American Journal on Intellectual and Developmental Disabilities

Social network diversity and mental health among mothers of individuals with autism

--Manuscript Draft--

Manuscript Number:	AJIDD-D-21-00079R2
Article Type:	Research Report
Keywords:	Autism spectrum disorder; Social networks; Mothers; Mental Health; Adolescence and Adulthood
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Social Network Diversity and Mental Health among Mothers of Individuals with Autism

Abstract

The present study examined the associations between networks of social relationships and psychological well-being among mothers of adolescents and adults with autism (n = 352) over a 12-year period of time. A structural equation modeling approach was used to delineate the relative impacts of network size and relationship diversity on maternal mental health; and to assess whether such effects are bidirectional. Mothers with more diverse relationships experienced reductions in depression and anxiety symptoms over time, and the psychological benefits of diversity remained after adjusting for network size. Results also suggest bidirectional links between network size, diversity, and maternal mental health. Research and clinical implications are discussed.

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Introduction

The adverse psychological impacts associated with caring for a child with an autism spectrum disorder (ASD) are well-documented. Parents, especially mothers, raising children with ASD report greater levels of negative affect and worse emotional well-being compared to parents of children without disabilities (Smith et al., 2010; Totsika et al., 2011) and compared to parents of children with disabilities other than autism (Smith, Seltzer, et al., 2012; Totsika et al., 2011). Elevated rates of psychiatric morbidities have also been observed among parents of children with ASD (Karst & Van Hecke, 2012). Past research concerning the determinants of psychological adaptation in parents has largely focused on characteristics of the child, such as symptom severity and maladaptive behaviors (Rivard et al., 2014). There is increasing awareness of the cumulative impact of these stressors (Seltzer et al., 2010), as many parents continue to provide care as their children age into adolescence and adulthood (Marsack & Perry, 2018). Given the prevalence of ASD in the United States (Kogan et al., 2018), identifying resources to bolster parent well-being across the life course is of critical public health importance.

Social networks serve a key function in the pathways that link stress, coping, and health (Berkman et al., 2000; Thoits, 2011), yet their role in promoting well-being among parents of children with ASD is not well understood. The purpose of this study is to investigate the association between network factors and mental health among mothers of adolescents and adults with ASD. Conceptually, networks of social relationships play an important part in the coping process by facilitating the exchange of psychosocial and material resources. In this study, we focus on delineating the relative impacts of two interrelated network attributes: network size, or the *quantity* of mothers' relationships, and network diversity, or the *variety* in the types of mothers' relationships. The present analysis also examines bidirectional relationships between these network factors and maternal mental health.

Positive Adaptation as a Social Process

At least since Crnic et al. (1983) conceptualized family adaptation using a stress-and-coping framework, researchers have aimed to identify factors that promote positive outcomes in parents raising children with developmental disabilities (DDs). Recent studies have drawn attention to the ways in which parents' social contexts contribute to their well-being (Dembo et al., 2022; Marsack & Samuel, 2017). This work suggests that interactions of risk and protective factors across multiple levels – individual, family, community – shape parents' abilities to manage the challenges of caregiving. Interpersonal relationships are a mechanism that foster these cross-level interactions by facilitating social integration and by furnishing psychosocial resources (Berkman et al., 2000). Thus, examining whether and how social ties facilitate well-being becomes crucial to understanding positive adaptation in families of children with ASD.

Past research that considers the impacts of socio-contextual factors on parents of children with ASD primarily concentrates on social support. From a network perspective, support is a resource provided by social ties, and its receipt depends on the network in which an individual is embedded (Berkman et al., 2000). In other words, network relationships can be thought of as the channels connecting people to each other, with resources, such as support, flowing through them (Benson, 2012). Whereas social support studies are concerned with the nature, quality, or adequacy of the support resource, network research leverages information about the social ties that surround an individual, including attributes of the network and the people within it (e.g., Berkman et al., 2000). In the present study, we focus on networks themselves to further elucidate how social relationships facilitate well-being in parents of individuals with ASD.

Networks of Social Relationships and Mental Health

There is limited research examining the role that social network factors play with respect to the well-being of parents of children with ASD, though there is considerable evidence that

social connectedness has an important, positive impact on adults' mental health more broadly (Thoits, 2011). Individuals who are more socially integrated are reported to have greater subjective well-being (Litwin & Shiovitz-Ezra, 2011), lower levels of depression and anxiety (Domènech-Abella et al., 2019), and a reduced risk of suicide (Tsai et al., 2015).

Despite these findings in the general literature, the pathways through which network factors influence psychological well-being remain unclear. Part of this uncertainty may be because the measures used to assess social connectedness often emphasize the number, rather than the types, of relationships that comprise respondents' networks (Ali et al., 2018). The few network studies about families of children with ASD also largely focus on the quantity of parents' relationships. For example, an analysis by Barker et al. (2011) found that mothers of individuals with ASD who had larger social networks experienced less anxiety over time. Drawing from the same longitudinal study, Smith et al. (2012) showed network size to be associated with fewer depressive symptoms and increased positive affect. In a study of mothers of elementary school-aged children with ASD, Benson (2012) found that those with larger networks experienced greater well-being, though this effect was mediated by perceptions of support.

The research cited above suggests that, for mothers of individuals with ASD, having a greater number of relationships is psychologically beneficial. Theoretically, larger networks are salubrious because they provide an individual with access to more resources, fostering the perception that one has adequate support to manage exigent challenges (Cornwell et al., 2008; Haines et al., 2008). However, the extent that network size exerts positive health effects implicitly assumes that each social relation can fulfill similar support needs, regardless of their role in the network (Ali et al., 2018). Alternatively, it is possible that the resources flowing

through social ties vary based on the relationship between the focal individual (i.e., the mother) and the network member. Normative expectations associated with a relationship (e.g., spouse, friend) can permit or constrain a network member from fulfilling certain support functions (Agneessens et al., 2006). As such, network members with distinct relational roles may be differentially able to support mothers in a given circumstance.

Mothers of children with autism experience a range of different stressors and have a variety of support needs. Indeed, the challenges of caring for an individual with ASD are both acute and chronic (Seltzer et al., 2010), varying over time (Baker et al., 2011), and affect multiple aspects of parents' lives (Smith et al., 2010). Thus, there may be unique psychological benefits conferred to parents whose networks are comprised of a diverse set of role relationships. In addition to providing a variety of support resources, diverse networks may offer greater opportunities for social engagement and participation (Ali et al., 2018; Litwin & Shiovitz-Ezra, 2011). Prior studies have shown that parents of children with DDs who maintain high levels of social integration tend to exhibit better mental health outcomes (Dembo et al., 2022).

Network size and diversity are highly correlated: networks with more relationships have greater capacity to include a variety of relationship roles. This raises the question of whether larger networks, per se, are salutary or whether the benefits of network size partially capture the effects of having a diverse set of relationships. For example, Ali et al. (2018) found that older adults with larger networks had a lower risk of mortality and better physical functioning, but that these effects were attenuated after taking network diversity into account. Networks with diverse types of relationships, rather than simply a larger number of relationships, were associated with greater health benefits for the study's participants.

Little is known about how network diversity may promote well-being in mothers of individuals with ASD. Prior research in the general literature has identified positive consequences, mostly with respect to physical health, of having a variety of types of social relationships (Ali et al., 2018; Wu et al., 2018). In the present study, we focus on delineating the effects of network size and diversity on mothers' mental health.

Social Selection and Social Causation

Two primary mechanisms have been advanced to explain the association between social ties and mental health. The social causation hypothesis posits that interpersonal relationships, and the resources that they confer, influence individuals' mental health (e.g., Kaniasty & Norris, 2008). Past research in the ASD literature is largely aligned with this theoretical view insofar as it evaluates the *effects* of network characteristics *on* maternal mental health. In contrast to social causation, the social selection hypothesis considers whether well-being has an impact on an individual's ability to access social resources through personal contacts (Li & Zhang, 2015). Poor health may constrain opportunities for social participation and challenge one's capacity to maintain or form new social relationships (Kaniasty & Norris, 2008; Li & Zhang, 2015). A few studies of the general population have found that worse psychological well-being results in sparser social ties, with attenuating effects on both the size and the diversity of individuals' networks (Houtjes et al., 2014; Li & Zhang, 2015). Understanding whether there is a uni- or bidirectional relationship between network factors and well-being can further inform interventions about how best to support mothers of individuals with autism.

