Twice as Nice or Double Trouble: Examination of IVF Twins relative to IVF Singletons and their Families' Outcomes in Adolescence

A Dissertation
SUBMITTED TO THE FACULTY OF THE
UNIVERSITY OF MINNESOTA
BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Dr. Martha A. Rueter

April, 2016

Acknowledgements

I would be remiss if I did not first thank my advisor, Dr. Martha Rueter, for the many ways in which she has supported me over the past five years. She is a brilliant scientist, but I believe an even better person. Thank you for the effort you have invested in bolstering my mind and also my spirit: I will forever be a better person because of your shining example of how to criticize with kindness. I would also like to thank the members of my committee: Dr. Jodi Dworkin, Dr. Abigail Gewirtz, and Dr. Richard Lee. I am grateful for your encouragement, your guidance, and for the unique ways you all have placed me as a priority in your lives while helping me meet my goals. I wish to thank the University of Minnesota Graduate School Eva O. Miller Endowed Fellowship committee for providing me with funding for my dissertation year. I am also grateful for the families that participated in research with the Family Communication Project. I hope research presented here shows our participants their path to successful parenthood after infertility will continue to shape science and the experiences of other struggling families.

Finally, I need to express my utmost gratitude to my wonderful and supportive spouse, Christopher, for holding me together in every way over this process. There are simply no words to describe how dedicated and kind I think you are. I would also like to thank my parents, Randy and Sharon Lawton, who I am certain set me forth on this path even as a small child. Thank you for supporting me in large ways and small as I work towards the many things I want to do in this life. Lastly, I would like to thank the many other members of my family and all of my friends. You all are the lights in my life, and I still do not know how I got lucky enough to be blessed with your love and friendship.

Dedication

This dissertation is dedicated to my grandmother, Mary Birk, who is always in my heart.

Abstract

The two presented studies examine outcomes of *in vitro* fertilization (IVF)-conceived twins relative to IVF singletons and their families in adolescence (Study 1: n = 194 families, Study 2: n = 192 families). ***Study 1*** used nested ANCOVAs to examine differences in family environment and adolescent adjustment outcomes among 11 – 17 year-old IVF twins and IVF singletons and their families. Despite notable statistical power, there were no differences between adolescent-aged IVF twins and IVF singletons and their families. This suggests IVF twins and their families function well into adolescence. ***Study 2*** tested two autoregressive path models that propose parental conformity expectations have differential effects on twins' and singletons' parent-adolescent relationship satisfaction, which indirectly accounts for relative changes in twins' and singletons' adjustment over time. Despite the developmental need for increased autonomy in adolescence, results indicate high conformity expectations play a positive role for adolescent-aged twins and their families. These studies suggest that, while adolescent IVF twins and IVF singletons and their families function well, research on singletons should not be universally applied to understand twins and their families.

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Twin births are considered a primary complication of infertility treatments such as *in vitro* fertilization (IVF; ASRM, 2012). Citing early health and family risks, reproductive medicine and public health governing bodies have called for a reduction in U.S. IVF twin births (ASRM, 2012; CDC, 2014). Yet, the 26-28% U.S. twin birth rate after IVF remains high (CDC, 2015). The relative number of twins in the general population is also on the rise due to increased IVF use (Hamilton, Martin, Osterman, Curtin, & Mathews, 2015) and infertile patients' desire for twin births (Hojgaard, Ottosen, Kesmodel, & Ingerslev, 2007; Sharara, 2013).

IVF Twins in Early Childhood: Creating a Cause for Concern

Extant literature on infant and toddler-aged IVF twins suggests they may live in less optimum family environments relative to IVF singletons. For example, parents of IVF twins report greater mental health difficulties, and in particular depressive symptomatology, relative to parents of IVF singletons (Ellison et al., 2005; Olivennes, Golombok, Ramogida, Rust, & the Follow-Up Team, 2005; Vilska et al., 2009; Vilska & Unkila-Kallio, 2010). Parents of IVF twins also tend to have less positive parent-child interactions relative to IVF singleton parents. This includes elevated parenting stress (Freeman, Golombok, Olivennes, Ramogida, & Rust, 2007; Glazebrook, Sheard, Cox, Oates, & Ndukwe, 2004) and reduced parenting and parent-child relationship satisfaction (Olivennes et al., 2005). Yet, there have been few differences reported in couple relationship quality between parents of IVF twins and IVF singletons (Ellison et al., 2005; Golombok et al., 2007; Roca de-Bes, Maldonado, & Gris Martinez, 2009).

Concerns have also been raised about IVF twins' long-term development. Between 50 – 60% of IVF twins are born preterm or at low birth weights relative to 6 – 10% of IVF singleton children (ASRM, 2012; Davies et al., 2012). IVF twin children also tend to have less adaptive cognitive development relative to IVF singletons (Bonduelle et al., 2003; Olivennes et al., 2005; Pinborg, 2005). Research with singletons born without medical assistance suggests less optimum perinatal health (Nosarti, Murray, & Hack 2010), cognitive development (Lindsay, Dockrell, & Strand, 2007; Nigg, Quamma, Greenberg, & Kusche, 1999), parent mental health (Goodman et al., 2011; Leve, Kim, & Pears, 2005), and parent-child interactions (Miner & Clarke-Stewart, 2008; Letcher, Smart, Sanson, & Toumbourou, 2009) are related to long-term child psychosocial adjustment problems. While young IVF twins and IVF singletons have similar adjustment (Golombok et al., 2007; Montgomery et al., 1999; Olivennes et al., 2005), concerns have arisen about the *long-term* emotional and behavioral adjustment of older IVF twins.

IVF Twins in Middle Childhood: A Period of Resilience

Only two known studies have examined IVF twins relative to IVF singletons and their families once children reach middle childhood (Anderson et al., 2014; Anderson, Rueter, Connor, Chen, & Damario, 2015). These studies suggest parents of 6 – 12 year-old IVF twins and IVF singletons have comparable mental health and couple relationship quality (Anderson et al., 2014). Parents of 6 – 12 year-old IVF twins also report being as satisfied with their parent-child relationships as IVF singleton parents (Anderson et al., 2014). However, IVF twin parents tend to create environments that demand more conformity to parental rules to possibly reduce the stress of parenting twins (Anderson et

al., 2015). Despite early stressors, 6 – 12 year-old IVF twins have similar emotional adjustment, and fewer behavioral problems, relative to IVF singleton children (Anderson et al., 2014, 2015).

IVF Twins in Adolescence: The Present Study

Despite initial indications that IVF twins and their families function as well as or better than IVF singletons and their families in middle childhood, it is necessary to monitor IVF twins and their families into adolescence. Adolescence is marked by a number of potentially stressful life transitions (Smetana, Campione-Barr, & Metzger, 2006; Steinberg & Morris, 2001). While many transitions are considered normative, the nature and broader family environment of these transitions may place some adolescents and their families at increased risk for difficulties (c.f., Ary, Duncan, Duncan, & Hops, 1999; Costello, Copeland, & Angold, 2011; Farrington, 2009; Graber & Sontag, 2009; Letcher et al., 2009). Moreover, parent-child interactions change as children gain autonomy in adolescence (Kim, Oesterle, Catalano, & Hawkins, 2015; Smetana et al., 2006; Steinberg, 2001) and normative trajectories of children's psychosocial adjustment problems shift as children grow across developmental periods (Bongers, Koot, van der Ende, & Verlhust, 2003; Costello et al., 2011; Leve et al., 2005). Collectively, this indicates IVF twins and IVF singletons and their families should continue to be monitored in adolescence.

While some research examines adolescent twins conceived without medical assistance (Barnes & Boutwell, 2013; Ehringer, Rhee, Young, Corley, & Hewitt, 2006; Gjone & Novik, 1995), no studies compare IVF twins to IVF singletons once children

transition into and reach adolescence. This study contributes to literature on IVF twins and their families' long-term outcomes by comparing parent mental health, couple relationship quality, parent-adolescent interactions, and adolescent psychosocial adjustment across 11 – 17 year-old IVF twins and IVF singletons. Given differences between IVF twins and IVF singletons (or lack thereof) at the most recent developmental period where research is available, study hypotheses are as follows:

H1. Parents of 11 – 17 year-old IVF twins and IVF singletons will report similar mental health.

H2. Parents of 11 – 17 year-old IVF twins and IVF singletons will report comparable couple relationship quality.

H3a. Parents of 11 – 17 year-old IVF twins will report higher levels of parental conformity expectations relative to parents of 11 – 17 year-old IVF singletons.

H3b. Parents of 11 – 17 year-old IVF twins will report higher parenting stress relative to parents of 11 – 17 year-old IVF singletons.

H3c. Parents of 11 – 17 year-old IVF twins and IVF singletons will report comparable levels of parent-adolescent relationship satisfaction.

H4a. 11 **–** 17 year-old IVF twins and IVF singletons will have similar emotional adjustment.

H4b. 11 – 17 year-old IVF twins will have fewer behavioral problems relative to 11 – 17 year-old IVF singletons.

Methods

Participants

Eligible families were headed by heterosexual parent(s) with twin or singleton children born between 1998 and 2004 after being conceived via *in vitro* fertilization (IVF) procedures, including standard IVF and intra-cytoplasmic sperm injection (ICSI). Families were recruited from a metropolitan Midwestern U.S. university reproductive endocrinology clinic when the first wave of data were collected in 2010. At Wave 1, when study children were 6 – 12 years-old, 85.8% of eligible families from the clinic were located and 81.9% of located families participated. Most families lived in the Midwestern U.S. (94.5%), although those living across the country were included. Five years after the first wave of data collection, a second wave of data were collected in 2015. At Wave 2, when study children were 11 – 17 years-old, 62.9% of families were retained from Wave 1. Although drawn from a longitudinal project, data presented in this study were from Wave 2 when the IVF children were in adolescence (aged 11 – 17).

Data for the present study were drawn from 194 families with 279 11 – 17 year-old IVF children (54.1% were female; *M* child age = 13.35, *SD* = 1.37, *Min age* = 11.08, *Max age* = 17.91; *n* = 122 twins from 61 pairs, *n* = 157 singletons). On average, families included *M* = 2.26 children (*SD* = 0.92). Three-fourths (75.0%) of the IVF singletons had at least one sibling (*M* = 1.20, *SD* = 1.01). Approximately two-fifths (41.0%) of the IVF twins had at least one non-twin sibling (*M* = 0.52, *SD* = 0.74). Siblings may have included IVF or non-IVF children of any age. However, only outcome data on IVF children 11 – 17 years-old were collected and utilized in this study. Based on parent-report, 46.2% of the children were conceived via standard IVF, 53.0% via ICSI, and 0.7%

via IVF – distinct procedure not specified. In accordance with clinic and national averages (CDC, 2015), 28.0% of study IVF pregnancies resulted in twin births.

