitional_housing] + Exiting_STH[Rapid_rehousing] - Reentering_STH[Emergency_shelter] - Reentering_STH[Transitional_housing] - Reentering_STH[Rapid_rehousing] - Stabilizing_from_STH) * dt {NON-NEGATIVE}

INIT Families_no_longer_in_services = 500 UNITS: Families

INFLOWS:

Exiting_STH[Emergency_shelter] = Families_in_short_term_housing[Emergency_shelter]/Length_of_Stay.Average_length_of_stay[Emergency_shelter] {UNIFLOW} UNITS: Families/Months

Exiting_STH[Transitional_housing] = Families_in_short_term_housing[Transitional_housing]/Length_of_Stay.Average_length_of_stay[Transitional_housing] {UNIFLOW} UNITS: Families/Months

Exiting_STH[Rapid_rehousing] = Families_in_short_term_housing[Rapid_rehousing]/Length_of_Stay.Average_length_of_stay[Rapid_rehousing] {UNIFLOW} UNITS: Families/Months

OUTFLOWS:

Reentering_STH[Emergency_shelter] = Families_no_longer_in_services*FR_ES_reentry {UNIFLOW}
UNITS: Families/Months

Reentering_STH[Transitional_housing] = Families_no_longer_in_services*FR_TH_reentry {UNIFLOW}
UNITS: Families/Months

Reentering_STH[Rapid_rehousing] = Families_no_longer_in_services*FR_RRH_rentry {UNIFLOW}
UNITS: Families/Months

Stabilizing_from_STH = Families_no_longer_in_services*FR_stabilizing_from_services {UNIFLOW}
UNITS: Families/Months

Families_no_longer_receiving_prevention(t) = Families_no_longer_receiving_prevention(t - dt) + (Exiting_prevention - Reentering_prevention - Stabilizing_after_prevention) * dt {NON-NEGATIVE}

INIT Families_no_longer_receiving_prevention = 1 UNITS: Families

INFLOWS:

Exiting_prevention = Families_receiving_prevention/Average_duration_of_prevention_services {UNIFLOW}
UNITS: Families/Months
OUTFLOWS:
Reentering_prevention =
System_capacity.FR_reentering_prevention*Families_no_longer_receiving_prevention {UNIFLOW} UNITS:
Families/Months
Stabilizing_after_prevention = Families_no_longer_receiving_prevention*FR_of_stabilizing_after_prevention
{UNIFLOW} UNITS: Families/Months
Families_receiving_prevention(t) = Families_receiving_prevention(t - dt) + (Receiving_prevention +
Reentering_prevention - Exiting_prevention) * dt {NON-NEGATIVE}
INIT Families_receiving_prevention = 50 UNITS: Families
INFLOWS:
Receiving_prevention = Families_Needing_Services*FR_receiving_prevention {UNIFLOW} UNITS:
Families/Months
Reentering_prevention =
System_capacity.FR_reentering_prevention*Families_no_longer_receiving_prevention {UNIFLOW} UNITS:
Families/Months
OUTFLOWS:
Exiting_prevention = Families_receiving_prevention/Average_duration_of_prevention_services {UNIFLOW}
UNITS: Families/Months
Total_People_in_Homeless_Services(t) = Total_People_in_Homeless_Services(t - dt) + (Total_Entering_System +
Total_Reentering - Total_Exiting_System) * dt {NON-NEGATIVE}
INIT Total_People_in_Homeless_Services = 900 UNITS: Households
INFLOWS:
Total_Entering_System = Entry_rate {UNIFLOW} UNITS: Households/Months
Total_Reentering = Total_People_No_Longer_in_Services*FR_of_reentry {UNIFLOW} UNITS:
Households/Months
OUTFLOWS:
Total_Exiting_System = Total_People_in_Homeless_Services*FR_of_exit {UNIFLOW} UNITS:
Households/Months
Total_People_No_Longer_in_Services(t) = Total_People_No_Longer_in_Services(t - dt) + (Total_Exiting_System -
Total_Stabilizing - Total_Reentering) * dt {NON-NEGATIVE}
INIT Total_People_No_Longer_in_Services = 900 UNITS: Households
INFLOWS:
Total_Exiting_System = Total_People_in_Homeless_Services*FR_of_exit {UNIFLOW} UNITS:
Households/Months
OUTFLOWS:

Total_Stabilizing = Total_People_No_Longer_in_Services*FR_stabilizing {UNIFLOW} UNITS: Households/Months

Total_Reentering = Total_People_No_Longer_in_Services*FR_of_reentry {UNIFLOW} UNITS: Households/Months

Actual_time_in_services = Families_in_short_term_housing[Emergency_shelter]*Length_of_Stay.Average_length_of_stay[Emergency_shelter]+Families_in_short_term_housing[Transitional_housing]*Length_of_Stay.Average_length_of_stay[Transitional_housing]+Families_in_short_term_housing[Rapid_rehousing]*Length_of_Stay.Average_length_of_stay[Rapid_rehousing]+Families_in_PSH*Average_duration_of_PSH+Families_receiving_prevention*Average_duration_of_prevention_services UNITS: Families*Months

Average_duration_of_prevention_services = 5.2 UNITS: Months

Average_duration_of_PSH = 21 UNITS: Months

Avg_wait_for_prevention = 9 UNITS: Months

Avg_wait_for_PSH = 9 UNITS: Months

Avg_wait_for_RRH = 3 UNITS: Months

Avg_wait_for_shelter = 6 UNITS: Months

Avg_wait_for_TH = 3 UNITS: Months

Effect_of_wait_time_on_giving_up = GRAPH(Time_waiting_for_services)
(0, 0.220), (10000, 0.220), (20000, 0.280), (30000, 0.360), (40000, 0.520), (50000, 0.860), (60000, 1.140), (70000, 1.190), (80000, 1.210), (90000, 1.210), (100000, 1.210) UNITS: dmnl

Entry_rate = 50 UNITS: Households/Months

FR_entering_PSH = ((System_capacity.Available_PSH_units-Families_in_PSH)/System_capacity.Available_PSH_units) *(Prop_entering_PSH/Avg_wait_for_PSH) UNITS: 1/Months

FR_entering_RRH = ((System_capacity.Available_STH_units[Rapid_rehousing]-Families_in_short_term_housing[Rapid_rehousing])/System_capacity.Available_STH_units[Rapid_rehousing]) *(Prop_entering_RRH/Avg_wait_for_RRH) UNITS: 1/Months

FR_entering_TH = ((System_capacity.Available_STH_units[Transitional_housing]-Families_in_short_term_housing[Transitional_housing])/System_capacity.Available_STH_units[Transitional_housing]) *(Prop_entering_TH/Avg_wait_for_TH) UNITS: 1/Months

FR_ES_reentry = ((System_capacity.Available_STH_units[Emergency_shelter]-Families_in_short_term_housing[Emergency_shelter])/System_capacity.Available_STH_units[Emergency_shelter]) *Initial_FR_ES_reentry UNITS: 1/Months

FR_giving_up = Initial_FR_of_giving_up*Effect_of_wait_time_on_giving_up UNITS: 1/Months

FR_of_entering_shelter = ((System_capacity.Available_STH_units[Emergency_shelter]-Families_in_short_term_housing[Emergency_shelter])/System_capacity.Available_STH_units[Emergency_shelter]) *(Prop_entering_shelter/Avg_wait_for_shelter) UNITS: 1/Months

FR_of_exit = .1 UNITS: 1/Months

FR_of_reentry = .1 UNITS: 1/Months

FR_of_stabilizing_after_prevention = .75 UNITS: 1/Months

FR_receiving_prevention = ((System_capacity.Max_families_receiving_prevention-Families_receiving_prevention)/System_capacity.Max_families_receiving_prevention) *(Prop_entering_prevention/Avg_wait_for_prevention) UNITS: 1/Months