This Study

The purpose of this study was to analyze the relative effects of network size and diversity on mental health among mothers of adolescents and adults with ASD. Leveraging longitudinal data, we also tested the directional associations among these constructs. Our primary analysis

focused on maternal *depression*. In a supplemental analysis, we also considered the associations between network factors and maternal *anxiety* [materials for the supplemental analysis are provided here: https://minds.wisconsin.edu/handle/1793/82995].

Drawing on the literature reviewed above, we hypothesized that: (1) larger networks would be associated with lower levels of depression; (2) greater network diversity would be associated with lower levels of depression; (3) the effect of network size on maternal depression would be reduced after taking network diversity into account; (4) the association between networks and maternal depression would be bidirectional, such that mothers with more depression symptoms would have smaller and less diverse networks. We expected the associations between network size/diversity and maternal *anxiety* to be similar to those hypothesized for depression.

Methods

Data and Sample

The data were collected as part of a longitudinal study of 406 adolescents and adults with autism and their families, conducted between 1998 and 2014. Families were recruited through service agencies, schools, and diagnostic clinics (masked). Our analysis draws cases from the same overall sample as two prior studies that examined aspects of social relationships and maternal well-being (Barker et al., 2011; Smith, Greenberg, et al., 2012). Half of the sample participants lived in Wisconsin (n=202) and half in Massachusetts (n=204). There were three initial inclusion criteria for the study: (1) the family had a child 10 years of age or older; (2) the (adolescent or adult) child had received a diagnosis on the autism spectrum (Autistic Disorder, Asperger's Disorder, Pervasive Developmental Disorder–Not Otherwise Specified) from a health or educational professional, as reported by parents; and (3) the child had a researcher-

administered Autism Diagnostic Interview-Revised (ADI-R) (Lord et al., 1994) profile consistent with their diagnosis. The age range of the adolescents and adults was 10 to 52 years at baseline.

The analysis for the present study included data from five time points, spanning 12 years: Wave 2 (2000-2001), Wave 3 (2002-2003), Wave 4 (2004-2005), Wave 7 (2007-2008), and Wave 9 (2011-2012). Data from Waves 1, 5, 6, and 8 were omitted because respondents were not asked the same set of questions about their social relationships as in the other time points. In the present study, we refer to Waves 2, 3, 4, 7 and 9 as Times 1 to 5 (or T1 - T5), respectively. Data at each wave were collected via self-administered questionnaire and an in-home interview. Mothers were administered the network instrument during the interview portion of the study. Data collection procedures were approved by the Institutional Review Board at [masked]. Written informed consent was obtained from all participants at each point of data collection.

There were 372 families who participated in at least one of the time points used in this study. Cases in which someone other than the mother (e.g., the father) was the respondent were omitted from the sample (n=11). There were some mothers who provided information on more than one child with an ASD. One child was randomly selected to serve as the "focal child" and the others were dropped (n=9). The final sample included 352 mothers. The number of participants at each time point was: 339 (T1), 325 (T2), 293 (T3), 236 (T4), and 201 (T5). Maternal sociodemographic characteristics are summarized in Table 1. The average age of mothers at T1 was 52 years; nearly three-quarters of mothers were married at each time point; and approximately half had a college or graduate degree.

Measures

Network Size and Diversity

To measure aspects of respondents' networks of social relationships, the interview instrument incorporated questions adapted from Antonucci and Akikyama's (1987) social

convoy model. This portion of the interview began with a *name generator* to elicit the names of people comprising mothers' networks. At the baseline survey, each mother was asked to list individuals with whom she felt "a special bond" and who were "close and important" to her. During subsequent periods of data collection, mothers were shown the roster of names from the prior wave and asked whether those listed were still the most important people in the network, and if there were any other people they wanted to add. Up to 10 network members could be listed. Each network member was categorized by relationship type: spouse; child; sibling; parent; in-law; other relative; friend; and professional. *Network size* was measured as the number of individuals named at each time point. *Network diversity* was calculated as the number of different types of relationships represented in the mother's network.

Maternal Mental Health

Depression. The 20-item Center for Epidemiologic Studies – Depression Scale (CES-D; Radloff, 1977) measured mothers' depressive symptoms at each time point. For each item, respondents reported the frequency with which they experienced the depressive symptom in the past week, from 0 (*never*) to 3 (*5-7 days*). The theoretical range of the scale is from 0 to 60. Across the five time points, the alpha coefficients for the CES-D were between 0.91 and 0.93. Depression was modeled as a continuous variable.

Covariates

Characteristics of Adolescents and Adults with ASD. The models included several time-varying and -invariant characteristics of the focal child. These variables were selected based on prior research to control for their potential relationship with mothers' networks and mental health (Barker et al., 2011; Benson, 2012; Smith, Greenberg, et al., 2012; Totsika et al., 2011).

Intellectual Disability (time invariant). Intellectual disability (ID) was assessed by several sources. Trained interviewers determined the adolescent or adult's IQ with the Wide

Range Intelligence Test (WRIT; Glutting, Adams, & Sheslow, 2000); the Vineland screener (Sparrow et al., 1993) was administered to mothers to assess the adolescent or adult's adaptive behavior. Consistent with diagnostic guidelines (Luckasson et al., 2002), individuals were classified as having an ID if they had a standard score of 70 or below on both the WRIT and Vineland instruments (0=does not have ID, 1=has ID).

Behavior Problems and Autism Symptoms (time varying). At each time point, mothers completed the Behavior Problem subscale of the Scales of Independent Behavior-Revised (SIB-R; Bruininks, Woodcock, Weatherman, & Hill, 1996). Mothers reported on eight categories of behavior problems spanning three domains: internalizing (hurtful to self, unusual or repetitive habits, withdrawal or inattentive), externalizing (hurtful to others, destructive to property, disruptive) and asocial behavior (socially offensive, uncooperative). Mothers rated the frequency and severity with which their child displayed each behavior. Standardized algorithms (Bruininks et al., 1996) were then used to translate the ratings into an overall maladaptive behavior score. Higher scores on the SIB-R measure indicate worse maladaptive behavior. The SIB-R has demonstrated satisfactory reliability and validity (Bruininks et al., 1996).

The ADI-R (Lord et al., 1994) was used to measure autism symptoms at each time point. Interviewers administered 33 items from the diagnostic algorithm that were deemed appropriate for adolescents and adults. Items were scored by a trained interviewer on a scale from 0 (no impairment) to 3 (severe impairment). Inter-rater agreement among interviewers and supervising psychologists averaged 89% at baseline (mean Kappa=0.81). Based on the recommendation of Lord et al. (1994), scores of 3 were recoded to 2. A summary score was then calculated, with higher scores reflecting more severe impairments in social reciprocity, repetitive behaviors and stereotyped interests, and communication. Verbal items were excluded from the overall summary

measure so scores could be calculated for non-verbal individuals. The satisfactory psychometric properties of the ADI-R have been previously documented (Hill et al., 2001).

Residential Status (time varying). All models controlled for the residential status of the child, measured at each wave (0=child lived elsewhere, 1=child lived with the mother).

Child's Sex. We also controlled for the sex of the focal child (0=male, 1=female).

Characteristics of Mothers. Several characteristics of the mothers were included as covariates.

Sociodemographic Controls. The models controlled for mothers' marital status, as marriage may confer psychological benefits (Smith, Greenberg, et al., 2012) and impact personal network characteristics (Cornwell et al., 2008). Marital status was treated as a time-varying covariate (0=not married, 1=married). Models controlled for educational attainment because it is positively correlated with larger networks (Cornwell et al., 2008) and is protective for psychological well-being (Clarke et al., 2011). Mothers' highest level of education, measured at baseline, was included as a time-invariant covariate (0=high school or less; 1=some college; 2=college degree; 3=graduate degree). We controlled for the mother's age rather than the child's age; the two are highly correlated (r=0.87) but the former relates to the study's unit of analysis.