Within the 194 families, mothers (96.9%) and fathers (95.0%) were predominantly White. Most families were headed by two married parents (*n* = 179; 92.3%). The remaining families that were headed by one parent were because of single motherhood by choice (*n* = 1; 0.5%), marital separation (*n* = 3; 1.5%), divorce (*n* = 8; 4.1%), or widowhood (*n* = 3; 1.5%). Consistent with national U.S. IVF user demographics (Hammoud et al., 2009; Pasch et al., 2012), families had above-average incomes and education. Median annual family incomes were between $100,000 and $149,000 (range: less than $10,000 to more than $200,000), and most mothers (74.0%) and fathers (65.2%) held a Bachelor's degree or higher. Demographic differences between 11 – 17 year-old IVF twins and IVF singletons and their families can be found in Table 1.1 and the Preliminary Analysis section (*pages 14-15*).

Procedure

Prior to Wave 1, eligible study participants were identified from patient medical records at a university reproductive endocrinology clinic. In all cases, the patient was the mother. At Wave 2, using IRB-approved procedures, letters were sent to participating mothers asking them to complete an online survey. The letter also invited fathers to complete the survey. The survey included demographic questions and measures used to assess parent mental health, couple relationship quality, parent-adolescent interactions, and the IVF adolescents' psychosocial adjustment. Families received a $25 gift certificate as remuneration for their time.

Fathers eligible for study participation at Wave 2 were required to live with the IVF adolescent(s) at least 50% of the time. Among the 180 eligible fathers, 63 completed the survey (35.0%). Few differences were found on demographic and study variables between the subset of fathers who participated and those who did not participate. There were two exceptions to this general lack of differences. In families with participating fathers, mothers (participated: M = 5.21, SE = 0.12; did not participate: M = 4.68, SE = 0.10; t = -3.14, p = .002) and fathers (participated: M = 5.03, SE = 0.14; did not participate: M = 4.52, SE = 0.13; t = -2.69, p = .008) had more education than in families with fathers who did not participate. Participating fathers also had wives who reported higher couple relationship satisfaction when children were 6 – 12 years-old at Wave 1 relative to families with fathers who did not participate (participated: M = 6.08, SE = 0.13; did not participate: M = 5.64, SE = 0.12; t = -2.49, p = .014).

Measures

Parent mental health. Mothers and fathers reported on their own depressive symptoms using the Centers for Epidemiologic Studies Depression Scale-Short Form (CES-D-10; Björgvinsson, Kertz, Bigda-Peyton, McCoy, & Aderka, 2013; Radloff, 1977). The CES-D has acceptable test-retest reliability (r = .67) and construct and criterion validity (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993; Radloff, 1977). To calculate each parents' CES-D score, 10 items measured on a 4-point scale (0 = *rarely or none of the time* to 3 = *all of the time*) were reverse-coded as necessary and summed. A score of 10 or greater is considered clinically depressed. Higher scores indicate more mental health problems (mothers: α = .72; fathers: α = .70).

Couple relationship quality. For participants in partnered relationships, mothers and fathers reported couple relationship quality using the Dyadic Adjustment Scale (Sharpley & Rogers, 1984; Spanier, 1976). The DAS-7 has demonstrated reliability as well as construct and criterion validity (Hunsley, Best, Lefebvre, & Vito, 2001). To calculate each parents' DAS score, six relationship quality items measured on a 6-point scale (0 = *never or always disagree* to 5 = *always agree or more often*) and one relationship satisfaction item measured on a 7-point scale (0 = *extremely unhappy* to 6 = *perfect*) were summed (Hunsley et al., 2001). Higher scores indicate more positive couple relationship quality (mothers: $\alpha = .85$; fathers: $\alpha = .83$).

Parent-adolescent interaction quality. Three aspects of perceived parent-adolescent interaction quality were assessed in this study. These aspects included parental conformity expectations, parenting stress, and parent-adolescent relationship satisfaction.

Parental conformity expectations. Mothers and fathers reported on parental conformity expectations once per family using the Revised Family Communication Patterns Questionnaire conformity subscale (RFCP; Ritchie & Fitzpatrick, 1990). This family-level construct assesses parental expectations for structure and hierarchy in the family (Koerner & Fitzpatrick, 2002). The RFCP has been used in family research with demonstrated reliability and validity (Koerner & Fitzpatrick, 2002). The conformity scale includes 11 items assessed on a 7-point scale (1 = *disagree completely* to 7 = *agree completely*). Items include "I feel that it is important for parents to be the boss," and "I often say things like 'my ideas are right and you should not question them.'" Items were

reverse-coded as necessary and averaged; higher scores indicate stronger parental expectations for adolescent conformity (mothers: $\alpha = .70$; fathers: $\alpha = .74$).

Parenting stress. Mothers and fathers reported on perceived parenting stress for each of their 11 – 17 year-old IVF children using the Stress Index for Parents of Adolescents (SIPA; Sheras, Konold, & Abidin, 1998). The SIPA has good test-retest reliability ($r = .93$) and construct validity (Sheras et al., 1998). The SIPA measures stress experienced as a function of parenting a particular adolescent, including stress from adolescent, parent, and parent-adolescent relationship domains. Items include "My child has a negative attitude" (adolescent domain), "Since having a teenager, I have a lot fewer chances to see my friends and to make new friends" (parent domain), and "I cannot get my child to listen to me" (parent-adolescent domain). The SIPA includes 90 items measured on a 5-point scale (1 = *strongly disagree* to 5 = *strongly agree*). Items were reverse-coded as necessary and summed; higher scores indicate greater stress in parenting each particular IVF adolescent in the family (mothers: $\alpha = .96$; fathers: $\alpha = .95$).

Parent-adolescent relationship satisfaction. Mothers and fathers reported on parent-adolescent relationship satisfaction for each of their 11 – 17 year-old IVF children using an adaptation of the Huston Marital Opinion Questionnaire (Huston & Vangelisti, 1991). The adaptation from marital to parent-child relationship satisfaction has been used in family research with demonstrated reliability and validity (Anderson et al., 2014, 2015; Caughlin & Afifi, 2004). The adaptation consists solely of changing the instructions from asking parents to describe their relationship with their romantic partner to asking parents to describe their relationship with their adolescent.

Parents were presented with 11 sematic differential items, starting with the statement "I would describe my relationship as…" The first 10 items give opposing adjectives for relationship satisfaction (e.g., 1 = *hard* to 7 = *easy*; 1 = *rewarding* to 7 = *disappointing*). The last item reflects global relationship satisfaction (1 = *completely satisfied* to 7 = *completely dissatisfied*). The first 10 items were averaged, and the mean of these items was averaged with the global satisfaction score to create an overall score. Items were reverse-coded as necessary; higher scores indicate greater parent-adolescent relationship satisfaction (mothers: $\alpha = .96$; fathers: $\alpha = .97$).

Adolescent psychosocial adjustment. Mothers and fathers reported on emotional and behavioral problems for each 11 – 17 year-old IVF adolescent in the family. Adolescent emotional and behavioral adjustment were measured using the Internalizing (32 items; mothers: $\alpha = .82$; fathers: $\alpha = .83$) and Externalizing (35 items; mothers: $\alpha = .86$; fathers: $\alpha = .95$) subscales of the Child Behavior Checklist, respectively (CBCL; Achenbach & Rescorla, 2001). The CBCL has high test-retest reliability ($r = .91$-$.95$) and demonstrated validity (Achenbach & Rescorla, 2001). Items were measured on a 3-point scale (0 = *not true* to 2 = *very true or often true*). Higher summed scale scores indicate more adolescent psychosocial adjustment problems.

Covariates. Preliminary analyses illustrating differences between IVF twins and IVF singletons (*see Table 1.1 and Preliminary Analyses section, pages 14-15*) and evidence drawn from previous research led to the inclusion of covariates. For example, parent education and family income have associations with parent mental health (Rich-Edwards et al., 2006) and family relationships (Conger & Donnellan, 2007). Each parent

reported their own education (1 = *did not complete high school* to 7 = *doctoral degree*) and their combined annual family income (1 = *Less than $10,000* to 13 = *$200,000 or more*). When mother and father reports of family income were not congruent, the average of both responses were used to construct the income covariate.

Parent-reported adolescent age, sex (1 = *female*, 2 = *male*) and gestational length at birth (0 = *born at term*, 1 = *premature*) have associations with adolescent psychosocial adjustment (Bongers et al., 2003; Nosarti et al., 2010). Adolescents who were born prior to 37 weeks gestation were considered premature (ACOG, 2004; ASRM, 2012). Although IVF twins were more likely to be premature than IVF singletons (*see Preliminary Analyses, pages 14-15*), only a moderate relationship existed between IVF twin status and prematurity (r = .39; Cohen, 1992). This suggests prematurity can be included in analyses without substantial multicollinearity concerns.

The participant's mental health at the time of data collection can artificially inflate relationships among study constructs (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). For example, depressed participants often report more negatively across all study measures (Najman et al., 2001). To reduce the potential for this shared trait bias, each parent's own mental health at the time of data collection were used as a covariate in analyses assessing couple relationship quality, parent-adolescent interaction quality, and the adolescents' psychosocial adjustment.

Missing Data

Missing data ranged from 0 – 53.8%, with demographic and father-reported variables missing less than 7% of the data. Variables with more than 7% missing data

(46.2 – 53.8%) were largely due to maternal attrition from Wave 1 to Wave 2. Families with complete data on all variables were compared with those missing data on any variable using *t*-tests and chi-squared tests. Few differences were found on demographic and study variables between families with and without missing data. There were two exceptions to the general lack of differences. Families without missing data had fewer children (no missing data: $M = 1.97$, $SE = 0.11$, missing data: $M = 2.41$, $SE = 0.06$; $t = -3.52$, $p = .001$) and mothers with more education (no missing data: $M = 5.18$ (Bachelor's degree), $SE = 0.14$, missing data: $M = 4.80$ (between an Associate's and a Bachelor's degree), $SE = 0.07$; $t = 2.50$, $p = .015$) than families with missing data.

When missing data are unrelated to study outcome variables – as in this study – statistical approaches to recovering missing data are preferred over listwise deletion (Enders, 2010; Schafer & Graham, 2002). To handle missing data, Mplus adjusts model parameter estimates using full-information maximum-likelihood estimation (FIML) (Múthen & Shedden, 1999; Schafer & Graham, 2002). To obtain reliable estimates, Mplus requires proportions of complete data for each variable and between each pair of variables are greater than .10. In this study, proportions were above .45, and the majority were above .90. Thus, FIML was used to handle missing data for both the mother-reported and father-reported analyses.