FR_RRH_rentry = ((System_capacity.Available_STH_units[Rapid_rehousing]-Families_in_short_term_housing[Rapid_rehousing])/System_capacity.Available_STH_units[Rapid_rehousing])*Initial_FR_RRH_reentry UNITS: 1/Months

FR_stabilizing = .1 UNITS: 1/Months

FR_stabilizing_from_services = .03 UNITS: 1/Months

FR_TH_reentry = ((System_capacity.Available_STH_units[Transitional_housing]-Families_in_short_term_housing[Transitional_housing])/System_capacity.Available_STH_units[Transitional_housing])*Initial_FR_TH_reentry UNITS: 1/Months

FR_transition_ES_to_TH = Initial_FR_of_transition_from_ES_to_TH*System_capacity."Step-down_ON"
  UNITS: 1/Months

FR_transitioning_to_PSH = 0+STEP(.25, 60)*System_capacity.Increasing_PSH_capacity_ON
  UNITS: 1/Months

"Gap_in_services/_Unmet_need" = Needed_time_in_services-Actual_time_in_services
  UNITS: Families*Months

Initial_families_at_risk = 150 UNITS: Families/Months

Initial_FR_ES_reentry = .1 UNITS: 1/Months

Initial_FR_of_giving_up = .001 UNITS: 1/Months

Initial_FR_of_transition_from_ES_to_TH = 0+STEP(0.03, 60) UNITS: 1/Months

Initial_FR_RRH_reentry = .075 UNITS: 1/Months

Initial_FR_TH_reentry = .075 UNITS: 1/Months

Needed_time_in_services = Actual_time_in_services + Time_waiting_for_services UNITS: Families*Months

Prop_entering_prevention = .61 UNITS: dmnl

Prop_entering_PSH = .024 UNITS: dmnl

Prop_entering_RRH = .038 UNITS: dmnl

Prop_entering_shelter = .27 UNITS: dmnl

Prop_entering_TH = .06 UNITS: dmnl

Reentry_rate = (Reentering_STH[Emergency_shelter]+Reentering_STH[Transitional_housing]+Reentering_STH[Rapid_rehousing]+Reentering_prevention)/Transitions_after_services UNITS: dmnl

Time_waiting_for_prevention = Families_Needing_Services*Prop_entering_prevention*Avg_wait_for_prevention
  UNITS: Families*Months

Time_waiting_for_PSH = Families_Needing_Services*Prop_entering_PSH*Avg_wait_for_RRH UNITS: Families*Months

Time_waiting_for_services = Time_waiting_for_PSH + Time_waiting_for_STH_services + Time_waiting_for_prevention UNITS: Families*Months

Time_waiting_for_STH_services = Families_Needing_Services*(Prop_entering_shelter*Avg_wait_for_shelter+Prop_entering_TH*Avg_wait_for_TH+Prop_entering_RRH*Avg_wait_for_RRH) UNITS: Families*Months

Transitions_after_services = Stabilizing_from_STH + SUM(Reentering_STH[*]) + Reentering_prevention + Stabilizing_from_PSH + Stabilizing_after_prevention UNITS: Families/Months

Length_of_Stay:

Average_length_of_stay[Emergency_shelter] = Initial_average_length_of_ES_stay*Effect_of_empowerment_on_ES_LOS*Pressure_on_staff.Pressure_on_staff*Effect_of_stress_on_avg_shelter_LOS UNITS: Months

Average_length_of_stay[Transitional_housing] = Initial_average_length_of_TH_stay*Effect_of_empowerment_on_TH_LOS*Effect_of_stress_on_avg_TH_LOS UNITS: Months

Average_length_of_stay[Rapid_rehousing] = Initial_average_length_of_RRH_stay*Effect_of_empowerment_on_RRH*Effect_of_stress_on_avg_RRH_LOS UNITS: Months

Effect_of_empowerment_on_ES_LOS = GRAPH(Empowerment.Avg_empowerment_in_services[Emergency_shelter])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.000), (6.00, 0.982), (7.00, 0.738), (8.00, 0.611), (9.00, 0.587), (10.00, 0.584) UNITS: dmnl

Effect_of_empowerment_on_RRH = GRAPH(Empowerment.Avg_empowerment_in_services[Rapid_rehousing])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.000), (6.00, 1.000), (7.00, 0.829), (8.00, 0.534), (9.00, 0.426), (10.00, 0.413) UNITS: dmnl

Effect_of_empowerment_on_TH_LOS = GRAPH(Empowerment.Avg_empowerment_in_services[Transitional_housing])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 0.998), (6.00, 0.960), (7.00, 0.760), (8.00, 0.515), (9.00, 0.460), (10.00, 0.450) UNITS: dmnl

Effect_of_stress_on_avg_RRH_LOS = GRAPH(Caregiver_stress.Avg_stress_in_services[Rapid_rehousing])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.095), (6.00, 1.332), (7.00, 1.771), (8.00, 1.849), (9.00, 1.857), (10.00, 1.859) UNITS: dmnl

Effect_of_stress_on_avg_shelter_LOS = GRAPH(Caregiver_stress.Avg_stress_in_services[Emergency_shelter])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.000), (6.00, 1.060), (7.00, 1.210), (8.00, 1.445), (9.00, 1.655), (10.00, 1.770) UNITS: dmnl

Effect_of_stress_on_avg_TH_LOS = GRAPH(Caregiver_stress.Avg_stress_in_services[Transitional_housing])
(0.00, 1.000), (1.00, 1.000), (2.00, 1.000), (3.00, 1.000), (4.00, 1.000), (5.00, 1.000), (6.00, 1.354), (7.00, 1.715), (8.00, 1.797), (9.00, 1.797), (10.00, 1.802) UNITS: dmnl
Initial_average_length_of_ES_stay = 1.5 UNITS: Months
Initial_average_length_of_RRH_stay = 5 UNITS: Months
Initial_average_length_of_TH_stay = 7 UNITS: Months

Pressure_on_staff =
GRAPH(Families_in_services.Families_in_short_term_housing[Emergency_shelter]/System_capacity.Total_ES)
(0.000, 1.000), (0.100, 1.000), (0.200, 1.000), (0.300, 1.000), (0.400, 1.000), (0.500, 1.037), (0.600, 1.250), (0.700, 1.521), (0.800, 1.761), (0.900, 1.824), (1.000, 1.835) UNITS: dmnl

System_capacity:
Available_prevention_resources(t) = Available_prevention_resources(t - dt) + (Prevention_funding - Prevention_spending) * dt {NON-NEGATIVE}
INIT Available_prevention_resources = 2000000 UNITS: Dollars
INFLOWS:
Prevention_funding = Initial_monthly_prevention_funding {UNIFLOW} UNITS: Dollars/Months
OUTFLOWS:
Prevention_spending =
Available_prevention_resources/Average_time_for_prevention_spending+Monthly_prevention_spending {UNIFLOW} UNITS: Dollars/Months
Available_PSH_units(t) = Available_PSH_units(t - dt) + (Net_change_in_PSH_availability + Increasing_PSH_capacity) * dt {NON-NEGATIVE}
INIT Available_PSH_units = 100 UNITS: Families
INFLOWS:
Net_change_in_PSH_availability = (Unavailable_PSH_units*Families_in_services.Stabilizing_from_PSH-Available_PSH_units*Families_in_services.Entering_PSH)/Total_PSH_units UNITS: Families/Months
Increasing_PSH_capacity = Rate_of_increasing_PSH_capacity {UNIFLOW} UNITS: Families/Months
Available_STH_units[Emergency_shelter](t) = Available_STH_units[Emergency_shelter](t - dt) + (Net_change_in_STH_availability[Emergency_shelter] + Increasing_STH_capacity[Emergency_shelter] + "Increasing_\"step-down\"_beds"[Emergency_shelter]) * dt {NON-NEGATIVE}
INIT Available_STH_units[Emergency_shelter] = 80 UNITS: Families
Available_STH_units[Transitional_housing](t) = Available_STH_units[Transitional_housing](t - dt) + (Net_change_in_STH_availability[Transitional_housing] + Increasing_STH_capacity[Transitional_housing] + "Increasing_\"step-down\"_beds"[Transitional_housing]) * dt {NON-NEGATIVE}
INIT Available_STH_units[Transitional_housing] = 67 UNITS: Families