Network Confounders. The models controlled for two additional network characteristics: proportion of network members who (1) are female and (2) reside with the mother. Prior research suggests that individuals are more likely to discuss health concerns with network members who are female and with those who are co-residing (Cornwell et al., 2009). Women have also been shown to be more likely than men to take responsibility for the well-being of others (Haines et al., 2008); and the presence of co-residing network members may reduce the need for support from other sources (Goldman, 2020). The proportions of female and co-residing network

members have also been found to be correlated with other attributes of networks, including their size (Cornwell et al., 2009). We therefore controlled for these network characteristics as potential confounders. Both variables were transformed into quartiles due to skewness.

Analytic Strategy

The present study had three goals: (1) examine associations between network size and diversity and mental health in mothers of adolescents and adults with ASD; (2) evaluate the relative effects of network size and diversity on maternal mental health; (3) and discern whether these associations are bidirectional. We descriptively summarized changes in network size, diversity, and maternal mental health over the course of each respondent's participation in the study. Change was assessed relative to the standard deviation (SD) of each variable at the first time point it was measured: "increase" of at least half of a SD; "decrease" of at least half of a SD; or change of less than half of a SD ("stable"). One-half of a SD is commonly used to represent a "medium" effect size in behavioral research (Kline, 2004) and is a magnitude of change considered to be clinically meaningful (Norman et al., 2003).

Two techniques are commonly employed when modeling causal relationships with longitudinal observational data (Allison et al., 2017; Williams et al., 2018), and each has complementary strengths and limitations. The first strategy aims to control for unmeasured characteristics (e.g., mixed models); this approach adjusts for unobserved confounding, but does not illuminate the direction of effects across time. The second strategy aims to control for lagged dependent variables (e.g., cross-lagged panel models); this approach can be useful in ascertaining the direction of causal relationships and to protect against reverse causation. However, in traditional cross-lagged models, unmeasured characteristics are not directly estimated, so it is not possible to distinguish the autoregressive effect from other sources of unobserved heterogeneity.

Standard modeling approaches that combine both strategies can lead to estimation problems, including biased coefficients (Allison et al., 2017).

We employed an innovative method, sometimes termed dynamic panel modeling, to fully leverage the longitudinal data *and* to overcome the challenges described above. Specifically, we address the key study aims by fitting a series of autoregressive cross-lagged regressions in a structural equation framework with maximum likelihood estimation (Allison et al., 2017; Williams et al., 2018). This method accommodates lagged endogenous regressors and random effects, providing a powerful vehicle to make more valid inferences regarding the causal direction between network factors and mental health. The lagged endogenous regressors account for state dependence and unobserved, between-person heterogeneity, reducing bias in the estimates of the other exogenous variables. The random effects were operationalized as a latent variable, controlling for unobservables assumed to be uncorrelated with time-varying covariates.

Separate models were estimated for each direction of effects (e.g., network size predicting depression; depression predicting network size); this approach tends to be more robust to misspecification (Allison et al., 2017) and, in our case, was required to achieve convergence. Figure 1 illustrates the dynamic panel model approach used to estimate the effects of network characteristics on maternal mental health with five time points.

[Figure 1 about here]

Four models were estimated as part of the main analysis: network size predicting depression; depression predicting network size; network diversity predicting depression; and depression predicting network diversity. We also conducted a supplemental analysis with a parallel set of four models that examined maternal anxiety (supplemental Tables S2-S4). All time-varying covariates were lagged by one unit to ensure that they were measured prior to the outcome. To relax the normality assumption, the models were fit with robust standard errors with

a sandwich variance estimator. The depression, behavior problems, and autism symptoms scales were standardized by unit variance for ease of interpretation and to aid in model convergence.

Bayesian information criteria (BIC) indicated that models with stationarity constraints were preferred to those that allowed effects to freely vary over time (available from authors). Thus, prospective associations between the same variables were set to be equal across waves. Several statistics were used to assess model fit: the root mean squared error of approximation (RMSEA), with a recommended cutoff of $\leq$.05 or .08; the standardized root mean squared residual (SRMR), with a recommended cutoff of $\leq$.08 or .09; and the comparative fit index (CFI) with a recommended cutoff of $\geq$ .95 (Hu & Bentler, 1999; Iacobucci, 2010). The analyses were conducted in Stata (StataCorp, 2019) using the *xtdpdml* command (Williams et al., 2018).

Attrition analysis. As with most longitudinal studies, there was panel attrition, due either to death or loss to follow-up. The models were fit with full information maximum likelihood to address missingness. This approach allowed all respondents to remain in the analytic sample; parameter estimates were derived from whatever information was available in the data, including partially observed cases. Concerning attrition, we compared the values of all study variables at T1 for mothers who remained in the study for all waves and mothers who attrited by T5. There were no differences between mothers who attrited and those who were retained with respect to mental health or network characteristics. Regarding other characteristics, at T1, retained mothers were respectively more likely to be married (79.20% *vs.* 70.0%, p=.054), to have a college or graduate degree (52.80% *vs.* 38.03%, p=.01), to be living with their child with ASD (69.04% *vs.* 50.70%, p=.001), and were younger (M=50.51 years *vs.* M=55.19 years, p<.001) than those who attrited. Each of these variables was controlled in the analysis.

Results

Descriptive Statistics

Table 1 presents descriptive statistics for the study variables. Regarding the adolescents and adults with autism (T1 mean age=23 years, range=11–53 years), co-residence with the mother declined over the course of the study, from 61.36% to 48.50%; 70.21% had an ID; and about a quarter were female. Mean behavior problems and autism symptoms varied modestly over time. On average, mothers listed between 7 and 8 network members and about 4 types of relationships at each time point. Mean depression scores increased from 12.09 at to 12.86 over the course of the study; at each wave, 25%–30% of the sample had CES-D scores ≥ 16, indicating risk for clinically significant depressive symptoms (Lewinsohn et al., 1997).

[Table 1 about here]

Table 2 describes changes in network size, diversity, and maternal depression over the course of each respondent's participation in the study. The predominant trend was one of stability, with 70.64% of respondents exhibiting limited change in network size, and 53.44% and 55.66% of respondents reporting stable levels of depression and network diversity, respectively. In terms of change that was observed, there was greater overall fluctuation (both increases and decreases) in levels of network diversity than in network size. Similar proportions of respondents experienced increases (24.26%) and decreases (22.30%) in depression.

[Table 2 about here]

There were several significant correlations among study variables, as measured at Time 1 (supplemental Table S1). Network size was moderately correlated with diversity ($r = .55$, $p<.001$). Correlations between network variables and maternal depression were weak but statistically significant (network size and depression $r = -.19$, $p<.001$; network diversity and depression $r = -.18$, $p=.001$).

Table 3 includes details about the relationship types that comprised mothers' networks at T1. The table also provides an indication of how network composition and role diversity are related. Spouses and friends were the most common types of relationships, with 75.61% of mothers naming the former and 91.16% naming the latter. More than half of the networks described at T1 included a child (60.06%) or a sibling (57.32%), whereas fewer included a parent (41.77%) or an in-law (36.89%). Extended kin (20.43%) and professionals (14.33%) were listed by respondents with the least frequency. As can be discerned in Table 3, networks that are more diverse also tend to include less common role relationships.

[Table 3 about here]

Multivariate Results

Network Size, Network Diversity, and Maternal Depression

Network size. Table 4 presents results of the models for network size and depression (models 1a and 1b). As indicated by the RMSEA, CFI, and SRMR, all models demonstrated good fit. The autoregressive effect of depression exhibited a weak trend (b=0.14, p=.091), indicating some variation in depression levels over time. Conversely, the autoregressive effect of network size is large (b=0.84, p<.001), suggesting temporal stability in this construct. There was a significant cross-lagged effect of network size on depression (b=-0.06, p=.001), controlling for prior depression levels. We also observed an association between earlier levels of depression and subsequent network size (b=-0.10, p=.017). Hence, depression had a deleterious *longitudinal* impact on the size of mothers' networks. Taken together, the cross-lagged effects from models 1a and 1b suggest that the relationship between network size and maternal depression is bidirectional. The cross-lagged associations between network size and *anxiety* followed a similar pattern as those for depression (supplemental Table S4).