Data Analysis Plan

The study hypotheses called for comparing the effect of being a member of one of two groups (IVF twin or IVF singleton) on an outcome variable, while accounting for covariates. Using mother-reported data, the study hypotheses were tested using seven

ANCOVAs. Covariates differed across ANCOVAs to best utilize variables with a previously demonstrated effect on each outcome. The first ANCOVA tested hypothesis one (H1) by comparing mental health for mothers of IVF twins relative to IVF singletons, controlling for maternal education, family income, and the adolescents' premature birth status. The second ANCOVA tested hypothesis two (H2) by comparing couple relationship quality for mothers of IVF twins relative to IVF singletons, controlling for maternal education and mental health, family income, and the adolescents' premature birth status. Three ANCOVAs were used to test hypotheses 3a, 3b, and 3c by comparing mother-adolescent interactions across IVF twins and IVF singletons (ANCOVA 3 (H3a): parental conformity expectations, ANCOVA 4 (H3b): parenting stress, ANCOVA 5 (H3c): mother-adolescent relationship satisfaction). Covariates for this group of three ANCOVAs included maternal education and mental health, family income, and the adolescents' premature birth status. Two ANCOVAs were used to test hypotheses 4a and 4b by comparing mother-reported adolescent psychosocial adjustment across IVF twins and IVF singletons (ANCOVA 6 (H4a): emotional problems, ANCOVA 7 (H4b): behavioral problems). Covariates for this set of two ANCOVAs included maternal education and mental health, and the adolescents' sex, age, and premature birth status. A similar set of seven ANCOVAs were run using the subset of participating fathers' data.

Each of the analytical models were tested using samples with multiple adolescents from within the same family (mother report: n = 277 adolescents from 192 families; father report: n = 96 adolescents from 65 families). This suggests the presence of shared family variance (Cook, 2012). Shared variance may be a particular concern in twin

families because twins have a shared perinatal environment (Leonard, 2002) and tend to be treated similarly (Fraley & Tancredy, 2012). To account for the inflated inference estimates that occur due to shared variance, analyses were run using the COMPLEX specification in Mplus 7.3 (Múthen & Múthen, 2012).

Power analyses (Faul, Erdfelder, Lang, & Buchner, 2007) suggest the mother-reported sample of $n = 277$ provided greater than .80 power to detect statistically significant effects using alpha $\leq .05$ when the effect size was larger than .17, a small effect (Cohen, 1992). Using the same power and alpha criteria, the father-reported sample of $n = 96$ had the power to detect effect sizes larger than .29, a medium effect (Cohen, 1992).

Results

Preliminary Analyses

Table 1.1 presents demographic comparisons across IVF twins and IVF singletons using mother-reported data. Results show that mothers of IVF twins were less highly educated than mothers of IVF singletons ($b = -0.39$, $p = .003$). There were no other effects of IVF twin status on family demographics or adolescent age. Differences in the distribution of IVF twins' and IVF singletons' sex and premature birth status were also tested. There were no differences in the proportion of female and male children by IVF twin status ($\chi^2 = 0.22$, $p = .638$). Of the IVF twins, 65 were premature (53.3%) and 57 were born at term (46.7%). Of the IVF singletons, 25 were premature (16.1%) and 130 were born at term (83.9%). As expected, IVF twins were more likely to be premature

than IVF singletons ($\chi^2 = 42.95$, $p < .001$). Demographic comparisons with the subset of father-reported data produced largely similar findings, and thus are not reported.

Results of Hypothesis Testing

H1. Parent mental health. As shown in Table 1.2, the expectation that mothers of 11 – 17 year-old IVF twins and IVF singletons would report similar mental health was supported. No covariates produced a significant effect on maternal mental health.

As shown in Table 1.3, the expectation that fathers of 11 – 17 year-old IVF twins and IVF singletons would report comparable mental health was also supported. Among the model covariates, an increase in family income was related to a decrease in paternal mental health problems ($b = -0.44$, 95% CI [-0.80, -0.09], $\beta = -0.34$, $t = -2.49$, $p = .013$). Having an adolescent who was premature at birth was also associated with higher levels of paternal mental health problems ($b = 2.22$, 95% CI [0.82, 3.62], $\beta = 0.36$, $t = 3.51$, $p < .001$).

H2. Couple relationship quality. Results presented in Table 1.2 indicate the hypothesis that mothers of 11 – 17 year-old IVF twins and IVF singletons would report comparable couple relationship quality was supported. Among the model covariates, an increase in maternal mental health problems was associated with a less positive view of her couple relationship quality ($b = -0.34$, 95% CI [-0.61, -0.07], $\beta = -0.22$, $t = -2.61$, $p = .009$).

Results presented in Table 1.3 indicate the hypothesis that fathers of 11 – 17 year-old IVF twins and IVF singletons would report similar couple relationship quality was

supported. No covariates produced a significant effect on father-reported couple relationship quality.

H3a. Parental conformity expectations. As noted in Table 1.2, the hypothesis that mothers of 11 – 17 year-old IVF twins would report higher conformity expectations relative to mothers of 11 – 17 year-old IVF singletons was not supported. No covariates produced a significant effect on mother-reported parental conformity expectations.

As noted in Table 1.3, the hypothesis that fathers of 11 – 17 year-old IVF twins would report higher conformity expectations compared to fathers of 11 – 17 year-old IVF singletons was not supported. Among the model covariates, an increase in paternal mental health problems was related to higher levels of father-reported parental conformity expectations (b = 0.07, 95% CI [0.02, 0.12], β = 0.30, t = 2.90, p = .004).

H3b. Parenting stress. Results shown in Table 1.2 indicate the hypothesis that mothers of 11 – 17 year-old IVF twins would have higher parenting stress levels relative to mothers of 11 – 17 year-old IVF singletons was not supported. Among the model covariates, an increase in maternal mental health problems was related to greater levels of maternal parenting stress (b = 5.68, 95% CI [3.34, 8.02], β = 0.48, t = 4.80, p < .001).

Results shown in Table 1.3 indicate the hypothesis that fathers of 11 – 17 year-old IVF twins would have higher parenting stress levels relative to fathers of 11 – 17 year-old IVF singletons was not supported. Among the model covariates, an increase in paternal mental health problems was associated with higher levels of paternal parenting stress (b = 6.68, 95% CI [3.97, 9.38], β = 0.55, t = 5.05, p < .001).

H3c. Parent-adolescent relationship satisfaction. As demonstrated in Table 1.2, the hypothesis that mothers of 11 – 17 year-old IVF twins and IVF singletons would have similar mother-adolescent relationship satisfaction was supported. Among the model covariates, an increase in maternal mental health problems was associated with diminished mother-adolescent relationship satisfaction (b = -0.10, 95% CI [-0.15, -0.04], β = -0.37, t = -3.21, p = .001).

As demonstrated in Table 1.3, the hypothesis that fathers of 11 – 17 year-old IVF twins and IVF singletons would have comparable father-adolescent relationship satisfaction was supported. Among the model covariates, an increase in paternal mental health problems was related to reduced father-adolescent relationship satisfaction (b = -0.17, 95% CI [-0.27, -0.07], β = -0.59, t = -4.29, p < .001).

H4a. Adolescents' emotional adjustment. Results presented in Table 1.2 suggest, based on mother-report, the hypothesis that 11 – 17 year-old IVF twins and IVF singletons would have similar emotional adjustment was supported. Importantly, IVF twins and IVF singletons scored within the normal range for adolescent emotional problems on the CBCL (boys: M = 5.60, SD = 5.30; girls: M = 6.50, SD = 5.70) (Achenbach & Rescorla, 2001). Among the model covariates, an increase in maternal mental health problems was associated with higher levels of adolescent emotional problems (b = 0.40, 95% CI [0.11, 0.70], β = 0.31, t = 2.50, p = .012).

Results presented in Table 1.3 suggest, based on father-report, the hypothesis that 11 – 17 year-old IVF twins and IVF singletons would have comparable emotional adjustment was supported. As with the mother-reported data, the IVF adolescents scored

within the normal range for emotional problems on the CBCL (Achenbach & Rescorla, 2001). Among the model covariates, an increase in paternal mental health problems was associated with higher levels of adolescent emotional problems (b = 0.68, 95% CI [0.30, 1.07], β = 0.52, t = 4.42, p < .001).

H4b. Adolescents' behavioral adjustment. As shown in Table 1.2, based on mother-report, the hypothesis that 11 – 17 year-old IVF twins would have fewer behavioral problems relative to 11 – 17 year-old IVF singletons was not supported. Of note, IVF twins and IVF singletons scored within the normal range for adolescent behavioral problems on the CBCL (boys: M = 7.50, SD = 7.50; girls: M = 6.60, SD = 7.00) (Achenbach & Rescorla, 2001). Among the model covariates, an increase in maternal mental health problems was related to greater adolescent behavioral problems (b = 0.33, 95% CI [0.14, 0.53], β = 0.28, t = 3.37, p = .001). Older (b = 0.57, 95% CI [0.05, 1.09], β = 0.22, t = 2.33, p = .020), male (b = 1.35, 95% CI [0.14, 2.57], β = 0.19, t = 2.39, p = .017) adolescents had more mother-reported behavioral problems.

As shown in Table 1.3, based on father-report, the hypothesis that 11 – 17 year-old IVF twins would have fewer behavioral problems relative to 11 – 17 year-old IVF singletons was not supported. As with the mother-reported data, the IVF adolescents scored within the normal range for behavioral problems on the CBCL (Achenbach & Rescorla, 2001). Among the model covariates, an increase in paternal mental health problems was associated with more adolescent behavioral problems (b = 1.02, 95% CI [0.36, 1.69], β = 0.55, t = 7.14, p < .001).

Discussion

The current study's results provide evidence that IVF twins and their families may not have as poor long-term functioning as expected given early health and family risks. Of note, research on families with infant and toddler-aged IVF children indicates that, relative to IVF singletons, IVF twins and their families may be at-risk for less optimum long-term outcomes (Davies et al., 2012; Ellison et al., 2005; Golombok et al., 2007; Olivennes et al., 2005; Vilska et al., 2009). However, earlier studies on IVF twins in middle childhood challenge expectations for IVF twins and their families' poor long-term adjustment (Anderson et al., 2014, 2015). The present study extends earlier findings to report outcomes for adolescent-aged IVF twins compared to IVF singletons. Study results suggest adolescent IVF twins and IVF singletons and their families function equally well across multiple family environment and adolescent psychosocial adjustment domains.

Developmental Processes: (Potential) Influences on IVF Twins' Environments?

Available research on IVF twins versus IVF singletons suggests the less optimum family environment characteristics found in families with young twins improve over time. For example, relative to IVF singletons, families with infant and toddler-aged IVF twins have less positive parent-child interactions (Freeman et al., 2007; Glazebrook et al., 2004; Holditch-Davis, Roberts, & Sandelowski, 1999; Olivennes et al., 2005). However, families with middle childhood-aged IVF twins tend to have similar or more adaptive parent-child interactions (Anderson et al., 2014, 2015). This study indicates parent-child interactions are comparable for adolescent-aged IVF twins and IVF singletons. Similar patterns have been described for IVF twins' versus IVF singletons' parent mental health (Anderson et al., 2014; Ellison et al., 2005; Olivennes et al., 2005; Vilska et al., 2009).

While this suggests IVF twins' environments improve after early childhood, longitudinal research with data from early childhood through adolescence are needed to specifically examine these changes in IVF twins' and IVF singletons' family environments.