Available_STH_units[Rapid_rehousing](t) = Available_STH_units[Rapid_rehousing](t - dt) + (Net_change_in_STH_availability[Rapid_rehousing] + Increasing_STH_capacity[Rapid_rehousing] + "Increasing_\"step-down\"_beds"[Rapid_rehousing]) * dt {NON-NEGATIVE}

INIT Available_STH_units[Rapid_rehousing] = 34 UNITS: Families

INFLOWS:

Net_change_in_STH_availability[Emergency_shelter] = (Unavailable_STH_units[Emergency_shelter]*(Families_in_services.Exiting_STH[Emergency_shelter]+Families_in_services.Transition_from_ES_to_TH[Emergency_shelter])/Total_ES)-(Available_STH_units[Emergency_shelter]*(Families_in_services."Entering_short-term_housing_assistance"[Emergency_shelter]+Families_in_services.Reentering_STH[Emergency_shelter])/Total_ES) UNITS: Families/Months

Net_change_in_STH_availability[Transitional_housing] = (Unavailable_STH_units[Transitional_housing]*(Families_in_services.Exiting_STH[Transitional_housing]/Total_TH))- (Available_STH_units[Transitional_housing]*((Families_in_services."Entering_short-term_housing_assistance"[Transitional_housing]+Families_in_services.Reentering_STH[Transitional_housing]+Families_in_services.Transition_from_ES_to_TH[Transitional_housing])/Total_TH)) UNITS: Families/Months

Net_change_in_STH_availability[Rapid_rehousing] = (Unavailable_STH_units[Rapid_rehousing]*(Families_in_services.Exiting_STH[Rapid_rehousing]/Total_RRH))-(Available_STH_units[Rapid_rehousing]*((Families_in_services."Entering_short-term_housing_assistance"[Rapid_rehousing]+Families_in_services.Reentering_STH[Rapid_rehousing])/Total_RRH)) UNITS: Families/Months

Increasing_STH_capacity[Short_term_housing] = Rate_of_increasing_STH_capacity {UNIFLOW} UNITS: Families/Months

"Increasing_\"step-down\"_beds"[Emergency_shelter] = 0 {UNIFLOW} UNITS: Families/Months

"Increasing_\"step-down\"_beds"[Transitional_housing] = Rate_of_increasing_TH {UNIFLOW} UNITS: Families/Months

"Increasing_\"step-down\"_beds"[Rapid_rehousing] = 0 {UNIFLOW} UNITS: Families/Months

Unavailable_PSH_units(t) = Unavailable_PSH_units(t - dt) + (- Net_change_in_PSH_availability) * dt {NON-NEGATIVE} INIT Unavailable_PSH_units = 200 UNITS: Families

OUTFLOWS:

Net_change_in_PSH_availability = (Unavailable_PSH_units*Families_in_services.Stabilizing_from_PSH-Available_PSH_units*Families_in_services.Entering_PSH)/Total_PSH_units UNITS: Families/Months

Unavailable_STH_units[Emergency_shelter](t) = Unavailable_STH_units[Emergency_shelter](t - dt) + (- Net_change_in_STH_availability[Emergency_shelter]) * dt {NON-NEGATIVE}

INIT Unavailable_STH_units[Emergency_shelter] = 120 UNITS: Families

Unavailable_STH_units[Transitional_housing](t) = Unavailable_STH_units[Transitional_housing](t - dt) + (- Net_change_in_STH_availability[Transitional_housing]) * dt {NON-NEGATIVE}

INIT Unavailable_STH_units[Transitional_housing] = 135 UNITS: Families

Unavailable_STH_units[Rapid_rehousing](t) = Unavailable_STH_units[Rapid_rehousing](t - dt) + (- Net_change_in_STH_availability[Rapid_rehousing]) * dt {NON-NEGATIVE}

INIT Unavailable_STH_units[Rapid_rehousing] = 34 UNITS: Families

OUTFLOWS:

Net_change_in_STH_availability[Emergency_shelter] = (Unavailable_STH_units[Emergency_shelter]*(Families_in_services.Exiting_STH[Emergency_shelter]+Families_in_services.Transition_from_ES_to_TH[Emergency_shelter])/Total_ES)-(Available_STH_units[Emergency_shelter]*(Families_in_services."Entering_short-term_housing_assistance"[Emergency_shelter]+Families_in_services.Reentering_STH[Emergency_shelter])/Total_ES) UNITS: Families/Months

Net_change_in_STH_availability[Transitional_housing] = (Unavailable_STH_units[Transitional_housing]*(Families_in_services.Exiting_STH[Transitional_housing]/Total_TH))- (Available_STH_units[Transitional_housing]*((Families_in_services."Entering_short-term_housing_assistance"[Transitional_housing]+Families_in_services.Reentering_STH[Transitional_housing]+Families_in_services.Transition_from_ES_to_TH[Transitional_housing])/Total_TH)) UNITS: Families/Months

Net_change_in_STH_availability[Rapid_rehousing] = (Unavailable_STH_units[Rapid_rehousing]*(Families_in_services.Exiting_STH[Rapid_rehousing]/Total_RRH))-(Available_STH_units[Rapid_rehousing]*((Families_in_services."Entering_short-term_housing_assistance"[Rapid_rehousing]+Families_in_services.Reentering_STH[Rapid_rehousing])/Total_RRH)) UNITS: Families/Months

Average_time_for_prevention_spending = 1 UNITS: Months

FR_reentering_prevention = ((Max_families_receiving_prevention-Families_in_services.Families_receiving_prevention)/Max_families_receiving_prevention)*Initial_FR_reentering_prevention UNITS: 1/Months

Increased_prevention_funding_ON = 0 UNITS: dmnl

Increasing_PSH_capacity_ON = 0 UNITS: dmnl

Increasing_STH_capacity_ON = 0 UNITS: dmnl

Initial_FR_reentering_prevention = .01 UNITS: 1/Months

Initial_monthly_prevention_funding = 83000+STEP(Prevention_funding_increase*Increased_prevention_funding_ON, 60) UNITS: Dollars/Months

Initial_rate_of_increasing_PSH_capacity = PULSE(300, 60, 140) UNITS: Families/Months

Initial_rate_of_increasing_STH_capacity[Emergency_shelter] = PULSE(200, 60, 140) UNITS: Families/Months

Initial_rate_of_increasing_STH_capacity[Transitional_housing] = PULSE(202, 60, 140) UNITS: Families/Months

Initial_rate_of_increasing_STH_capacity[Rapid_rehousing] = PULSE(68, 60, 140) UNITS: Families/Months

Max_families_receiving_prevention = Prevention_funding/Prevention_dollars_per_family UNITS: Families