[Table 4 about here]

Network diversity. Models 2a and 2b estimated the autoregressive and cross-lagged relationships for network diversity and depression (see Table 4). The models fit the data well, according to the RMSEA, CFI, and SRMR. With respect to the autoregressive effects, diversity was stable over time (b=0.76, p<.001) and, consistent with the findings from model 1a, depression was not (b=0.13, p=.11). Model 2a shows a significant negative cross-lagged association between prior diversity and subsequent depression (b=-0.08, p=.032). Concerning the reverse causal direction, the results of model 2b suggest that previous levels of depression were negatively associated with subsequent network diversity (b=-0.06, p=.009). Thus, there was a bidirectional relationship between network diversity and depression: having greater network diversity predicted decreases in depression symptoms over time, whereas higher scores on the depression scale predicted diminishing network diversity over time. The analysis of network diversity and maternal *anxiety* yielded similar results to the depression models. The anxiety model estimates are presented in supplemental Table S4.

Network Size versus Network Diversity

The results presented in Table 4 (model 1a) suggest benefits of having more network members; larger networks were associated with decreases in maternal depression. This effect, however, was not robust to the inclusion of network diversity. After diversity was taken into account (model 2a), the size of the coefficient for network size was attenuated by about half, from -0.06 (p=.001) to -0.03 (p=.064) when predicting depression. The supplemental analysis of anxiety resulted in a similar pattern (Table S4), such that, in both cases, adjustment for network diversity reduced the statistical association between network size and mental health (depression or anxiety) to a non-significant level. In contrast, network diversity was significantly associated with both depression and anxiety above and beyond the effects of network size. In sum, when

network size and network diversity are considered simultaneously, it is the latter and not the former that is protective for mothers' psychological well-being.

Other Results

Estimates of the covariates revealed several additional findings. Children's behavior problems were significantly associated with higher depression (models 1a, 2a). Mothers with a greater proportion of network members who were female at an earlier time point reported lower levels of depression, as did those with greater educational attainment (models 1a, 2a). None of the covariates were associated with network size (model 1b). However, mothers of adolescents and adults with ID had less diverse networks (model 2b). Network gender composition was also associated with diversity; having a greater proportion of network members who were female predicted a decrease in the number of different types of role relationships reported (model 2b).

Discussion

The purpose of this study was to investigate the associations between social network factors and mental health in a sample of mothers of adolescents and adults with ASD. Building on prior research, we examined the psychological impacts of two attributes of mothers' social contexts: network size and relationship role diversity. We also assessed the direction of these effects, applying an innovative method to longitudinal data collected over a 12-year period of time. This study contributes a greater understanding to the ways in which social relationships impact mothers' well-being, and sheds new light on the reciprocal associations between networks and mental health.

Larger networks have been shown to be psychologically protective for mothers of children with ASD (Barker et al., 2011; Smith, Greenberg, et al., 2012). The larger the network, the greater its capacity to include a variety of types of relationships; thus, a key contribution of this study is clarifying whether the mental health benefits are a function of network size, per se,

or whether they are derived from relationship role diversity. The findings suggest that mothers of individuals with ASD who have more diverse networks experience longitudinal improvements in mental health, controlling for network size, prior levels of psychological symptoms, and maternal and child characteristics. Further, the positive, psychological effects of network size were considerably attenuated once network diversity was taken into account.

These findings have important implications. Parents of children with autism and other DDs tend to be less socially active than other parents (Dembo et al., 2022); such gradients may widen in later life (Seltzer et al., 2011). Given the risks of isolation that these parents face as they age (Marsack & Perry, 2018), it is critical to discern which social factors are most helpful in buffering against the psychological consequences of lifelong caregiving. Importantly, the salutary nature of social connections extends beyond the amount of support that individuals receive. As this study demonstrates, networks play a meaningful role in linking interpersonal relationships to mental health, particularly as a result of the diversity of social ties. Therefore, strategies to improve social connectedness in this population should not only focus on increasing the quantity of network contacts. Rather, maintaining a broad range of relationship types may serve as a unique, adaptive resource for mothers of individuals with autism.

There are several plausible mechanisms that might explain the positive effects of network diversity. Interpersonal behaviors tend to be influenced by the normative expectations ascribed to social roles (Thoits, 2012). Thus, the coping resources to which a mother has access depend not only on the quantity – but also the diversity – of relationships in her network. Because individuals experience varying challenges and stressors, the types of supports available through a given relationship may be of benefit in certain circumstances but not in others. For example, mothers may turn to their friends for socialization and companionship (Agneessens et al., 2006)

but seek out kin to discuss health-related matters (Schafer, 2013) and for help making medical decisions (Cornwell et al., 2009). Mothers who can call upon a diverse set of relationships likely have greater access to the specific resources that meet their exigent support needs.

A related explanation for our findings is based on the positive association between multiple roles and well-being, which has been documented among mothers of children with DDs (Hong & Seltzer, 1995) and in the general population (Thoits, 2012). Those with a larger number of role identities are thought to experience greater meaning and purpose in life, perhaps because engaging in numerous types of relationships facilitates higher levels of personal mastery (Thoits, 2012). Future research could consider whether mothers' perceptions mediate the association between network diversity and mental health outcomes.

Network diversity may offer unique benefits to mothers as they age. Those in midlife and beyond are often tasked with coordinating their adolescent's transition out of secondary school (Taylor, 2009) and then with navigating the sparse service system for adults with autism (Laxman et al., 2019). Families commonly report a lack of age-appropriate programs (Taylor, 2009), which could contribute additional stress to caregivers. Maintaining a diverse network might be valuable for addressing these challenges. As Table 3 indicates, less frequently reported relationships – in-laws, extended kin, and professionals – tend to be included in highly diverse networks. Social connections that lay outside of one's immediate family may provide novel and non-redundant information (Schafer, 2013), and thus serve a distinct role in helping mothers identify crucial resources. Engaging with "weaker ties" in diverse networks could be an effective strategy toward reducing families' unmet needs for services and supports and, in turn, help to promote maternal well-being.

Using structural equation models, we sought to understand the direction of effects between network factors and maternal mental health, and thereby address a key limitation of prior research. To our knowledge, this is one of the first investigations into the directional nature of these associations in a sample of parents of individuals with autism. The longitudinal impacts of network diversity (and, to a lesser extent, network size) on psychological well-being lent support to the social causation hypothesis: specifically, that social relationships have an effect on maternal mental health. Importantly, we also find evidence that the connection between mental health and network factors are characterized by a selection mechanism. Increases in psychological symptoms were associated with reductions in network size and diversity over time, even after controlling for prior network characteristics and potential confounders. Hence, while networks size and diversity may promote positive adaptation, access to network resources, in part, depends on the status of mothers' mental health.

The findings from the bidirectional analysis are meaningful, both methodologically and practically. Much of the prior literature focused on social relationships and well-being among parents of children with ASD relies on cross-sectional data and is "vulnerable to misattributed causality" (Umberson et al., 2010, p. 12). When longitudinal data can be leveraged, it is crucial for research designs to explicitly model exogenous health effects so as not to overestimate the benefits of social relationships and to avoid reverse causation being the driver of observed associations (Haas et al., 2010). That network diversity was found to be psychologically advantageous even after controlling for reverse effects suggests it may constitute a robust resilience factor. The longitudinal impact of network size was also observed net its autoregressive effect; though, as we have discussed, the effect of larger networks was reduced after diversity was included in the model.