If longitudinal studies indeed confirm these initial indications that IVF twins' family environments improve after early childhood, relational developmental systems models (RDS; c.f., Ford & Lerner, 1992; Lerner, Agans, Desouza, & Gasca, 2013; Overton, 2015) may help explain this phenomenon. RDS concepts suggest that as children grow over time, family environment characteristics such as parent mental health and parent-child interactions may also change. This change is due to the interplay between shifting developmental stressors and the broader context within which parents and their children are situated. For example, after early childhood, children grow increasingly independent (Masten & Coatsworth, 1998; McElhaney, Allen, Stephenson, & Hare, 2009). The reduced caregiving demands that occur when children become more independent may be especially beneficial for twin parents because of the rigorous demands of caring for young same-aged children (Ellison & Hall, 2003). Parents may then be able to reinvest in social networks, which can improve family environment characteristics (Bornstein, 2015; Robertson, Grace, Wallington, & Stewart, 2004). Future research should test this and other possible explanations for potential changes in IVF twins' family environments over time, and in particular, after early childhood.

Twins' and Singletons' Adjustment: (Potential) Changes from Middle Childhood?

Study findings suggest adolescent-aged IVF twins and IVF singletons have comparable psychosocial adjustment. These findings are primarily in line with results

presented in the available literature on adolescent twins and singletons born without medical assistance (Barnes & Boutwell, 2013; Ehringer et al., 2006; Gjone & Novik, 1995; but for an exception see DiLalla, 2006). Congruence with the literature on the most closely comparable population of adolescent twins gives credence to this study's results.

Results suggest change may occur in IVF twins' relative to IVF singletons' overall psychosocial adjustment from middle childhood to adolescence. According to the present study, adolescent IVF twins and IVF singletons have similar emotional *and* behavioral adjustment. In middle childhood, previous research suggests IVF twins and IVF singletons have similar emotional adjustment, but IVF twins tend to have fewer behavioral problems than IVF singletons (Anderson et al., 2014, 2015). This suggests the possibility of change in IVF twins' relative to IVF singletons' psychosocial adjustment, and in particular behavioral problems, from middle childhood to adolescence. Given the cross-sectional nature of this research, longitudinal assessment of the possible changes in IVF twins' versus IVF singletons' adjustment over time are needed.

If longitudinal studies confirm initial indications that IVF twins' and IVF singletons' adjustment changes from middle childhood to adolescence, mechanisms accounting for these changes should be considered. Parent-child interaction characteristics that alter the broader family environment may be one such mechanism. Extant research suggests parent-child interactions account for changes in psychosocial adjustment across developmental periods (Pardini, Fite, & Burke, 2008; Willoughby & Hamza, 2011). Moreover, previous research suggests parental conformity expectations have differential effects on *middle childhood*-aged IVF twins' and IVF singletons'

parent-child relationship satisfaction and child psychosocial adjustment (Anderson et al., 2015). Thus, it is possible that interaction-based family environment characteristics explain changes in IVF twins' and IVF singletons' adjustment from middle childhood to adolescence. Longitudinal research is needed to test this proposed explanation.

Study Strengths and Limitations

This study has a number of strengths increasing confidence in results. Results were based on a large sample of IVF families (n = 194 families with 279 adolescents). Among study families, data from all eligible mothers and a subset of fathers were used in this study. Given the large sample, there was more than .80 power to have detected small (mother-reported data) or medium effects (father-reported data) should they have existed (Cohen, 1992). This provides confidence that the absence of differences between IVF twins and IVF singletons in this study may indeed represent a dearth of substantive differences between groups and not a lack of power.

This study used data from both mothers and fathers of IVF adolescents. Research on IVF twins has primarily utilized data on and from mothers (c.f., Anderson et al., 2014; Glazebrook et al., 2004; Golombok et al., 2007; Olivennes et al., 2005). This practice occurs despite a growing body of research suggesting fathers have unique, vital influences in families (Lamb & Lewis, 2013). Relative to IVF singleton fathers, the limited research on IVF twin fathers indicates they may have less optimum mental health and parent-child interactions in early childhood (Holditch-Davis et al., 1999; Vilska et al., 2009). This study adds to the small literature on the experiences of IVF twin versus IVF singleton fathers. It is important to recognize the paternal recruitment rate was low

(35.0%), and thus data on the fathers should be seen as preliminary (*see page seven for differences between eligible fathers who did and did not participate*).

Data on all 11 – 17 year-old IVF children in the family were included in this study. In families with twins, the influence of same-aged children is paramount. For example, including only the most difficult twin can inflate the negative adjustment of IVF twins and their families by not including data on well-functioning twins. Using data on multiple children from within the same family requires statistical methods that account for shared variance be used (Cook, 2012). This study did so, and thus using data on all 11 – 17 year-old IVF children was a study strength.

Limits to generalizability and clarifications for future research should also be considered. Although the sample of families was representative of the clinic from which it was drawn, this study drew data from families who utilized one U.S. reproductive endocrinology clinic. It is important to note, however, that the twin birth rate in this study is similar to the national twin birth rate for IVF conceptions when children were conceived (CDC, 2015). Demographic data reflects the population of U.S. IVF patients, even in states where IVF is covered by insurance (Jain, 2006): high income, highly educated White families (Hammoud et al., 2009; Pasch et al., 2012). While caution should be taken when generalizing results, demographic data comparisons indicate study families appear similar to U.S. families with IVF twins and IVF singletons.

Attrition is always a concern in longitudinal studies, and this study is no different. There was substantial attrition from Wave 1 to Wave 2 of the broader longitudinal study from which data for the current study were drawn. However, advanced statistical

approaches can provide unbiased parameter estimates even with considerable missing data if data are unrelated to study outcomes (Schafer & Graham, 2002). This study meets this requirement. Thus, FIML was appropriately used to estimate parameters and effectively deal with missing data and attrition.

Finally, it is important to note that the current study utilized parent-reported data. The use of parent report for assessment of parent-adolescent interactions and adolescents' psychosocial adjustment in particular may be prone to social desirability bias. This may be especially true among IVF families with highly-desired children (Hahn, 2001). Parents of adolescents also may be unaware of all aspects of adolescents' behavior (van der Ende, Verhulst, & Tiemeier, 2012), which may result in underreporting adolescents' adjustment problems. However, studies with IVF children show consistent findings across informants from multiple domains (c.f., Golombok, Blake, Casey, Roman, & Jadva, 2013; Tully, Moffitt, & Caspi, 2003). Parents of IVF twins and IVF singletons are also known to report socially undesirable traits (c.f., Hammarberg, Fisher, & Wynter, 2008). Importantly, this study aimed to compare mean levels of IVF twins and IVF singletons and their families' outcomes and not report absolute levels of outcome difficulties. There is no current reason to believe parents of IVF twins relative to IVF singletons (or vice-versa) are prone to biased reporting in a way that would affect study results. To further minimize these respondent biases (Podsakoff et al., 2003), ANCOVAs assessing family relationship and psychosocial adjustment differences between IVF twins and IVF singletons accounted for each respective parents' mental health at data collection.

Conclusion

While concerns about young IVF twins and their families are persistent in the literature, available research on middle childhood-aged IVF twins challenge these concerns. This study adds to the growing literature on older IVF twins that indicates they and their families function at least as well as IVF singletons in middle childhood and adolescence. Future research should use longitudinal data to confirm and explain shifts in IVF twins and IVF singletons and their families' outcomes across developmental periods. In doing so, clinicians working with the growing number of patients assessing the long-term implications of multiple-embryo transfer and twin pregnancies may be able to more fully assess long-term IVF twin risks. The recommended future research would also allow for the possible identification of empirically-based strategies that bolster IVF twins' long-term psychosocial adjustment, despite substantial early stressors.

Conformity Expectations in Adolescence:

A Protective Factor for Twins and their Families

The United States twin birth rate has risen from about 1% to 3.4% over the past 35 years (Hamilton, Martin, Osterman, Curtin, & Mathews, 2015). The climbing twin rate is of interest and potential concern for family well-being and child development because twins' early stressors are thought to place them at-risk for long-term adjustment problems (Boivin et al., 2005; Davies et al., 2012; Thorpe, Rutter, & Greenwood, 2003; Vilska et al., 2009). Yet, available research on older twins suggests they are doing well (Anderson et al., 2014; Barnes & Boutwell, 2013; Ehringer, Rhee, Young, Corley, & Hewitt, 2006; Moilanen et al., 1999; Pulkkinen, Vaalamo, Hietala, Kaprio, & Rose, 2003). Twins' adaptive adjustment thus challenges concerns about their long-term psychosocial adjustment (Thorpe & Danby, 2006; Wilson, Fisher, Hammarberg, Amor, & Halliday, 2011), and indicates there are factors buffering twins against long-term negative effects of early stressors.

One such factor found to be protective for middle childhood-aged twins is parental conformity expectations (Anderson, Rueter, Connor, Chen, & Damario, 2015). The effect of conformity expectations on *adolescent*-aged twins and their families, however, has not been examined. This study tests a model proposing parental conformity expectations have differential effects on twins' versus singletons' parent-*adolescent* relationship satisfaction. These differential effects are expected to indirectly relate to child adjustment and may account for changes in twins' and singletons' adjustment from middle childhood to adolescence (*see Figure 2.1*).

Growth of Twins: The Role of Infertility Treatments and *In Vitro* Fertilization (IVF)

The three-fold population increase in twin births is primarily due to the growing use of *in vitro* fertilization (IVF) procedures to treat infertility (Chauhan, Scardo, Hayes, Abuhamad, & Berghella, 2010; Hamilton et al., 2015). Notably, in the past few decades, between 20% (Europe; ESHRE, 2014) and 30% (United States; CDC, 2015) of IVF pregnancies have resulted in twin births. The IVF twin rate is more than 20 times the twin birth rate for children conceived without medical assistance (Adashi et al., 2003). Thus, there is a large, growing population of families raising twin children, particularly those conceived via IVF. Importantly, family research conducted with samples of singleton children may not apply to twins and their families (Anderson et al., 2015). It is therefore vital to examine the effects of family environment characteristics on family and child outcomes in the burgeoning population of IVF twin families.

Twins' Early Environments: A Potential Risk to Twins' Long-term Adjustment?

Medical and public health governing bodies have expressed apprehension about the increasing twin birth rate and the high volume of IVF twins (ASRM, 2012; CDC, 2014; Stillman, Richter, & Jones, 2013). Concern about the high twin rate is due to early risks associated with twin births. For example, twins are at increased risk for perinatal health problems such as premature and low birth weight births (Davies et al., 2012). For singleton children, perinatal health problems are related to child adjustment difficulties that persist into middle childhood and adolescence (Nosarti, Murray, & Hack, 2010).