Monthly_prevention_spending =
Prevention_dollars_per_family*Families_in_services.Families_receiving_prevention UNITS: Dollars/Months
Prevention_dollars_per_family = 1500 UNITS: Dollars/Families/Months
Prevention_funding_increase = 83000 UNITS: Dollars/Months
Rate_of_increasing_PSH_capacity = Initial_rate_of_increasing_PSH_capacity*Increasing_PSH_capacity_ON
  UNITS: Families/Months
Rate_of_increasing_STH_capacity[Short_term_housing] =
Initial_rate_of_increasing_STH_capacity*Increasing_STH_capacity_ON UNITS: Families/Months
Rate_of_increasing_TH = PULSE(202, 60, 140)*"Step-down_ON" UNITS: Families/Months
"Step-down_ON" = 0 UNITS: dmnl
Total_ES = Available_STH_units[Emergency_shelter] + Unavailable_STH_units[Emergency_shelter] UNITS:
Families
Total_PSH_units = Available_PSH_units + Unavailable_PSH_units UNITS: Families
Total_RRH = Available_STH_units[Rapid_rehousing] + Unavailable_STH_units[Rapid_rehousing] UNITS:
Families
Total_TH = Available_STH_units[Transitional_housing] + Unavailable_STH_units[Transitional_housing] UNITS:
Families
{ The model has 183 (289) variables (array expansion in parens).
 In root model and 6 additional modules with 1 sectors.
 Stocks: 15 (25) Flows: 31 (59) Converters: 137 (205)
 Constants: 42 (46) Equations: 126 (218) Graphicals: 19 (21)}

APPENDIX V: Experiments

Table A2 Parameter values for "business as usual" run and Experiments 1-4

Module	Variable	Experiment 1: Increased STH Capacity	Experiment 2: More "Next Step" Beds	Experiment 3: Increased PSH	Experiment 4: Increased Prevention	Experiment 5: Stress reduction
Families in Services	Initial families at risk	150	150	150	150	150
	Families at risk	1000	1000	1000	1000	1000
	Average wait for emergency shelter	6	6	6	6	6
	Proportion entering emergency shelter	0.27	0.27	0.27	0.27	0.27
	Average wait for transitional housing	3	3	3	3	3
	Proportion entering transitional housing	0.06	0.06	0.06	0.06	0.06
	Average wait for rapid rehousing	3	3	3	3	3
	Proportion entering rapid rehousing	0.038	0.038	0.038	0.038	0.038
	Average wait for permanent supportive housing	9	9	9	9	9
	Proportion entering permanent supportive housing	0.024	0.024	0.024	0.024	0.024
	Average wait for prevention	9	9	9	9	9
	Proportion receiving prevention	0.61	0.61	0.61	0.61	0.61
	Initial FR giving up	0.001	0.001	0.001	0.001	0.001
	Families in short-term housing [emergency shelter]	120	120	120	120	120
	Families in short-term housing [transitional housing]	135	135	135	135	135

	Families in short-term housing [rapid rehousing]	30	30	30	30	30
	Families receiving prevention	50	50	50	50	50
	Initial average length of ES stay	1.5	1.5	1.5	1.5	1.5
	Initial average length of TH stay	7	7	7	7	7
	Initial average length of RRH stay	5	5	5	5	5
	FR of transition from ES to TH	0	**0.05**	0	0	0
	Fractional rate of transition from STH to PSH	0	0	**0.25**	0	0
	Fractional rate of transition from STH to Prevention	0	0	0	**0.25**	0
	Families no longer receiving services	500	500	500	500	500
	Families in PSH	200	200	200	200	200
	Initial FR of ES reentry	0.1	0.1	0.1	0.1	0.1
	Initial FR of TH reentry	0.075	0.075	0.075	0.075	0.075
	Initial FR of RRH reentry	0.075	0.075	0.075	0.075	0.075
	FR stabilizing from STH services	0.03	0.03	0.03	0.03	0.03
	Average duration of PSH	21	21	21	21	21
	Initial FR reentering prevention	0.01	0.01	0.01	0.01	0.01
	FR stabilizing after prevention	0.75	0.75	0.75	0.75	0.75
System Capacity	Unavailable STH units [emergency shelter]	120	120	120	120	120
	Unavailable STH units [transitional housing]	135	135	135	135	135
	Unavailable STH units [rapid rehousing]	34	34	34	34	34
	Available STH units [emergency shelter]	**200**	80	80	80	80
	Available STH units [transitional housing]	**202**	**202**	67	67	67
	Available STH units [rapid rehousing]	**68**	34	34	34	34

	Unavailable PSH units	200	200	200	200	200
	Available PSH units	100	100	**200**	100	100
	Monthly prevention funding	83,000	83,000	83,000	**166,000**	83,000
	Available prevention resources	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
	Prevention dollars per family	1500	1500	1500	1500	1500
Caregiver Stress	Stress in services [emergency shelter]	6*120	6*120	6*120	6*120	6*120
	Stress in services [transitional housing]	6*135	6*135	6*135	6*135	6*135
	Stress in services [rapid rehousing]	6*34	6*34	6*34	6*34	6*34
	Initial increasing stress [emergency shelter]	1000	1000	1000	1000	1000
	Initial increasing stress [transitional housing]	1000	1000	1000	1000	1000
	Initial increasing stress [rapid rehousing]	1000	1000	1000	1000	1000
	Max individual stress	10	10	10	10	10
	Initial average stress when entering	6	6	6	6	6
	Average time to decrease stress	6	6	6	6	**1**
Empowerment	Empowerment in services [emergency shelter]	3*120	3*120	3*120	3*120	3*120
	Empowerment in services [transitional housing]	3*135	3*135	3*135	3*135	3*135
	Empowerment in services [rapid rehousing]	3*34	3*34	3*34	3*34	3*34
	Initial increasing empowerment [emergency shelter]	1000	1000	1000	1000	1000
	Initial increasing empowerment [transitional housing]	1000	1000	1000	1000	1000
	Initial increasing empowerment [rapid rehousing]	1000	1000	1000	1000	1000
	Max individual empowerment	10	10	10	10	10

Initial average empowerment when entering	3	3	3	3	3
Average time to decrease empowerment	1	1	1	1	1

APPENDIX VI: Sensitivity Analysis

Sensitivity analyses build confidence in the model structure. Parameter testing assesses how robust results are to changes in parameter values. Given that models are built using a combination of raw, calculated, and assumed parameters, it is important to assess whether particular parameter values rather than model structure are driving dynamics (Breierova & Choudhari, 2001; Sterman, 2002). Sensitivity tests on a number of initial values were run to assess the robustness of the model structure to parameter values.

I: Initial Families at Risk (0-1000)

The model was sensitive to the value of auxiliary variable "Initial families at risk." The initial assumed value of 150 families per month; however, a sensitivity analysis allowing this variable to vary from 0 to 1000 families per month showed the reentry rate was highly sensitive to the initial number of families (Figure A8). Given capacity constraints on the numbers of families who could enter services at any given time, reducing the number of new families entering *increased* the number of families who could reenter after exiting services. Conversely, increasing the number of new families entering services *reduced* the number of families who could reenter. Average length of stay in short-term housing services – particularly transitional housing – was also substantially decreased when the initial number of families seeking services dipped below 10. This likely occurred because when the initial families seeking services was low enough, crowding declined sufficiently to reduce stress and therefore reduce length of stay. Otherwise, crowding could not be reduced enough to have any impact on stress.