The bidirectional network relationships with mental health underscore the risks of a "vicious cycle" that some mothers might face. On the one hand, those with smaller and less diverse networks may endure adverse psychological outcomes. Poor mental health, in turn, can result in reductions in network size and diversity. On the other hand, programs targeting *either* mental health *or* networks may catalyze a positive, mutually bolstering feedback loop.

These results may be used to inform interventions. For example, network assessment tools can help mothers map out their current relationships and identify gaps therein. To augment diversity, family support practitioners might encourage mothers to identify and activate latent ties (e.g., reaching out to an extended relative) and to explore opportunities to meet new people (e.g., joining an organization). While promoting the mental health of parents is an important goal in its own right, there are also indirect consequences that should be considered. Consistent with transactional models of development, there is evidence that parents' own internalizing symptoms can negatively impact functioning and exacerbate behavior problems in children with ASD (Karst & Van Hecke, 2012). Furthermore, psychological distress has been shown to reduce the effectiveness of parent-delivered interventions and is linked with decreased parenting self-efficacy (Karst & Van Hecke, 2012). By improving parents' mental health, network interventions may enable those with long-term caregiving responsibilities to meet the needs of their children with ASD more effectively.

There were some notable results concerning the covariates. Behavior problems exhibited by the individual with ASD was a reliable predictor of maternal depression. Future studies might consider whether network qualities moderate the effects of difficult behaviors on caregivers' well-being. We also found that mothers with more education had fewer depressive symptoms, which may reflect socioeconomic variation in access to psychosocial resources. Regarding

network controls, mothers with networks composed of a larger proportion of women tended to report lower levels of depression. Gender composition of networks has been long been recognized as an important determinant of well-being in the general population (e.g., House, 1987), and was identified as such in this study.

Regarding predictors of mothers' networks, we found that having a child with an ID was associated with less network diversity. Individuals with ASD and ID tend to have greater functional impairments (Ouyang et al., 2014) and require a higher level of support from their parents compared to those with ASD alone (Saunders et al., 2015). As a result, mothers may have fewer opportunities for social engagement and limited abilities to maintain diverse social connections. Mothers with networks comprised of a greater proportion of females also had less diverse role relationships. Because the sample only included mothers, it is unclear whether this finding reflects network gender composition or gender homophily of the respondents. The other covariates included in the models were not significantly associated with mothers' networks, in contrast to some prior studies of the general population (e.g., Cornwell et al., 2008; Waite et al., 2021). According to the convoy model of social relations (Antonucci et al., 2010), social networks are impacted by life course experiences and role demands. Thus, it is possible that the predictors of network characteristics among mothers of children with ASD *differ* from those of the general population. Future research is needed to understand whether the determinants of mothers' networks vary based on the exposure to stressful parenting circumstances.

Several limitations in this study should be acknowledged. The sample was primarily comprised of non-Hispanic white mothers (93.81%) and, in this respect, was not representative of families of individuals with ASD (Kogan et al., 2018). Subsequent studies should consider the relationships between networks and mental health of mothers from diverse racial and ethnic

backgrounds. It is particularly important for future research to assess these associations in cultures that place different levels of emphasis on familial and community connectedness. The data included in these analyses were largely based on mothers' self-reports. Future studies that leverage other sources of information (e.g., mental health diagnoses in electronic medical records) can help corroborate these findings. The sample was comprised only of mothers, and there remains a glaring gap in knowledge regarding fathers of individuals with ASD. Additional research is needed to better understand fathers' networks, including their characteristics and mental health effects.

Other measures of network diversity could also be considered in future research, for example, to assess the varied support functions offered by different types of relationships. In addition, modes of communication have changed rapidly in recent years and data are needed to understand the role that virtual contacts play in supporting mothers of individuals with autism. Future studies should also consider whether associations between network resources and mental health vary with age, for example, by comparing the effects among mothers of adolescents to mothers of adults with ASD.

Finally, we note that different approaches are used in longitudinal research to elicit the names of network members. In this study, respondents were shown the roster of names from the prior wave of data collection and asked if those network members should be removed or retained, and whether there were new people who should be added. Reviewing one's network members from a previous wave may reduce recall bias and panel conditioning (Hogan et al., 2020). However, this method may also have biased the networks toward stability if respondents chose to retain network members out of convenience. The results of this study should be interpreted with these considerations in mind.

The present research also had several strengths. The study was comprehensive in many respects, and included a large sample of mothers observed over a 12-year period of time. Fluctuations in social life may occur slowly, and the study's duration provides an opportunity to detect determinants and consequences of changes in mothers' networks. Our use of dynamic panel models allows for strong inferences regarding the longitudinal relationships between social connectedness and well-being. Extensive past research has examined social support and engagement among parents of children with ASD and other DDs (Benson, 2012; Dembo et al., 2022; Marsack & Samuel, 2017). The present study adds to this literature by focusing on key network resources and the role that they play in promoting positive maternal outcomes. The findings contribute to a greater understanding of the complex, dynamic, and bidirectional links between contextual factors and maternal well-being in families who have a child with ASD.

Conclusion

The present study illustrates how social networks play a key role in fostering greater well-being among midlife and older mothers of individuals with autism. Parenting a child with autism poses a range of challenges which evolve over the life course. As such, there may be unique advantages to having a varied set of network contacts to draw upon for support. The findings presented here suggest that the mental health benefits of social ties may be more contingent upon the diversity, rather than only the quantity, of relationships. This study also provides evidence that, for mothers of individuals with autism, the links between network factors and mental health are bidirectional. Interventions that take these dynamic associations into account can help foster concomitant improvements in both social integration and psychological well-being.

References

Agneessens, F., Waege, H., & Lievens, J. (2006). Diversity in social support by role relations: A typology. *Social Networks*, *28*(4), 427–441. doi:10.1016/j.socnet.2005.10.001

Ali, T., Nilsson, C. J., Weuve, J., Rajan, K. B., & Mendes de Leon, C. F. (2018). Effects of social network diversity on mortality, cognition and physical function in the elderly: A longitudinal analysis of the Chicago Health and Aging Project. *Journal of Epidemiology and Community Health*, *72*(11), 990–996. doi:10.1136/jech-2017-210236

Allison, P. D., Williams, R., & Moral-Benito, E. (2017). Maximum likelihood for cross-lagged panel models with fixed effects. *Socius*, *3*, 1–17. doi:10.1177/2378023117710578

Antonucci, T. C., & Akiyama, H. (1987). Social networks in adult life and a preliminary examination of the convoy model. *Journal of Gerontology*, *42*(5), 519–527. doi:10.1093/geronj/42.5.519

Antonucci, T. C., Fiori, K. L., Birditt, K., & Jackey, L. M. H. (2010). Convoys of social relations: Integrating life-span and life-course perspectives. In *The handbook of life-span development* (pp. 434–473). John Wiley & Sons. doi:10.1002/9780470880166.hlsd002012

Baker, J. K., Seltzer, M. M., & Greenberg, J. S. (2011). Longitudinal effects of adaptability on behavior problems and maternal depression in families of adolescents with autism. *Journal of Family Psychology*, *25*(4), 601–609. doi:10.1037/a0024409

Barker, E. T., Hartley, S. L., Seltzer, M. M., Floyd, F. J., Greenberg, J. S., & Orsmond, G. I. (2011). Trajectories of emotional well-being in mothers of adolescents and adults with autism. *Developmental Psychology*, *47*(2), 551–561. doi:10.1037/a0021268

Benson, P. R. (2012). Network characteristics, perceived social support, and psychological adjustment in mothers of children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *42*(12), 2597–2610. doi:10.1007/s10803-012-1517-9

Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine*, *51*(6), 843–857.

Bruininks, R. H., Woodcock, R. W., Weatherman, R. F., & Hill, B. K. (1996). *Scales of Independent Behavior-Revised*. Riverside.