There is also growing evidence that young twins live in stressed family environments that could pose a potential risk to their long-term adjustment. Twins' less

optimum environments occur because twins enter their family simultaneously, while singleton children typically enter their family a year or more apart. Not surprisingly, parents of young twins report considerable stress related to managing the daily care of multiple same-aged children (Ellison & Hall, 2003). As a result, twin families may experience a pileup of stressors that could negatively impact the family environment. For example, relative to singleton parents, parents of infant and toddler-aged twins report increased mental health problems, especially depressive symptomatology (Vilska & Unkila-Kallio, 2010). Parents of young twins also tend to have less adaptive parent-child interactions relative to singleton parents (Boivin et al., 2005; Lutz et al., 2012; Olivennes, Golombok, Ramogida, Rust, & the Follow-Up Team, 2005).

Research on singleton families shows early family environment stressors negatively influence long-term child psychosocial adjustment. For example, less optimum early parent mental health (c.f., Goodman et al., 2011; Leve, Kim, & Pears, 2005) or parent-child interactions (Letcher, Smart, Sanson, & Toumbourou, 2009; Miner & Clarke-Stewart, 2008) are related to greater emotional and behavioral problems for children in middle childhood and adolescence. The aforementioned research on singleton families forms the basis for the expectation that twins are at risk for long-term psychosocial adjustment difficulties given their early childhood stressors (c.f., Rutter & Redshaw, 1991; Thorpe & Danby, 2006; Wilson et al., 2011).

Conformity Expectations: Explaining Twins' Resiliency in Middle Childhood

Available research on middle childhood-aged twins suggests concerns about twins' long-term adjustment are largely unfounded. For example, in middle childhood,

twins tend to have more positive emotional and/or behavioral adjustment relative to singletons (Anderson et al., 2014; Moilanen et al., 1999; Pulkkinen et al., 2003; Robbers et al., 2010). Twins' adaptive middle childhood adjustment indicates there may be protective factors mitigating early twin health and family risks.

One protective factor that explains twins' adaptive middle childhood adjustment is related to how parents of twins alter their environments in response to stress. In families experiencing a pileup of stressors, such as twin families, parents may create environments that demand conformity to parental rules and expectations (Anderson et al., 2015; Deater-Deckard & Scarr, 1996). Family Communication Patterns Theory (FCPT; Koerner & Fitzpatrick, 2006) suggests parents with high conformity expectations believe in creating a traditional, hierarchical family structure in which parents make family decisions. Children who live in conformity-expectant environments are expected to obey parental decisions and adopt parental attitudes without question. Families with conformity-expectant parents often also have uniform values, avoid conflictual interactions, and discourage dissent from family norms and rules.

Research with singletons shows that high parental conformity expectations relate to poor family and child outcomes (Schrodt, Witt, & Messersmith, 2008), but this may not be true for twins and their families (Anderson et al., 2015). Anderson and colleagues (2015) demonstrate that twin parents with high conformity expectations feel more satisfied with their parent-child relationships relative to conformity-expectant singleton parents. Furthermore, the differential effect conformity expectations have on twins' versus singletons' parent-child relationship satisfaction indirectly accounts for twins'

more positive adjustment in middle childhood. Thus, family environment characteristics, such as high parental conformity expectations, likely play a unique and important role in twins and their families' long-term outcomes.

Conformity Expectations: Does this Remain Adaptive for Adolescent Twins?

While there is clear evidence that high conformity expectations play a positive role for twins and their families in middle childhood, the effect remains unknown in adolescence. Examination of conformity expectations' effect on twins relative to singletons in adolescence is vital because adolescence is marked by increasing, developmentally appropriate autonomy for children from their parents (Smetana, Campione-Barr, & Metzger, 2006; Steinberg, 2000, 2001). Theoretically, high parental conformity expectations reduce independence and child autonomy (Koerner & Fitzpatrick, 2006; McElhaney, Allen, Stephenson, & Hare, 2009). While elevated conformity expectations may be adaptive for twin families during middle childhood, research with singletons suggests autonomy restrictions are linked to less optimum parent-*adolescent* interactions (McElhaney et al., 2009; Sillars, Koerner, Fitzpatrick, 2005; Sillars et al., 2014), including less satisfying relationships (Sillars et al., 2005).

The effects of conformity expectations on parent-*adolescent* interactions may indirectly impact adolescent psychosocial adjustment. Extant research suggests positive parent-adolescent interactions enhance adolescents' emotional and behavioral adjustment (Letcher et al., 2009; Pardini, Fite, & Burke, 2008; Willoughby & Hamza, 2011). Thus, it is possible that differences in how conformity expectations influence twins versus singletons may also *indirectly* influence the adolescents' adjustment, through interaction

constructs such as relationship satisfaction.

Twin-Singleton Adjustment: Changes from Middle Childhood to Adolescence

While cross-sectional, previous research gives an initial indication that twins' and singletons' psychosocial adjustment may change from middle childhood to adolescence. In adolescence, available research largely suggests there are no differences in twins' emotional or behavioral adjustment relative to singletons (see dissertation study 1; Barnes & Boutwell, 2013; Ehringer et al., 2006; but for an exception see DiLalla, 2006). However, in middle childhood, studies indicate twins tend to have more positive emotional and/or behavioral adjustment relative to singletons (Anderson et al., 2014; Moilanen et al., 1999; Pulkkinen et al., 2003; Robbers et al., 2010). This study therefore examines how parental conformity expectations may indirectly account for *changes* in twins' and singletons' psychosocial adjustment from middle childhood to adolescence.

The Present Study

The rapidly growing twin rate has created a burgeoning population of families raising twins, particularly those conceived via IVF (Hamilton et al., 2015). The available literature on this growing population suggests research on singleton families may not apply to twin families. Thus, this study fills a growing need to examine the different effects family environment characteristics have on twin relative to singleton families. The present study is based on previous research indicating high parental conformity expectations have a detrimental effect on singletons and yet a positive effect on twins and their families in middle childhood (Anderson et al., 2015). Yet, the growing importance of autonomy in adolescence raises questions about whether conformity expectations

positively affect adolescent twins. This study expands on previous research by examining the effect of conformity expectations on twins versus singletons in adolescence.

Using a sample of IVF twins and IVF singletons, the present study tests a theoretical model derived from the aforementioned literature (*Figure 2.1)*. This moderated mediation auto-regressive path model proposes that twin status (twin versus singleton) and parental conformity expectations interact to affect parent-adolescent relationship satisfaction. This interaction is expected to indirectly account for changes in twins' and singletons' psychosocial adjustment from middle childhood to adolescence, through parent-adolescent relationship satisfaction.

Methods

Participants

Eligible families were headed by heterosexual parent(s) with twin or singleton children born between 1998 and 2004 after being conceived via *in vitro* fertilization (IVF) procedures. Families were recruited from a metropolitan Midwestern U.S. university reproductive medicine clinic when the first wave of data were collected in 2010. At Wave 1, when study children were 6 – 12 years-old, 85.8% of eligible families from the clinic were located and 81.9% of located families participated. Most families lived in the Midwestern U.S. (94.5%), although those living across the country were included. Five years after the first wave of data collection, a second wave of data were collected in 2015. At Wave 2, when study children were 11 – 17 years-old, 62.9% of families were retained from Wave 1.

Data for the present study were drawn from 192 families with 277 IVF children (54.2% were female; *M* child age at Wave 1 = 8.45 (*SD* = 1.36), *M* child age at Wave 2 = 13.35 (*SD* = 1.37)) and a mother living in the household. Within this sample of IVF children, there were 122 IVF twins from 61 pairs and 155 IVF singletons. On average, families included *M* = 2.26 children (*SD* = 0.92). Three-fourths (75.3%) of the IVF singletons had at least one sibling (*M* = 1.20, *SD* = 1.00). Approximately two-fifths (41.0%) of the IVF twins had at least one non-twin sibling (*M* = 0.52, *SD* = 0.74). Siblings may have included IVF or non-IVF children of any age. However, only outcome data on IVF children that were born between 1998 and 2004 were collected and utilized at Wave 1 and Wave 2 of this study. Based on mother-report, 45.8% of the children were conceived via standard IVF, 53.4% via intra-cytoplasmic sperm injection (ICSI), and 0.7% via IVF – distinct procedure not specified. In accordance with clinic and national averages (CDC, 2015), 28.2% of the IVF-based pregnancies in this study resulted in twin births.

Within the 192 families, mothers (96.9%) and fathers (95.0%) were predominantly White. Most families were headed by two married parents (*n* = 179, 93.2%). The remainder of the families were headed by the mother because of single motherhood by choice (*n* = 1, 0.5%), marital separation (*n* = 2, 1.0%), divorce (*n* = 8, 4.2%), or widowhood (*n* = 2, 1.0%). Consistent with national U.S. IVF user demographics (Hammoud et al., 2009; Pasch et al., 2012), families had above-average incomes and education. Median annual family incomes were between $100,000 and

$149,000 (range: less than $10,000 to more than $200,000), and most mothers (74.0%) and fathers (64.8%) held a Bachelor's degree or higher.

Procedure

Prior to Wave 1, eligible study participants were identified from patient medical records at a university reproductive medicine clinic. In all cases, the patient was the mother. At reproductive medicine clinics, patients are always women because they are seeking to become pregnant, even if male infertility is the presenting treatment issue. At Wave 1, using university IRB-approved procedures, letters from the clinic director were sent to each mother asking her to complete an online survey. At Wave 2, letters were again sent to mothers, asking them to complete an online survey now that IVF children had entered adolescence. At each wave, the survey included demographic questions and measures used to assess parental conformity expectations, mother-child relationship satisfaction, and the child(ren)'s psychosocial adjustment. Families received a $25 gift certificate at Wave 1 and Wave 2 for their time.

Measures

Parental conformity expectations. Mothers reported on conformity expectations once per family using the Revised Family Communication Patterns Questionnaire conformity subscale (RFCP; Ritchie & Fitzpatrick, 1990). Data were collected at Wave 2 when IVF children were 11 – 17 years-old. This family-level construct assesses parental expectations for family structure and hierarchy (Koerner & Fitzpatrick, 2002). The RFCP has been used in family research with demonstrated reliability and validity (Koerner & Fitzpatrick, 2002). The conformity subscale includes 11 items measured on a 7-point

scale (1 = *disagree completely* to 7 = *agree completely*). Items include "I feel that it is important for parents to be the boss," and "I often say things like 'my ideas are right and you should not question them.'" Items were reverse-coded as necessary and averaged; higher scores indicate stronger expectations for adolescent conformity ($\alpha = .70$).

Mother-adolescent relationship satisfaction. Mothers reported on mother-adolescent relationship satisfaction for each of their IVF children using an adaptation of the Huston Marital Opinion Questionnaire (Huston & Vangelisti, 1991). Data were collected at Wave 2 when IVF children were 11 – 17 years-old. The adaptation from marital to parent-child relationship satisfaction has been used in mother-reported family research with demonstrated reliability and validity (Anderson et al., 2014, 2015; Caughlin & Afifi, 2004). The adaptation consists solely of changing the instructions from asking mothers to describe their relationship with their romantic partner to asking mothers to describe their relationship with their adolescent. This measure was chosen as it assesses relationship satisfaction and does not include items related to conformity expectations, which reduces risks of finding artificially strong associations between constructs.