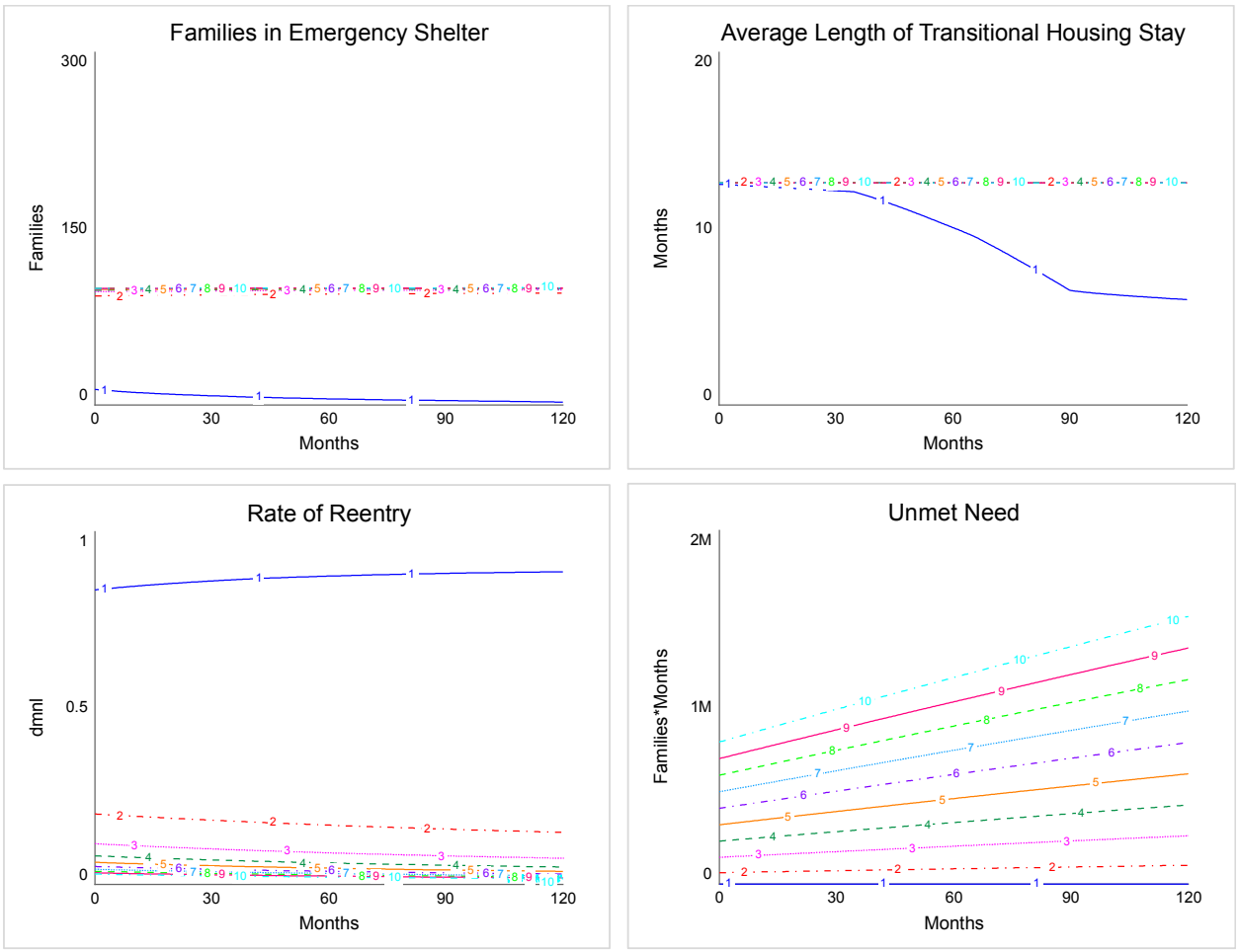


Figure A9. Results from Sensitivity Analysis I. "Initial families at risk" was allowed to vary from 0 to 1000 families per month.

Ia: Initial Families at Risk (0-50)

Qualitative changes in trends on key outcomes appeared to take place when the number of families at risk fell below 100, so a second analysis was conducted focusing on a narrower region. In Sensitivity Analysis Ia, "initial families at risk" was allowed to vary from 0 to 50 families per month. When the number of initial families at risk fell below 20 per month, the numbers of families in short-term housing programs declined over time; above this number of initial families, the number of families in services remained constant. Additionally, when the initial number of families at risk was below 20, the rate of reentry exceeded 0.5 for families who

had already exited. The average length of stay in short-term housing programs declined when fewer than 10 new families a month were at risk; above this number of families, average length of stay remained constant.

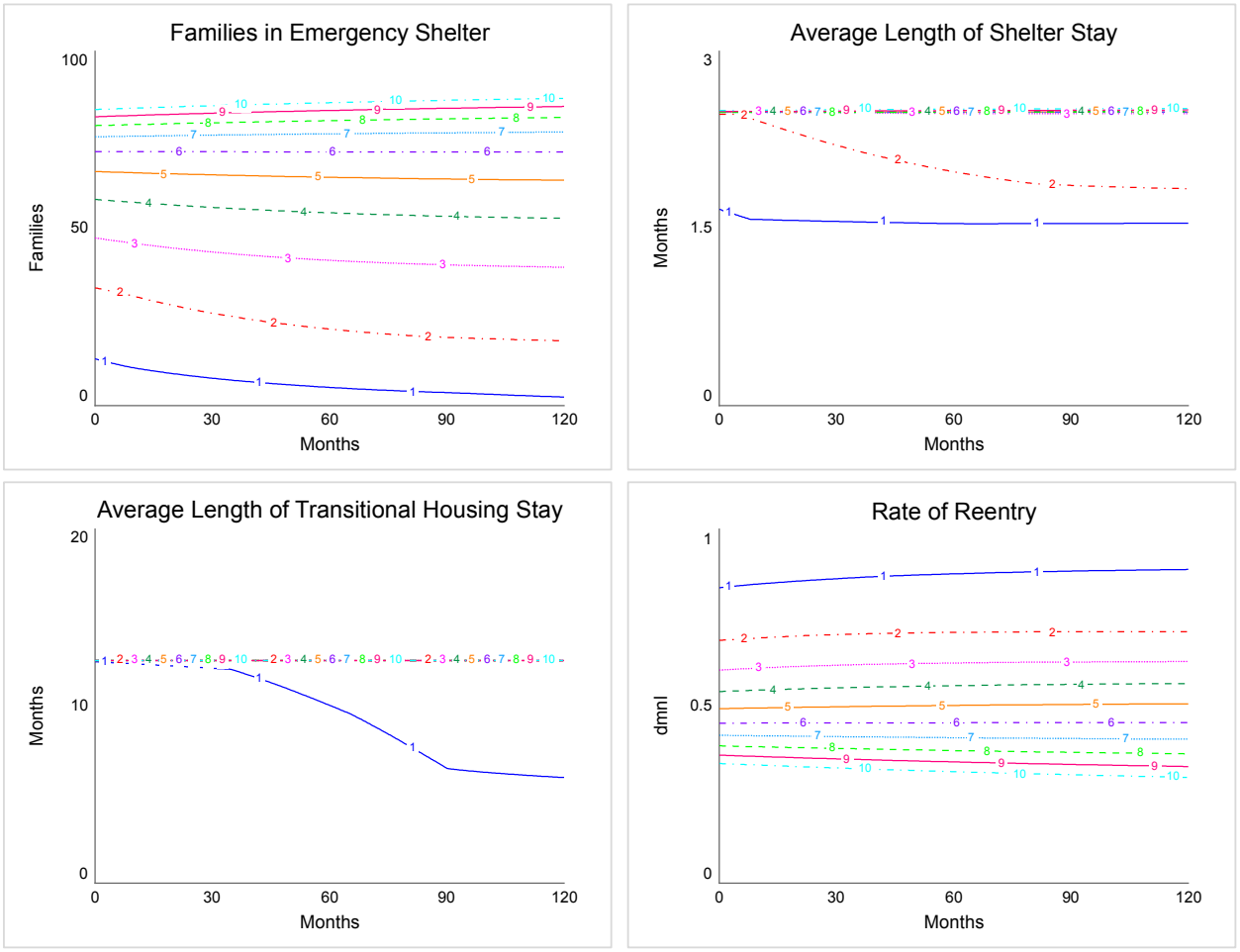


Figure A10. Results from Sensitivity Analysis Ia. "Initial families at risk" was allowed to vary from 0 to 50 families per month.