Clarke, P., Marshall, V., House, J., & Lantz, P. (2011). The social structuring of mental health over the adult life course: Advancing theory in the sociology of aging. *Social Forces, 89*(4), 1287–1313. doi:10.1093/sf/89.4.1287

Cornwell, B., Laumann, E. O., & Schumm, L. P. (2008). The social connectedness of older adults: A national profile. *American Sociological Review*, *73*(2), 185–203. doi:10.1177/000312240807300201

Cornwell, B., Schumm, L. P., Laumann, E. O., & Graber, J. (2009). Social networks in the NSHAP study: Rationale, measurement, and preliminary findings. *The Journals of Gerontology Series B, 64B*(Supplement 1), i47–i55. doi:10.1093/geronb/gbp042

Crnic, K. A., Friedrich, W. N., & Greenberg, M. T. (1983). Adaptation of families with mentally retarded children: A model of stress, coping, and family ecology. *American Journal of Mental Deficiency*, *88*(2), 125–138.

Dembo, R. S., Huntington, N., Mitra, M., Rudolph, A. E., Lachman, M. E., & Mailick, M. R. (2022). Social network typology and health among parents of children with developmental disabilities: Results from a national study of midlife adults. *Social Science & Medicine*, *292*, 114623. doi:10.1016/j.socscimed.2021.114623

Domènech-Abella, J., Mundó, J., Haro, J. M., & Rubio-Valera, M. (2019). Anxiety, depression, loneliness and social network in the elderly: Longitudinal associations from The Irish Longitudinal Study on Ageing (TILDA). *Journal of Affective Disorders*, *246*, 82–88.

doi:10.1016/j.jad.2018.12.043

Glutting, J., Adams, W., & Sheslow, D. (2000). *Wide range intelligence test*. Wide Range.

Goldman, A. W. (2020). The early-life origins of later-life networks. *Social Problems*, 1–29. doi:10.1093/socpro/spaa047

Haas, S. A., Schaefer, D. R., & Kornienko, O. (2010). Health and the structure of adolescent social networks. *Journal of Health and Social Behavior*, *51*(4), 424–439. doi:10.1177/0022146510386791

Haines, V. A., Beggs, J. J., & Hurlbert, J. S. (2008). Contextualizing health outcomes: Do effects of network structure differ for women and men? *Sex Roles*, *59*(3), 164–175. doi:10.1007/s11199-008-9441-3

Hill, A., Bölte, S., Petrova, G., Beltcheva, D., Tacheva, S., & Poustka, F. (2001). Stability and interpersonal agreement of the interview-based diagnosis of autism. *Psychopathology*, *34*(4), 187–191. doi:10.1159/000049305

Hogan, B., Janulis, P., Phillips, G. L., Melville, J., Mustanski, B., Contractor, N., & Birkett, M. (2020). Assessing the stability of egocentric networks over time using the digital participant-aided sociogram tool Network Canvas. *Network Science*, *8*(2), 204–222. doi:10.1017/nws.2019.27

Hong, J., & Seltzer, M. M. (1995). The psychological consequences of multiple roles: The nonnormative case. *Journal of Health and Social Behavior*, *36*(4), 386–398. doi:10.2307/2137327

House, J. S. (1987). Social support and social structure. *Sociological Forum*, *2*(1), 135–146.

Houtjes, W., van Meijel, B., van de Ven, P. M., Deeg, D., van Tilburg, T., & Beekman, A. (2014). The impact of an unfavorable depression course on network size and loneliness in

older people: A longitudinal study in the community. *International Journal of Geriatric Psychiatry*, *29*(10), 1010–1017. doi:10.1002/gps.4091

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. doi:10.1080/10705519909540118

Iacobucci, D. (2010). Structural equations modeling: Fit indices, sample size, and advanced topics. *Journal of Consumer Psychology*, *20*(1), 90–98. doi:10.1016/j.jcps.2009.09.003

Kaniasty, K., & Norris, F. H. (2008). Longitudinal linkages between perceived social support and posttraumatic stress symptoms: Sequential roles of social causation and social selection. *Journal of Traumatic Stress*, *21*(3), 274–281. doi:10.1002/jts.20334

Karst, J. S., & Van Hecke, A. V. (2012). Parent and family impact of autism spectrum disorders: A review and proposed model for intervention evaluation. *Clinical Child and Family Psychology Review*, *15*(3), 247–277. doi:10.1007/s10567-012-0119-6

Kline, R. B. (2004). *Beyond significance testing: Reforming data analysis methods in behavioral research*. American Psychological Association.

Kogan, M. D., Vladutiu, C. J., Schieve, L. A., Ghandour, R. M., Blumberg, S. J., Zablotsky, B., Perrin, J. M., Shattuck, P., Kuhlthau, K. A., Harwood, R. L., & Lu, M. C. (2018). The prevalence of parent-reported autism spectrum disorder among US children. *Pediatrics*, *142*(6). doi:10.1542/peds.2017-4161

Laxman, D. J., Taylor, J. L., DaWalt, L. S., Greenberg, J. S., & Mailick, M. R. (2019). Loss in services precedes high school exit for teens with autism spectrum disorder: A longitudinal study. *Autism Research*, *12*(6), 911–921. doi:10.1002/aur.2113

Lewinsohn, P. M., Seeley, J. R., Roberts, R. E., & Allen, N. B. (1997). Center for Epidemiologic

Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychology and Aging*, *12*(2), 277–287. doi:10.1037/0882-7974.12.2.277

Li, T., & Zhang, Y. (2015). Social network types and the health of older adults: Exploring reciprocal associations. *Social Science & Medicine*, *130*, 59–68. doi:10.1016/j.socscimed.2015.02.007

Litwin, H., & Shiovitz-Ezra, S. (2011). Social network type and subjective well-being in a national sample of older Americans. *The Gerontologist*, *51*(3), 379–388. doi:10.1093/geront/gnq094

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism Diagnostic Interview-Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, *24*(5), 659–685.

Luckasson, R., Borthwick-Duffy, S., Buntinx, W. H. E., Coulter, D. L., Craig, E. M., Reeve, A., Schalock, R. L., Snell, M. E., Spitalnik, D. M., Spreat, S., & Tassé, M. J. (2002). *Mental retardation: Definition, classification, and systems of supports* (10th ed.). American Association on Mental Retardation.

Marsack, C. N., & Perry, T. E. (2018). Aging in place in every community: Social exclusion experiences of parents of adult children with autism spectrum disorder. *Research on Aging*, *40*(6), 535–557. doi:10.1177/0164027517717044

Marsack, C. N., & Samuel, P. S. (2017). Mediating effects of social support on quality of life for parents of adults with autism. *Journal of Autism and Developmental Disorders*, *47*(8), 2378–2389. doi:10.1007/s10803-017-3157-6

Norman, G. R., Sloan, J. A., & Wyrwich, K. W. (2003). Interpretation of changes in health-

related quality of life: The remarkable universality of half a standard deviation. *Medical Care*, *41*(5), 582–592.

Ouyang, L., Grosse, S. D., Riley, C., Bolen, J., Bishop, E., Raspa, M., & Bailey, D. B. (2014). A comparison of family financial and employment impacts of fragile X syndrome, autism spectrum disorders, and intellectual disability. *Research in Developmental Disabilities*, *35*(7), 1518–1527. doi:10.1016/j.ridd.2014.04.009

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401. doi:10.1177/014662167700100306

Rivard, M., Terroux, A., Parent-Boursier, C., & Mercier, C. (2014). Determinants of stress in parents of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *44*(7), 1609–1620. doi:10.1007/s10803-013-2028-z

Saunders, B. S., Tilford, J. M., Fussell, J. J., Schulz, E. G., Casey, P. H., & Kuo, D. Z. (2015). The financial and employment impact of intellectual disability on families of children with autism. *Families, Systems & Health*, *33*(1), 36–45. doi:10.1037/fsh0000102

Schafer, M. H. (2013). Discussion networks, physician visits, and non-conventional medicine: Probing the relational correlates of health care utilization. *Social Science & Medicine*, *87*, 176–184. doi:10.1016/j.socscimed.2013.03.031

Seltzer, M. M., Floyd, F., Song, J., Greenberg, J., & Hong, J. (2011). Midlife and aging parents of adults with intellectual and developmental disabilities: Impacts of lifelong parenting. *American Journal on Intellectual and Developmental Disabilities*, *116*(6), 479–499. doi:10.1352/1944-7558-116.6.479

Seltzer, M. M., Greenberg, J. S., Hong, J., Smith, L. E., Almeida, D. M., Coe, C., & Stawski, R.