Mothers were presented with 11 sematic differential items, starting with the statement "I would describe my relationship as…" The first 10 items give opposing adjectives for relationship satisfaction (e.g., 1 = *hard* to 7 = *easy*; 1 = *rewarding* to 7 = *disappointing*). The last item reflects global relationship satisfaction (1 = *completely satisfied* to 7 = *completely dissatisfied*). The first 10 items were averaged, and the mean of these items was averaged with the global satisfaction score to create an overall score. Items were reverse-coded as necessary; higher scores indicate greater mother-adolescent

relationship satisfaction (α = .96).

Child and adolescent psychosocial adjustment. Mothers reported on emotional and behavioral problems for each of their IVF children using the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001). Data were collected on the study IVF children at Wave 1, when children were 6 – 12 years-old, and Wave 2, when children were 11 – 17-years old. Emotional adjustment was measured using the CBCL Internalizing subscale (32 items; Wave 1: α = .81, Wave 2: α = .82). Behavioral adjustment was measured using the CBCL Externalizing subscale (35 items; Wave 1: α = .88; Wave 2: α = .86). The CBCL has high test-retest reliability (*r* = .91-.95) and demonstrated validity (Achenbach & Rescorla, 2001). Items were measured on a 3-point scale (0 = *not true* to 2 = *very true or often true*). Higher scores on the summed scales indicate greater child (Wave 1) and adolescent (Wave 2) psychosocial adjustment problems.

Covariates. Covariates were chosen based on previous research. Covariates included constructs that may impact mothers' relationships with their children (Conger & Donnellan, 2007; Nelson, Boyer, Sang, & Wilson, 2014) and adolescent psychosocial adjustment (Bongers, Koot, van der Ende, & Verhulst, 2003). These include mother-reported education (1 = *did not complete high school* to 7 = *doctoral degree*) and adolescent age and sex (1 = *female*, 2 = *male*).

The participant's mental health at the time of data collection can artificially inflate relationships among study constructs (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). For example, depressed participants often report more negatively across all study

measures (Najman et al., 2001). To reduce the potential for this shared trait bias, the mother's mental health at the time of Wave 2 data collection were used as a covariate in all analyses. Mothers reported on their depressive symptoms using the Centers for Epidemiologic Studies Depression Scale – Short Form (CES-D 10; Björgvinsson, Kertz, Bigda-Peyton, McCoy, & Aderka, 2013; Radloff, 1977). The CES-D has acceptable test-retest reliability (r = .67) and construct and criterion validity (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993; Radloff, 1977). Ten items were measured on a 4-point scale (0 = *rarely or none of the time* to 3 = *all of the time*), reverse-coded as necessary, and summed. Higher scores indicate more maternal mental health problems (α = .72).

Missing Data

Missing data ranged from 0 – 53.4%, with demographic variables missing less than 5% of the data. Variables with more than 20% missing data (49.5 – 53.4%) were largely due to attrition from Wave 1 to Wave 2. Mothers with complete data on all variables were compared with those missing data on any variable using *t*-tests and chi-squared tests. Few differences were found on demographic and study variables between mothers with and without missing data. There were two exceptions to this general lack of differences. Mothers without missing data had fewer children (no missing data: M = 2.00, SE = 0.10, missing data: M = 2.43, SE = 0.06; t = -3.67, p < .001) and more education (no missing data: M = 5.24 (Bachelor's degree), SE = 0.11, missing data: M = 4.77 (between an Associate's and a Bachelor's degree), SE = 0.07; t = 3.48, p = .001).

When missing data are unrelated to study outcome variables – as in this study – statistical approaches to recovering missing data are preferred over listwise deletion

(Enders, 2010; Schafer & Graham, 2002). To handle missing data, Mplus adjusts model parameter estimates using full-information maximum-likelihood estimation (FIML) (Múthen & Shedden, 1999; Schafer & Graham, 2002). To obtain reliable estimates, Mplus requires proportions of complete data for each variable and between each pair of variables are greater than .10. In this study, proportions were all above .39. Thus, FIML was used to handle missing data for the present study analyses.

Data Analysis Plan

The theoretical model (*see Figure 2.1*) included direct, interaction, and indirect effects tested using two autoregressive moderated mediation path models. The two adolescent adjustment variables were tested in separate models (Model I: emotional problems, Model II: behavioral problems). In each model, IVF twin status, parental conformity expectations, and the interaction between IVF twin status and conformity expectations were entered as independent variables. The interaction between IVF twin status and parental conformity expectations was created by centering each variable by its mean and taking the product of the centered variables. The mediating variable, mother-adolescent relationship satisfaction, was regressed on IVF twin status, parental conformity expectations, the interaction term, and covariates that influence mothers' relationships with their children (maternal education and mental health, adolescent sex; e.g., Hahn, 2001; Najman et al., 2001; Nelson et al., 2014). The dependent adolescent adjustment variable (Model I: emotional problems, Model II: behavioral problems) was regressed on IVF twin status, parental conformity expectations, mother-adolescent relationship satisfaction, and covariates with an effect on adolescent adjustment (maternal

mental health, adolescent sex and age; Bongers et al., 2003; Najman et al., 2001). The adolescents' previous adjustment from middle childhood at Wave 1 was regressed on the respective adolescent adjustment variable at Wave 2 to model relative adjustment change from middle childhood to adolescence. Indirect effects from the interaction term to the adolescents' adjustment, through mother-adolescent relationship satisfaction, were estimated for both the emotional and behavioral problems models.

These analyses utilized a sample that included multiple adolescents from within the same family (n = 277 adolescents from 192 families), which suggests the presence of shared variance (Cook, 2012). Shared variance may be particularly important to account for in twin families as twins have shared perinatal environments (Leonard, 2002) and are often treated similarly (Fraley & Tancredy, 2012). To account for inflated inference estimates that occur due to shared variance, analyses were run using the COMPLEX specification in Mplus 7.3 (Múthen & Múthen, 2012).

Model fit was evaluated using multiple fit indices. A preponderance of the forthcoming criteria was required to indicate a good fitting model (Kenny, Kaniskan, & McCoach, 2014): a statistically non-significant χ^2 (Bollen, 1989), a comparative fit index (CFI) above .95, a standardized root mean square residual (SRMR) less than .08, and root mean square error of approximation (RMSEA) less than .06 (Hu & Bentler, 1999). For both the emotional and behavioral problems models, a fully-specified model was tested to ensure an alternative model did not produce a better fit to the data relative to the theoretical model. If the fully-specified models produced a significant χ^2 change value ($\Delta\chi^2 > 9.49$, $df = 4$), they would be used over the more parsimonious emotional and

behavioral problems theoretical models.

Results

Preliminary Analyses

Differences between IVF twins and IVF singletons were tested for all variables (*see Table 2.1*). Chi-square analyses indicate there were no differences in the proportion of male and female children by IVF twin status ($\chi^2 = 0.22$, $p = .638$). Of note in Table 2.1, mothers of IVF twins were less highly educated than mothers of IVF singletons ($b = -0.39$, $p = .003$). There were no mean differences between IVF twins and IVF singletons on other covariates, conformity expectations, mother-adolescent relationship satisfaction, or middle childhood or adolescent emotional adjustment. Comparisons *between* IVF twins and IVF singletons indicate that, while adolescent-aged IVF twins and IVF singletons had similar behavioral adjustment, IVF twins had fewer behavioral problems relative to IVF singletons in middle childhood ($b = -1.67$, $p = .002$). Adjustment scores were within U.S. national norms for both IVF twins and IVF singletons (Achenbach & Rescorla, 2001). Correlations between all study variables are presented in Table 2.2.

The theoretical model tested in this study proposes a process that explains changes in IVF twins' and IVF singletons' adjustment from middle childhood (Wave 1) to adolescence (Wave 2). Paired *t*-tests, run separately for IVF twins and IVF singletons, were used to test change in the adjustment variables from middle childhood to adolescence. There was no change in emotional adjustment for IVF twins ($t = 0.71$, $p = .477$) or IVF singletons ($t = 0.42$, $p = .677$) from Wave 1 to Wave 2. Results suggest IVF twins and IVF singletons remained at relatively similar levels of emotional adjustment

over time. Preliminary findings also indicate that, on average, IVF twins had stable, positive behavioral adjustment over time (t = -0.03, p = .975), whereas IVF singletons' overall behavioral adjustment improved from Wave 1 to Wave 2 (t = -2.03, p = .044). These preliminary findings support the need to test explanatory mechanisms for changes in IVF twins' and IVF singletons' adjustment from middle childhood to adolescence.

Model I Testing: Emotional Problems

Estimates produced by the emotional problems model can be found in Table 2.3. There were several significant associations among variables in the emotional problems model. There was a positive relationship between middle childhood and adolescent emotional problems (β = 0.61, p < .001). Of particular interest, mother-adolescent relationship satisfaction related negatively to adolescent emotional problems (β = -0.37, p < .001), after accounting for middle childhood emotional problems. The effect of the interaction term (IVF twin status by conformity expectations) on mother-adolescent relationship satisfaction and adolescent emotional problems was also of primary interest. The interaction term was related to mother-adolescent relationship satisfaction (β = 0.14, p = .045). The interaction effect is discussed on page 42, below, and is illustrated in Figure 2.2. The indirect effect of the interaction term on adolescent emotional problems was not significant (b = -0.66, 95% CI [-1.42, 0.10], β = -0.05, t = -1.68, p = .093).

Model II Testing: Behavioral Problems

Model direct effects. Estimates produced by the behavioral problems model can be found in Table 2.4. As can be seen, there were several significant main effect associations between variables in the behavioral problems model, including a positive

relationship between middle childhood and adolescent behavioral problems (β = 0.67, p < .001). Of notable interest, mother-adolescent relationship satisfaction negatively related to adolescent behavioral problems (β = -0.32, p < .001), after accounting for middle childhood behavioral problems.

Interaction effect on mother-adolescent relationship satisfaction. The effect of the interaction term (IVF twin status by conformity expectations) on mother-adolescent relationship satisfaction was of main study importance. In the behavioral problems model, the interaction term had a significant effect on mother-adolescent relationship satisfaction (β = 0.13, p = .048). Figure 2.2 provides a graphical depiction to aide in interpretation of this interaction effect.

To create Figure 2.2, the continuous conformity expectations variable was dichotomized using a mean split to characterize mothers who reported low versus high conformity expectations. Low conformity expectations included adolescents whose mothers reported a mean conformity score less than 3.44 (n = 143, 51.6%). High conformity expectations included adolescents whose mothers reported a mean score above 3.44 (n = 134, 48.4%). In the low conformity group, there was no relationship between IVF twin status and mother-adolescent relationship satisfaction (r = .02, p = .826). In the high conformity group, there was a positive association between IVF twin status and mother-adolescent relationship satisfaction (r = .20, p = .021).