II. Families Needing Services

The initial value for the stock "families needing services" was assumed due to lack of data. A sensitivity analysis tested the impact of this assumption on model behavior by allowing the value to range from 1 to 10,000 (initial model value: 1,000) families. Results showed the model was insensitive to this initial value; there was no impact on families in services or average

lengths of stay, and only incremental changes in rate of reentry and unmet need; these trends did not differ qualitatively, suggesting the model behaved consistently regardless of the initial value.

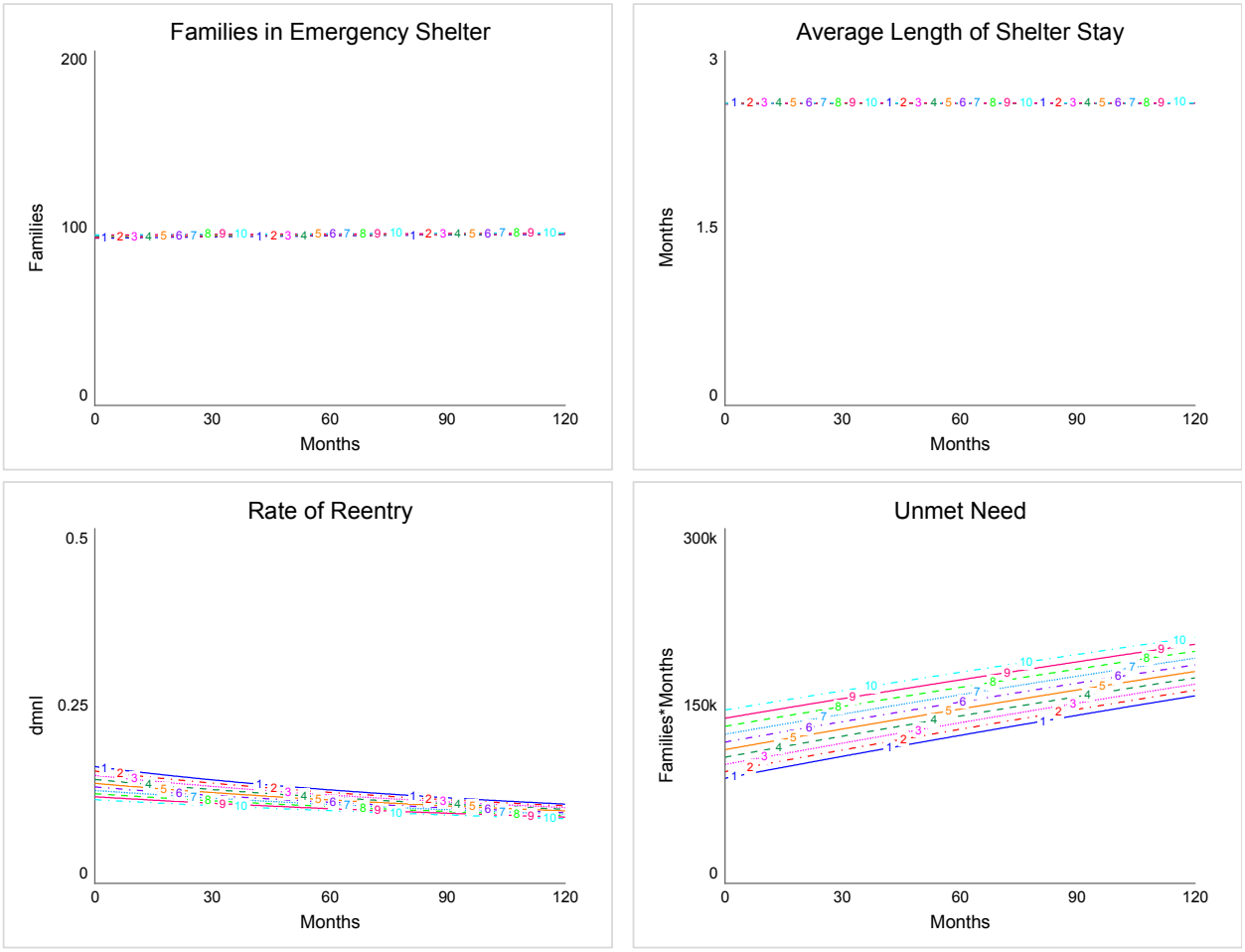


Figure A11. Results of Sensitivity Analysis II. The initial stock value of "Families needing services" was allowed to vary from 1 to 10,000 families.

III: Initial FR of Giving Up

The model assumed that a portion of families would "give up" and drop out of services if there was too much of a bottleneck at the entrance to services. Since no data were available on this phenomenon, the initial value was assumed to be low (0.001), and this was increased by wait times such that the more time families spent waiting for services, the more likely they were to drop out before receiving any. Additionally, it was assumed that system performance would

suffer as a result of long wait times because families who dropped out would be more likely to seek services again later. Thus, the rate of families dropping out increased the inflow of families entering. Given the assumed nature of these parameters, a sensitivity analysis was conducted on the initial fractional rate of giving up (Figure A12). Results showed when dropout was extremely low, the number of families in housing services increased as expected. The rate of reentry declined – likely due to capacity constraints; when more families entered services, there was less available space for families to reenter. An unintuitive finding was that when the likelihood of dropout was extremely small, system-wide unmet need increased dramatically; this indicated that the measure "unmet need" only captured that within the system, and dropout acted as a balance on accumulating unmet need. When families were more likely to drop out, system performance was mixed; reentry increased but unmet need decreased.