S. (2010). Maternal cortisol levels and behavior problems in adolescents and adults with ASD. *Journal of Autism and Developmental Disorders, 40*(4), 457–469. doi:10.1007/s10803-009-0887-0

Smith, L. E., Greenberg, J. S., & Seltzer, M. M. (2012). Social support and well-being at mid-life among mothers of adolescents and adults with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*(9), 1818–1826. doi:10.1007/s10803-011-1420-9

Smith, L. E., Hong, J., Seltzer, M. M., Greenberg, J. S., Almeida, D. M., & Bishop, S. L. (2010). Daily experiences among mothers of adolescents and adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 40*(2), 167–178. doi:10.1007/s10803-009-0844-y

Smith, L. E., Seltzer, M. M., & Greenberg, J. S. (2012). Daily health symptoms of mothers of adolescents and adults with fragile x syndrome and mothers of adolescents and adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*(9), 1836–1846. doi:10.1007/s10803-011-1422-7

Sparrow, S., Carter, A., & Cicchetti, D. (1993). *Vineland screener: Overview, reliability, validity, administration, and scoring*. Yale University Child Study Center.

StataCorp. (2019). *Stata Statistical Software: Release 16*. StataCorp LLC.

Taylor, J. L. (2009). The transition out of high school and into adulthood for individuals with autism and for their families. *International Review of Research in Mental Retardation, 38*, 1–32. doi:10.1016/S0074-7750(08)38001-X

Thoits, P. A. (2011). Mechanisms linking social ties and support to physical and mental health. *Journal of Health and Social Behavior, 52*(2), 145–161. doi:10.1177/0022146510395592

Thoits, P. A. (2012). Role-identity salience, purpose and meaning in life, and well-being among

volunteers. *Social Psychology Quarterly*, *75*(4), 360–384. doi:10.1177/0190272512459662

Totsika, V., Hastings, R. P., Emerson, E., Lancaster, G. A., & Berridge, D. M. (2011). A population-based investigation of behavioural and emotional problems and maternal mental health: Associations with autism spectrum disorder and intellectual disability. *Journal of Child Psychology and Psychiatry*, *52*(1), 91–99. doi:10.1111/j.1469-7610.2010.02295.x

Tsai, A. C., Lucas, M., & Kawachi, I. (2015). Association between social integration and suicide among women in the United States. *JAMA Psychiatry*, *72*(10), 987–993. doi:10.1001/jamapsychiatry.2015.1002

Umberson, D., Crosnoe, R., & Reczek, C. (2010). Social relationships and health behavior across life course. *Annual Review of Sociology, 36,* 139–157. doi:10.1146/annurev-soc-070308-120011

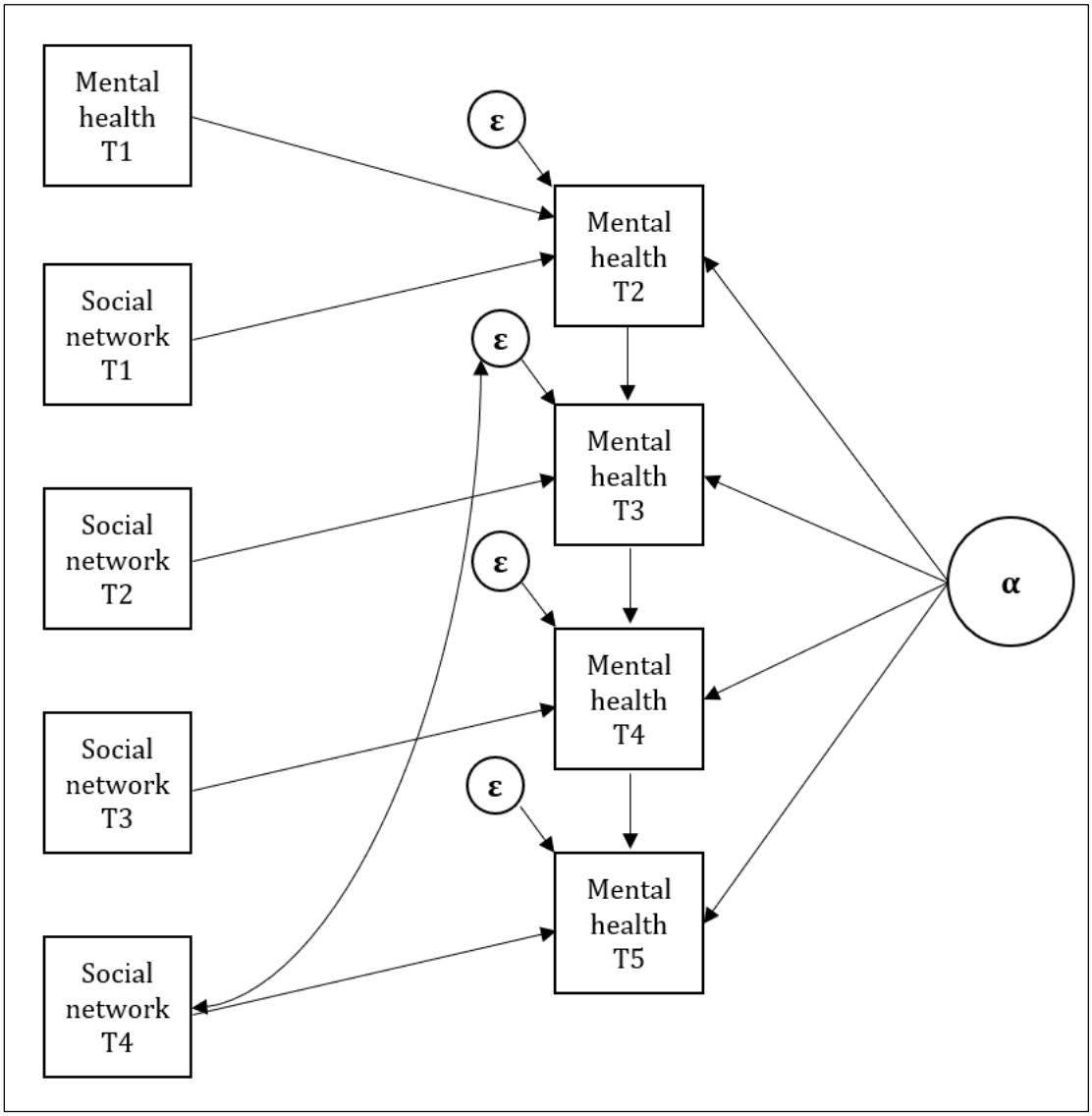
Waite, L. J., Duvoisin, R., & Kotwal, A. A. (2021). Social health in the National Social Life, Health, and Aging Project. *The Journals of Gerontology: Series B, 76*(Supplement_3), S251–S265. doi:10.1093/geronb/gbab138

Williams, R., Allison, P. D., & Moral-Benito, E. (2018). Linear dynamic panel-data estimation using maximum likelihood and structural equation modeling. *The Stata Journal*, *18*(2), 293–326. doi:10.1177/1536867X1801800201

Wu, Y.-H., Moore, S., & Dube, L. (2018). Social capital and obesity among adults: Longitudinal findings from the Montreal neighborhood networks and healthy aging panel. *Preventive Medicine, 111*, 366–370. doi:10.1016/j.ypmed.2017.11.028

Tables and Figures

Figure 1. Dynamic panel model for social networks predicting maternal mental health



Note. Adapted from Allison et al. (2017) and Williams et al. (2018). The latent random effect is represented by α. The correlation between "Social network T4" and the "Mental health T3" ε depicts the sequential exogeneity of the social network variable: when predicting mental health, the social network variable at time *t* is free to correlate with the error term for mental health at any prior time point (*t-1*, *t-2*, etc.). This correlation is what allows for the possibility of a reciprocal effect, from mental health to the social network variable. To enhance readability, some of the paths and correlations are omitted, including the covariances among exogenous variables and the lagged endogenous variable. Only one correlation is drawn to depict the sequential exogeneity of social networks. The control variables included in the models are also not shown.