Indirect effect on changes in behavioral problems over time. There was an indirect effect of the IVF twin status by parental conformity expectations interaction term on adolescent behavioral problems (b = -0.46, 95% CI [-0.90, -0.02], β = -0.04, t = -2.05,

p = .041), after accounting for middle childhood behavioral problems. This indirect effect operated through mother-adolescent relationship satisfaction as the mediating variable.

Combining autoregressive, interaction, and indirect effects. The study theoretical model included autoregressive, interaction, and indirect effects. To aide in interpretation of the overall model results, it is important to consider these effects in conjunction with other another. In examining the autoregressive effect, it is important to note that the strong association between middle childhood and adolescent behavior problems suggests there is high overall stability in IVF twins' and IVF singletons' adjustment over time (*see Tables 2.2, 2.3, and 2.4*). Yet, there was a statistically significant association between mother-adolescent relationship satisfaction and adolescent behavior problems. This significant association indicates there was at least some relative change in behavioral adjustment from middle childhood to adolescence, and this relative change over time was at least partially related to mother-adolescent relationship satisfaction. In accordance with the theoretical model (*Figure 2.1*), the interaction between IVF twin status and conformity expectations was significantly related to mother-adolescent relationship satisfaction. This interaction effect indicates that, in families with high conformity expectations, IVF twin mothers reported more mother-adolescent relationship satisfaction than IVF singleton mothers. It is important to recall that preliminary analyses indicated IVF twins showed little average change in behavioral problems from middle childhood to adolescence whereas IVF singletons showed an overall reduction in behavioral problems over time. Taken together, the indirect effect can be interpreted such that, in families with high conformity expectations, IVF twins had

less relative change in behavioral problems from middle childhood to adolescence relative to IVF singletons.

Alternative Model Testing

For both the emotional and behavioral problems models, a fully-specified model was tested to ensure an alternative model was not a statistical improvement over the parsimonious theoretical model. To produce fully-specified models, four additional paths were estimated: (1) adolescent age to mother-adolescent relationship satisfaction, (2) the adolescents' previous adjustment in middle childhood to mother-adolescent relationship satisfaction, (3) the interaction term to adolescent psychosocial adjustment, and (4) maternal education to adolescent psychosocial adjustment. For both the emotional and behavioral problems models, the fully-specified model did not produce a significant improvement over the more parsimonious model described in the Methods section (*see Tables 2.3, 2.4*). Thus, the theoretical model was retained.

Discussion

Previous research suggests high parental conformity expectations play an adaptive role for twins and their families in middle childhood (Anderson et al., 2015). While high conformity expectations are linked to less optimum outcomes for adolescent singletons (McElhaney et al., 2009; Sillars et al., 2005, 2014), results presented in the current study suggest that adolescent twins and their families may function well in high conformity environments. Coupled with available research on middle childhood-aged twins (Anderson et al., 2015), findings continue to suggest additional research is needed on the unique effects that family environment characteristics have on the growing population of

twins and their families.

Conformity Expectations: Positive Effects on Twin Parent-Adolescent Relationships

Study findings indicate that parental conformity expectations have differential effects on twins relative to singletons and their families. Literature on singleton families suggests attempts to limit adolescent autonomy, including through high conformity expectations, are linked to less optimum parent-adolescent interactions (Goldstein, Davis-Kean, & Eccles, 2005; McElhaney & Allen, 2001; McElhaney et al., 2009; Sillars et al., 2005, 2014). Thus, it is not surprising that this study found parents are less satisfied in their relationships with singletons in conformity-expectant environments. Study results are also in line with available research that suggests high conformity environments may play an adaptive role for twins and their families (Anderson et al., 2015). Notably, parents of early and middle childhood-aged twins may create conformity-expectant environments to potentially reduce the negative impact of early stressors (Anderson et al., 2015; Ellison & Hall, 2003). Despite the increasing developmental importance of autonomy in adolescence (Smetana et al., 2006; Steinberg, 2001), this study suggests adolescent twins and their families function well in high conformity environments.

Future research should extend this study to examine the differential effect that conformity expectations may have on twins and singletons and their families at older ages or other domains of adolescent functioning. For example, adolescents in the present sample were, on average, between early to middle adolescence (Smetana et al., 2006). Early to middle adolescence may be the beginning stages of increased adolescent autonomy granting (McElhaney et al., 2009). Thus, it is possible the more detrimental

effects of conformity seen among singletons could be more evident among twins as they progress later into adolescence. In addition to extending this study to include older adolescents, the effects of strong conformity expectations should be investigated for twins versus singletons in other domains of adolescent development. For example, studies with singletons have noted that inappropriately restricting autonomy may have a negative impact on academic outcomes (Soenens & Vansteenkiste, 2005), self-esteem (Noom, Dekovic, & Meeus, 1999), and peer relationships (Fuligni & Eccles, 1993; Goldstein et al., 2005).

Twins' and Singletons' Behavioral Adjustment: Explaining Changes over Time

Preliminary results indicate, on average, twins and singletons had relatively stable emotional adjustment over time, but there were changes in twins' and singletons' *behavioral* adjustment from middle childhood to adolescence. Results indicate that the differential effects of conformity expectations on parent-adolescent relationship satisfaction influence relative changes in twins' and singletons' behavioral adjustment over time. Study findings suggest that in high conformity environments, twins tended to have less relative change in behavioral problems over time than singletons.

However, it is likely that other environmental characteristics also account for relative changes in twins' and singletons' behavioral adjustment from middle childhood to adolescence. For example, sibling (Feinberg, Solmeyer, & McHale, 2012; Kim, McHale, Osgood, & Crouter, 2007; Shanahan, Waite, & Boyd, 2012) and peer relationships (Brown & Larson, 2009; Hafen, Laursen, & DeLay, 2012) play an increasingly salient role in adolescence. These relationships may also be experienced

differently for twins and singletons (Fraley & Tancredy, 2012; Noller, Conway, & Blakeley-Smith, 2008; Pulkkinen et al., 2003). Scholars should examine these factors as well as other family characteristics that may account for relative changes in twins' and singletons' *behavioral* adjustment from middle childhood to adolescence.

IVF Twins: A Context Unique from Twins Conceived without Medical Assistance

Although some studies show similarities in adjustment across twins conceived with and without medical assistance (Shelton et al., 2009; Tully, Moffit, & Caspi, 2003), this study's findings may not apply to all twin families. Caution should be taken when generalizing results because IVF twin families may have unique family environments that differ from families where twins were not conceived using medical assistance. For example, IVF patients invest substantial emotional, time, and financial resources in child-rearing pursuits that result in highly-desired children (McMahon, Ungerer, Beaurepaire, Tennant, & Saunders, 1995). While parents of twins conceived without medical assistance may not have a strong desire for twins (Goshen-Gottstein, 1980), patients undergoing IVF often report that twins are a highly-desired treatment outcome (Hojgaard, Ottosen, Kesmodel, & Ingerslev, 2007; Leese & Denton, 2010). Importantly, patients undergoing IVF can make treatment decisions that directly increase the probability of twins (Sharara, 2013), which could alter the meaning parents give to raising twins. Finally, IVF parents tend to be more highly educated with greater annual family incomes (Anderson et al., 2014; Hahn & DiPietro, 2001; Pasch et al., 2012). It is vital to consider these differences when attempting to generalize the results of the present study to other twin families.

Study Strengths & Limitations

This study has several strengths bolstering confidence in the results. Results are based on a large sample of IVF children (n = 277 children from 192 families). This study examined all IVF children in the family that were within the study age ranges. In families with twins, the influence of multiple same-aged children is uniquely important. For instance, if only data on the most difficult twin is used, results may reflect artificial, negative assessments of twin outcomes. However, when data on multiple family members are utilized in analyses, the correlated nature of the data must be taken into account (Cook, 2012). This study did so and thus we consider it a strength that data on all IVF children in the age ranges were used. The study statistical models also produced a preponderance of good fit statistics (Hu & Bentler, 1999; Kenny et al., 2014; Kline, 2005), which indicates the models provided an adequate approximation of sample family experiences. Finally, longitudinal data were used to examine relative changes in twins' and singletons' psychosocial adjustment over time. Studies have relied on cross-sectional (c.f., Barnes & Boutwell, 2013) or cohort-sequential data (c.f., Robbers et al., 2010) to assess twin-singleton adjustment differences at varied developmental periods. While providing a foundation for possible developmental variations in twins' and singletons' adjustment, these approaches provide limited understanding of how twins and singletons develop uniquely across time.

Limits to generalizability and clarifications for future research should also be noted. Although the sample of families were representative of the particular clinic from which the data were drawn, this study drew data from only one U.S. reproductive

medicine clinic. It is important to note the clinic and study twin pregnancy rate is consistent with the national twin birth rate for IVF conceptions when children were conceived (CDC, 2015). Families were also reflective of broader U.S. IVF user demographics. Even in U.S. states where IVF is covered by insurance (Jain, 2006), IVF users are predominantly highly educated, high income White families (Hammoud et al., 2009; Pasch et al., 2012). Demographic data suggest this sample of families is similar to the overall U.S. population of families with IVF twins and IVF singletons.

As in all longitudinal studies, attrition is a concern. There was considerable attrition from Wave 1 to Wave 2 in the present study. Importantly, advanced statistical approaches provide unbiased parameter estimates even with substantial missing data if the missing data are unrelated to study outcome variables (Schafer & Graham, 2002). This study meets this requirement. Thus, FIML was used to estimate parameters and effectively deal with study missing data and attrition.

A primary limitation of this study was the sole use of mother-reported data, which may be especially true in families with highly-desired children because mothers may lean towards a social desirability bias in their responses (Hahn, 2001). Mothers may also be unaware of all aspects of their adolescents' adjustment (van der Ende, Verhulst, & Tiemeier, 2012), which may result in underreporting of adolescents' emotional and behavioral problems. Despite limitations, it is vital to note that studies of IVF children show consistent findings across informants from multiple domains (c.f., Golombok, Blake, Casey, Roman, & Jadva, 2013; Tully et al., 2003). Mothers of IVF children have also been found to report socially undesirable traits (c.f., Hammarberg, Fisher, & Wynter,

2008). To mitigate some biases that occur because of single informant data (Podsakoff et al., 2003), maternal mental health at the time of data collection was included in all analyses. Future research should examine the models tested in this study with data from mothers and fathers as well as the adolescent-aged children.

Conclusion

Despite the developmental need for more autonomy in adolescence, elevated conformity expectations continue to play a positive role in adolescent parent-twin relationship satisfaction. Future research should examine the effects that elevated conformity expectations have on other domains of twins' versus singletons' adolescent development. Other factors that explain changes in twins' and singletons' behavioral adjustment over time should also be tested. Coupled with previous research, results from the current study suggest that research with singleton families should not be universally applied to twins and their families in middle childhood or adolescence.