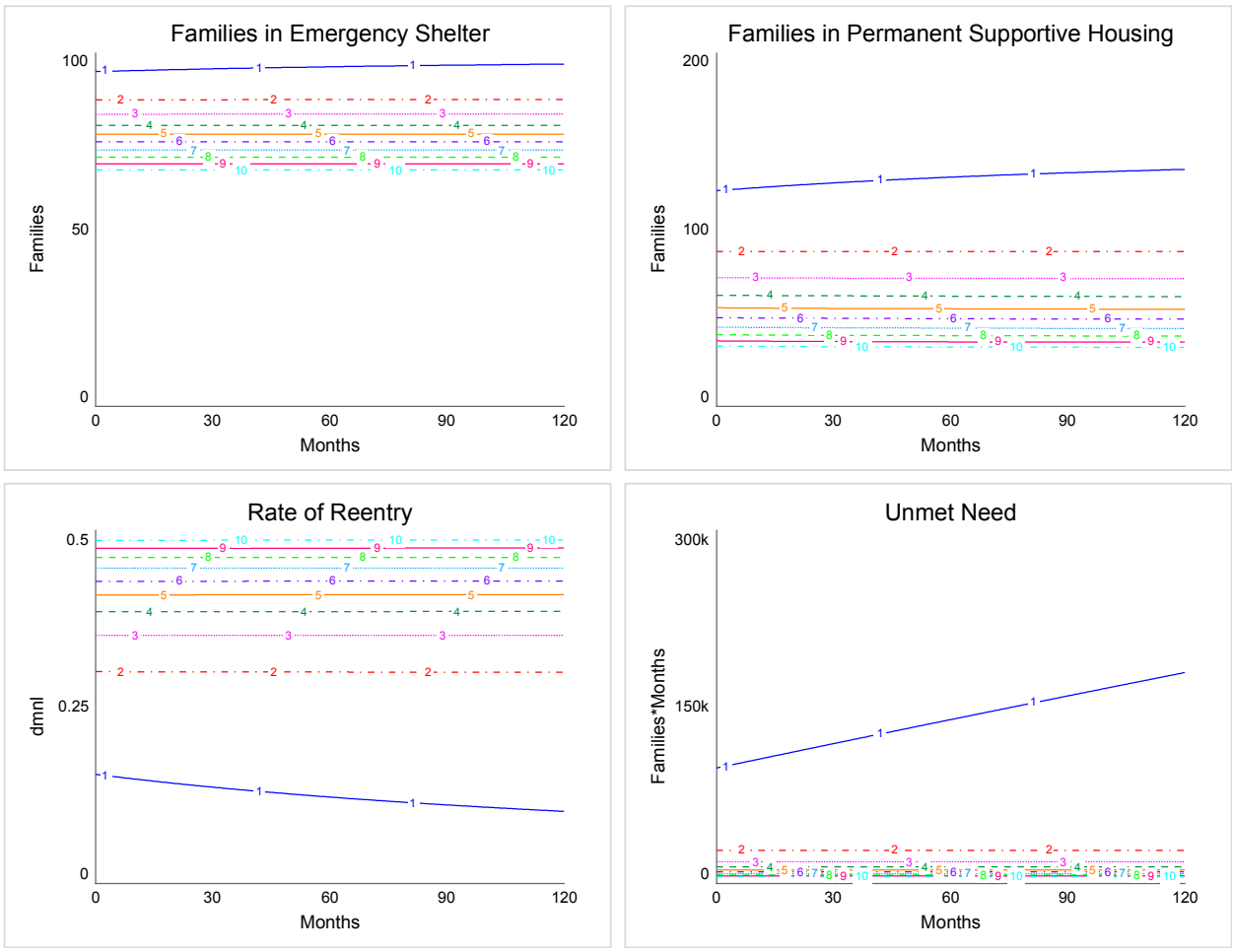


Figure A12. Results from Sensitivity Analysis II. "Initial FR of giving up" allowed to vary from 0.0001 to 1.

IV. Initial Prevention Funding

Initial prevention funding was obtained from budget reports of the Homelessness Prevention and Rapid Re-housing Program (HPRP; HUD, 2016). This analysis tested the impact of this value on system outcomes when initial prevention funding was allowed to vary from $1.00 to $10 million per month. Results showed that when fewer families were able to receive prevention services, more entered permanent supportive housing; this has important implications for service delivery, as families for whom prevention services are appropriate will differ significantly from those who would most benefit from permanent supportive housing services.

Lack of prevention funding increased the rate of reentry, but this declined over time. Finally, lack of prevention funding substantially increased unmet need, suggesting families were unable to get into appropriate services in a timely manner (Figure A13).

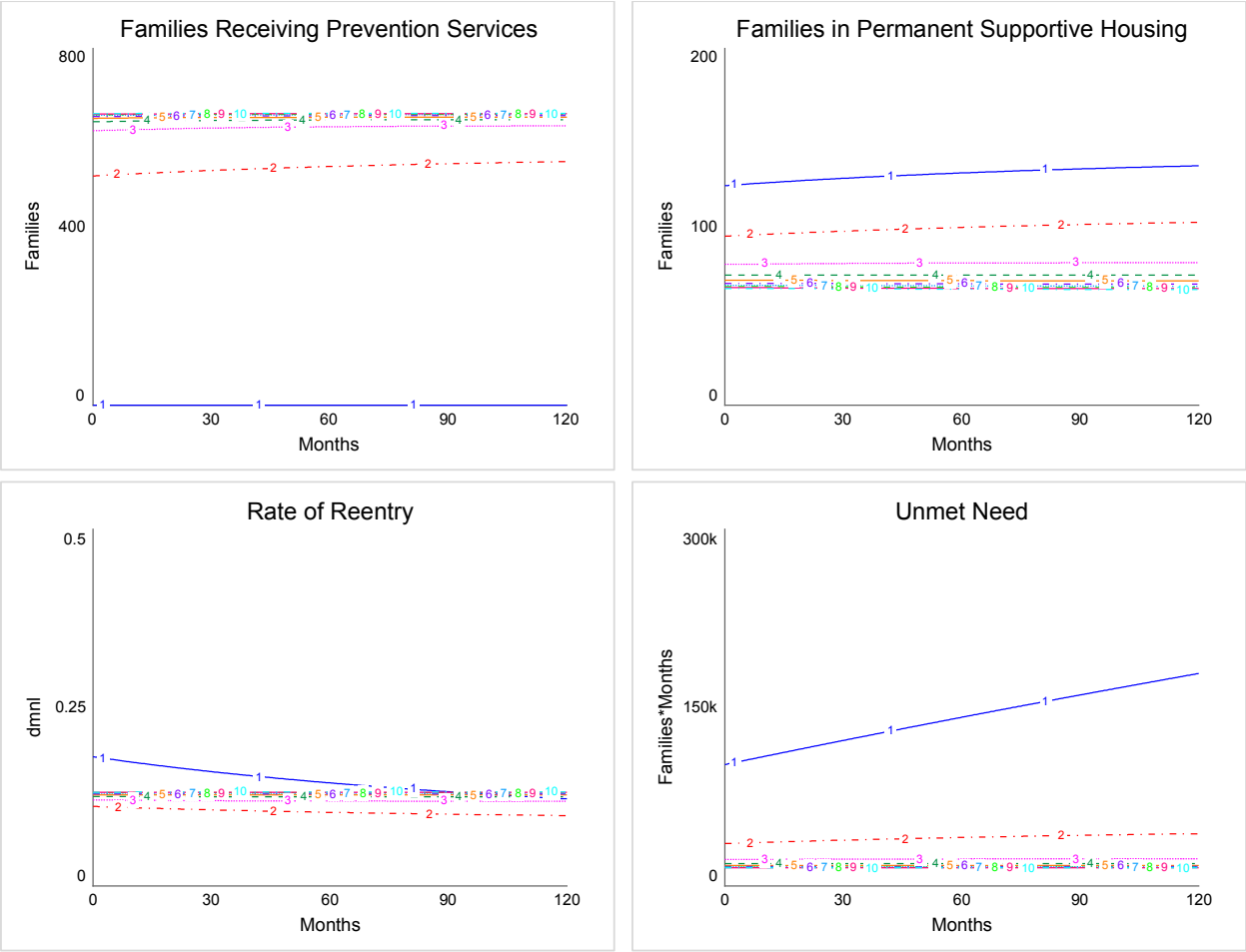


Figure A13. Results from Sensitivity Analysis III. "Initial monthly prevention funding" was allowed to vary from $1.00 to $10,000,000.

V. Stress

The "Caregiver Stress" module was calibrated through a combination of information from group model building and assumptions. A sensitivity analysis tested the impact of these assumptions on model behavior. Initial average stress when caregivers entered services was set at 6 stress units per person in the model (out of a maximum possible 10 stress units per person); the

sensitivity analysis allowed it to vary from 1 to 10. Results showed little impact on model behavior (Figure A14). Families in services, average length of stay, rate of reentry, and unmet need showed no qualitative changes in behavior over time trends.