Table 1. Descriptive statistics for participants in the [masked for review] study, 2000-2012

	Time 1 (n=339)	Time 2 (n=325)	Time 3 (n=293)	Time 4 (n=236)	Time 5 (n=201)
Maternal mental health					
Depression, M (SD)	12.09 (9.55)	12.40 (9.98)	11.85 (9.79)	12.91 (10.91)	12.86 (11.07)
Maternal social network characteristics					
Network size, M (SD)	7.72 (2.33)	7.86 (2.28)	7.88 (2.33)	8.00 (2.36)	7.68 (2.42)
Network diversity, M (SD)	3.98 (1.30)	4.02 (1.24)	4.04 (1.26)	4.06 (1.20)	3.92 (1.17)
Prop. female (quartiles), M (SD)	1.39 (1.18)	1.37 (1.18)	1.34 (1.13)	1.29 (1.09)	1.37 (1.04)
Prop. co-residing (quartiles), M (SD)	1.27 (1.19)	1.44 (1.07)	1.34 (1.10)	1.38 (1.04)	1.23 (1.06)
Maternal sociodemographic characteristics					
Married, %[a]	75.37	76.18	74.22	73.71	74.11
Educational attainment					
High school or less, %	24.48				
Some college, %	28.91				
College degree, %	24.48				
Graduate degree, %	22.12				
Age (mother) in years, M (SD)	52.47 (10.70)				
Characteristics of children (adolescents and adults) with autism spectrum disorder					
Autism symptoms, M (SD)	25.59 (8.11)	25.07 (8.15)	24.37 (8.95)	24.91 (9.14)	24.29 (9.40)
Behavior problems, M (SD)	112.78 (9.98)	112.84 (10.26)	111.20 (10.14)	110.59 (9.68)	111.32 (10.22)
Co-resides with mother, %[b]	61.36	59.38	54.27	45.34	48.50
Has intellectual disability, %[c]	70.21				
Female, %[d]	25.37				

Note: Prop. female refers to the proportion of the network that is female. Prop. co-residing refers to the proportion of the network that lives with the mother. Reference groups: (a) mother is not married; (b) child does not reside with mother; (c) child does not have intellectual disability; (d) child is male.

Table 2. Changes in maternal depression and social network characteristics across the study duration

	Decrease[a]		Stable[b]		Increase[c]	
	N	%	N	%	N	%
Depression	68	22.30	163	53.44	74	24.26
Network size	52	15.90	231	70.64	44	13.46
Network diversity	87	26.61	182	55.66	58	17.74

Note: Change over time was calculated for respondents for whom the variable was observed at least twice
a. Decrease of at least half SD relative to the SD at the first measurement
b. Change of less than half SD relative to the SD at the first measurement
c. Increase of at least half SD relative to the SD at the first measurement

Table 3. Prevalence of role relationships and mean network diversity at Time 1

	Percent of networks that include relationship	Mean diversity of networks that include relationship
Friend	91.16	4.06
Spouse	75.61	4.25
Child	60.06	4.37
Sibling	57.32	4.55
Parent	41.77	4.64
In-law	36.89	4.78
Extended kin	20.43	4.82
Professional	14.33	4.68

Note: Diversity refers to the number of different types of relationships in a mother's network.

Table 4. Autoregressive cross-lagged models for network size, network diversity, and maternal depression

	Model 1a Depression (Time *T*)	Model 1b Network size (Time *T*)	Model 2a Depression (Time *T*)	Model 2b Network diversity (Time *T*)
Autoregressive and cross-lagged effects				
Depression (Time *T-1*)	0.14† (0.08)	**-0.10* (0.04)**	0.13 (0.08)	**-0.06** (0.02)**
Network size (Time *T-1*)	**-0.06** (0.02)**	**0.84*** (0.03)**	-0.03† (0.02)	0.03 (0.03)
Network diversity (Time *T-1*)	--	--	**-0.08* (0.04)**	**0.76*** (0.11)**
Child characteristics, time invariant				
Has intellectual disability	-0.19 (0.11)	-0.03 (0.08)	-0.19† (0.12)	**-0.10* (0.04)**
Female	0.001 (0.09)	-0.02 (0.08)	0.01 (0.09)	0.05 (0.04)
Child characteristics, time varying				
Behavior problems	**0.11** (0.04)**	0.02 (0.04)	**0.11** (0.04)**	0.02 (0.02)
Autism symptoms	0.01 (0.04)	-0.001 (0.04)	0.02 (0.04)	0.02 (0.02)
Co-resides with mother	0.05 (0.08)	0.09 (0.08)	0.04 (0.08)	-0.05 (0.04)
Mother characteristics, time invariant				
Age	-0.01 (0.005)	0.01 (0.005)	-0.01 (0.005)	-0.004 (0.003)
Educational attainment	**-0.08* (0.04)**	0.02 (0.03)	**-0.09* (0.04)**	-0.004 (0.02)
Mother characteristics, time varying				
Married	-0.12 (.09)	-0.02 (0.10)	-0.06 (0.09)	0.11 (0.09)
Female network members	**-0.07* (0.03)**	0.02 (0.03)	**-0.08* (0.03)**	**-0.04* (0.02)**
Co-residing network members	-0.04 (0.03)	-0.005 (0.04)	-0.04 (0.03)	0.01 (0.02)
Model fit				
RMSEA (90% CI)	.042 (.031-.053)	.037 (.025-.048)	.041 (.030-.051)	.071 (.064-.081)
CFI	.991	.993	.992	.976
SRMR	.025	.022	.023	.023

† p<.1 *p<.05 **p<.01 ***p<.001. Notes: Bold indicates significance at p<.05. Robust standard errors in parentheses unless otherwise indicated. Time-varying variables are lagged. "Female network members" refers to the proportion of network members who are female, divided into quartiles. "Co-residing network members" refers to the proportion of network members living with the mother, divided into quartiles.

Reviewer comments and responses

Comment	Response
Editor comment: Please add the information about participants' ethnicity to Table 1. The authors mention the predominantly White sample as a limitation (p. 23) but you may want to add a few words to point out that social networks and their links to wellbeing may be particularly important to study in cultures in which familial and community interconnectedness are particularly salient.	Thank you for these helpful comments. We decided not to include race/ethnicity in Table 1, as the only variables in Table 1 are those that are used in the regression models. Instead, we have added information about the participants' race/ethnicity to the text of the discussion. Specifically, we included the percentage of respondents who were non-Hispanic white (see page 23). Based on the editor's great suggestion, we have also added additional text about the need to study families from diverse racial/ethnic backgrounds who place varying levels of emphasis on familial and community connectedness (see pages 23-24).
Editor comment: The Discussion could be tightened up further to reduce the length. There is some repetitive wording throughout. An example is p. 22 "Future intervention studies are needed to understand how changes in networks can be induced to best promote well-being in families of individuals with autism" and "By improving parents' mental health, network interventions may enable those with long-term caregiving responsibilities to meet the needs of their children with ASD more effectively." - this paragraph can be shortened. Also, the top of p. 23 could be tighter. Finally, the Conclusion section is rather redundant. Please reduce to just several key sentences.	We appreciate this feedback. We have shortened the discussion section generally (pages 18-25) and revised the specific areas pointed out by the editor (pages 22, 23). The conclusion section has also been shortened (page 25). These edits have cut 130 words from the discussion.
Reviewer #2 comment: I would use the word, "channel" instead of "metaphorical pipe" (which is awkward) to describe the relationship between networks and social support (assuming that the authors don't want to use "conduit" which is the term originally used by Benson.	Thank you for this suggestion. We have replaced the term "metaphorical pipes" with "channels" (see page 3).
Reviewer #2 comment: The second suggestion is to include p=values along with correlation coefficients in the descriptive stats section.	We have added the p-values for the correlation coefficients (see page 15).