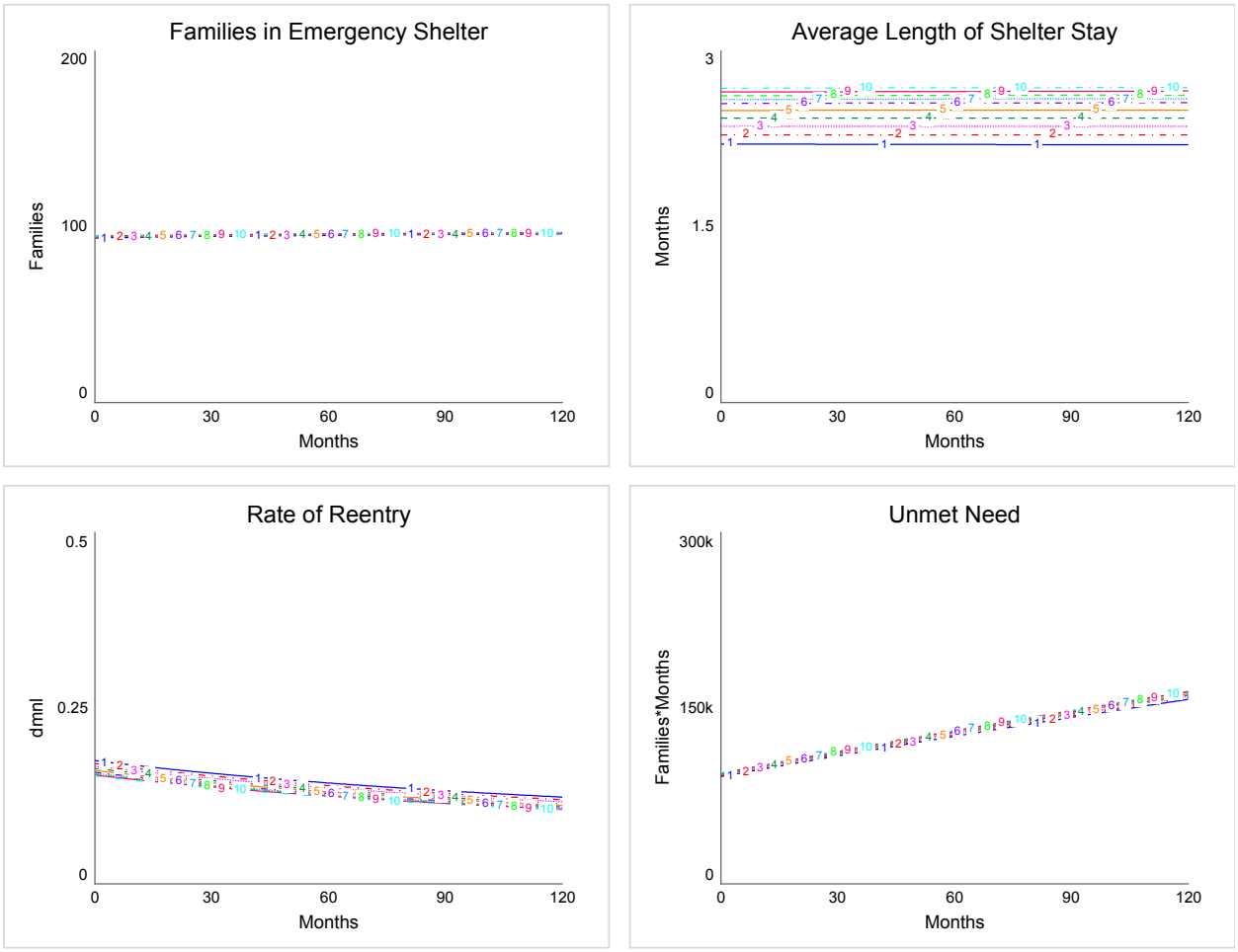


Figure A14. Results of Sensitivity Analysis V. "Initial average stress when entering" was allowed to range from 1 to 10 stress units per person.

VI. Empowerment

The "Caregiver Empowerment" module was calibrated through a combination of information from group model building and assumptions. A sensitivity analysis tested the impact of these assumptions on model behavior. Average empowerment when caregivers entered services was set at 3 empowerment units per person in the model (out of a maximum possible 10

empowerment units per person); the sensitivity analysis allowed it to vary from 1 to 10. Results showed little impact on model behavior (Figure A15). Families in services, average length of stay, rate of reentry, and unmet need showed no qualitative changes in behavior over time trends.

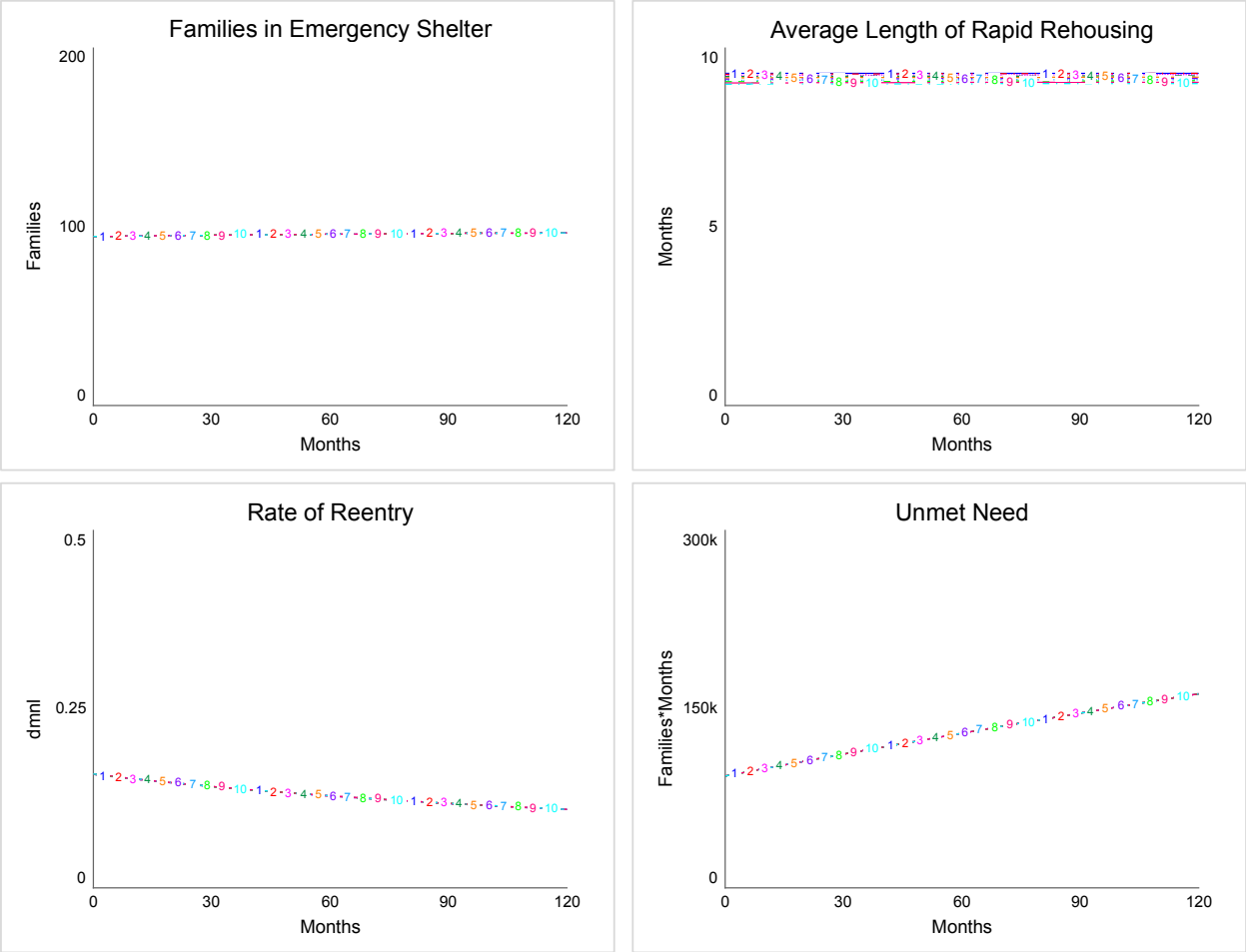


Figure A15. Results of Sensitivity Analysis VI. "Empowerment when entering" was allowed to vary from 1 to 10 empowerment units per person.