Table 1.1

Mother-Reported Demographic Differences between Families with 11 - 17 year-old IVF Twins and IVF Singletons

	IVF Twins (n = 122)		IVF Singletons (n = 155)				
	M	*SE*	*M*	*SE*	*b*	*t*	*p*
Maternal Age	47.39	0.41	47.58	0.37	-0.19	-0.34	.732
Paternal Age[+]	50.76	0.54	49.38	0.47	1.38	1.92	.056
Adolescent Age	13.35	0.15	13.26	0.11	0.09	0.52	.604
Maternal Education	4.66	0.09	5.05	0.08	-0.39	-3.18	.003
Paternal Education[+]	4.76	0.14	4.69	0.12	0.07	0.41	.684
Family Income	10.21	0.22	10.38	0.19	-0.17	-0.61	.545

Note. All means and standard errors reported for IVF twins and IVF singletons reflect marginal estimates after adjusting for shared family variance. Maternal and paternal education were measured on a seven-point scale (1 = did not complete high school, 2 = high school diploma, 3 = some college, 4 = Associate's degree, 5 = Bachelor's degree, 6 = Master's or professional degree, 7 = Doctorate). Family income was measured on a 13-point scale (1 ≤ $10,000, 2 = $10,000 – 19,999, 3 = $20,000 – 29,999, 4 = $30,000 – 39,999, 5 = $40,000 – 49,999, 6 = $50,000 – 59,999, 7 = $60,000 – 69,999, 8 = $70,000 – 79,999, 9 = $80,000 – 89,999, 10 = $90,000 – 99,999, 11 = $100,000 – 149,999, 12 = $150,000 – 199,999, 13 = $200,000+). [+]Data on paternal age and education were included only in families where the mother was in a partnered or married relationship.

Table 1.2

Mother-Reported Effects of IVF Twin Status on Study Family Environment and Adolescent Psychosocial Adjustment Variables

	Twins (n = 122)		Singletons (n = 155)						
	M	*SE*	*M*	*SE*	*b*	*95% CI*	β	*t*	*p*
Maternal Mental Health	4.21	0.57	3.62	0.34	0.49	[-0.67, 1.66]	0.08	0.83	.404
Couple Relationship Quality	24.13	0.85	23.45	0.76	0.76	[-1.15, 2.68]	0.08	0.79	.432
Mom-Adolescent Interaction Quality									
Conformity Expectations	3.48	0.12	3.41	0.08	0.15	[-0.12, 0.41]	0.12	1.09	.275
Parenting Stress	168.35	6.17	171.53	4.41	-0.32	[-11.89, 11.26]	<-0.01	-0.05	.957
Relationship Satisfaction	6.42	0.12	6.26	0.11	0.17	[-0.11, 0.44]	0.10	1.24	.217
Adolescent Psychosocial Adjustment									
Emotional Problems	3.41	0.64	3.41	0.49	0.36	[-1.27, 1.99]	0.04	0.43	.669
Behavioral Problems	2.59	0.56	2.74	0.44	-0.12	[-1.36, 1.13]	-0.02	-0.18	.856

Note. All reported statistics reflect marginal estimates after adjusting for shared family variance and study covariates.

Table 1.3

Father-Reported Effects of IVF Twin Status on Study Family Environment and Adolescent Psychosocial Adjustment Variables

	Twins (n = 46)		Singletons (n = 50)						
	M	*SE*	*M*	*SE*	*b*	*95% CI*	β	*t*	*p*
Paternal Mental Health	5.02	0.56	3.96	0.49	0.25	[-1.03, 1.52]	0.04	0.38	.704
Couple Relationship Quality	24.20	0.98	24.51	0.74	-0.70	[-2.85, 1.45]	-0.08	-0.65	.516
Dad-Adolescent Interaction Quality									
Conformity Expectations	3.69	0.15	3.54	0.11	0.09	[-0.28, 0.46]	0.07	0.48	.633
Parenting Stress	185.60	5.57	175.51	6.06	3.67	[-8.88, 16.22]	0.05	0.58	.563
Relationship Satisfaction	6.25	0.19	6.17	0.12	0.22	[-0.16, 0.61]	0.14	1.17	.242
Adolescent Psychosocial Adjustment									
Emotional Problems	3.02	0.75	3.45	0.69	-0.79	[-2.61, 1.04]	-0.11	-0.86	.390
Behavioral Problems	2.77	1.12	2.67	0.48	-0.52	[-2.42, 1.37]	-0.05	-0.52	.606

Note. All reported statistics reflect marginal estimates after adjusting for shared family variance and study covariates.

Table 2.1

Differences between IVF Twins and IVF Singletons on Study Variables

	Twins (n = 122)		Singletons (n = 155)				
	M	*SE*	*M*	*SE*	*b*	*t*	*p*
Conformity Expectations	3.48	0.12	3.41	0.08	0.15	1.09	.275
Mom-Adolescent Satisfaction	6.42	0.12	6.26	0.11	0.17	1.24	.217
Child Emotional Problems	2.87	0.45	3.52	0.35	-0.77	-1.43	.154
Adolescent Emotional Problems	3.41	0.64	3.41	0.49	0.04	0.43	.669
Child Behavior Problems	2.36	0.38	3.69	0.46	-1.67	-3.11	.002
Adolescent Behavior Problems	2.59	0.56	2.74	0.44	-0.02	-0.18	.856
Maternal Education	4.66	0.09	5.05	0.08	-0.39	-3.18	.003
Adolescent Age	13.35	0.15	13.26	0.11	0.09	0.52	.604
Maternal Mental Health	4.21	0.57	3.62	0.34	0.49	0.83	.404

Note. Differences between IVF twins and IVF singletons were tested using nested ANCOVAs that accounted for shared variance.

Table 2.2

Descriptive Statistics among Study Variables: Means, Standard Deviations, and Correlations

Measure	1	2	3	4	5	6	7	8	9	10	*M*	*SD*
1. IVF twin status	__										0.44	0.50
2. Conformity expectations	.03	__									3.44	0.63
3. Mom-adolescent satisfaction	.11	.03	__								6.29	0.79
4. Child emotional problems	-.10	.13*	-.14*	__							3.27	3.96
5. Adolescent emotional problems	-.10	.31**	-.49**	.48**	__						3.74	3.96
6. Child behavior problems	-.15*	.08	-.20**	.54**	.29**	__					3.10	4.43
7. Adolescent behavior problems	-.10	.12*	-.46**	.43**	.43**	.71**	__				2.82	3.56
8. Maternal education	-.18**	-.04	-.04	.08	.09	-.00	-.02	__			4.86	1.06
9. Adolescent sex	-.03	.03	-.17**	-.09	.08	-.01	.12*	.02	__		1.46	0.50
10. Adolescent age	.04	-.25**	-.11	.06	-.12*	.04	.10	-.05	.08	__	13.35	1.36
11. Maternal mental health	.05	.22**	-.24**	.12*	.38**	-.08	.15*	.12*	.10	-.10	3.92	3.03

Note. Twins = 1, Singletons = 0. *≤ .05, **< .01.

Table 2.3

Model Results and Fit Indices for the Emotional Problems Model

	Mother-Adolescent Relationship Satisfaction					Adolescent Emotional Problems				
Variables	*B*	*95% CI*	*β*	*t*	*p*	*B*	*95% CI*	*β*	*t*	*p*
IVF Twin Status	0.20	[-0.08, 0.48]	0.13	1.48	.140	0.89	[-0.11, 1.90]	0.11	1.75	.080
Conformity Expectations	-0.14	[-0.31, 0.04]	-0.11	-1.68	.093	0.41	[-0.19, 1.02]	0.06	1.36	.174
IVF Twin * Conformity	0.34	[0.01, 0.68]	0.14	2.00	.045	---	---	---	---	---
Mom-Adol. Satisfaction	---	---	---	---	---	-1.92	[-2.76, -1.08]	-0.37	-3.96	<.001
Child Emotional Problems	---	---	---	---	---	0.63	[0.44, 0.82]	0.61	7.22	<.001
Maternal Education	0.02	[-0.14, 0.18]	0.03	0.30	.768	---	---	---	---	---
Adolescent Sex	-0.23	[-0.48, 0.02]	-0.14	-1.80	.072	-0.28	[-1.20, 0.64]	-0.03	-0.60	.548
Adolescent Age	---	---	---	---	---	-0.25	[-0.61, 0.11]	-0.08	-1.37	.169
Maternal Mental Health	-0.09	[-0.14, -0.04]	-0.36	-3.52	<.001	0.18	[-0.04, 0.39]	0.13	1.56	.118

Note. Table 2.3 continues on page 57, below.

Table 2.3

Model Results and Fit Indices for the Emotional Problems Model (Continued)

	CFI	*RMSEA*	*SRMR*	*TM* χ^2	*df*	*p*	*AM* χ^2	*df*	*p*	$\Delta\chi^2$	*df*	*p*
Model Fit Indices	0.96	0.06	0.04	8.36	4	0.079	0.00	0	<.001	8.36	4	>.05

Note. R^2 = .20 for mother-adolescent relationship satisfaction (t = 2.42, p = .016); R^2 = .62 for adolescent emotional problems (t = 7.57, p < .001). In the model fit indices, TM refers to theoretical model and AM refers to the alternative model.

Table 2.4

Model Results and Fit Indices for the Behavioral Problems Model

	Mother-Adolescent Relationship Satisfaction					Adolescent Behavioral Problems				
Variables	*B*	*95% CI*	*β*	*t*	*p*	*B*	*95% CI*	*β*	*t*	*p*
IVF Twin Status	0.21	[-0.07, 0.48]	0.13	1.57	.117	0.69	[-0.18, 1.55]	0.10	1.64	.101
Conformity Expectations	-0.15	[-0.32, 0.03]	-0.12	-1.89	.059	-0.29	[-0.85, 0.27]	-0.05	-1.04	.298
IVF Twin * Conformity	0.32	[>0.00, 0.63]	0.13	1.97	.048	---	---	---	---	---
Mom-Adol. Satisfaction	---	---	---	---	---	-1.46	[-2.28, -0.65]	-0.32	-4.13	<.001
Child Behavior Problems	---	---	---	---	---	0.54	[0.41, 0.67]	0.67	9.27	<.001
Maternal Education	0.04	[-0.12, 0.20]	0.05	0.49	.623	---	---	---	---	---
Adolescent Sex	-0.24	[-0.49, >0.00]	-0.15	-1.94	.052	0.46	[-0.35, 1.26]	0.06	1.14	.254
Adolescent Age	---	---	---	---	---	0.11	[-0.21, 0.42]	0.04	0.66	.510
Maternal Mental Health	-0.09	[-0.14, -0.04]	-0.36	-3.53	<.001	0.19	[0.06, 0.32]	0.16	2.96	.003

Note. Table 2.4 continues on page 59, below.

Table 2.4

Model Results and Fit Indices for the Behavioral Problems Model (Continued)

	CFI	*RMSEA*	*SRMR*	*TM* χ^2	*df*	*p*	*AM* χ^2	*df*	*p*	$\Delta\chi^2$	*df*	*p*
Model Fit Indices	0.97	0.07	0.03	8.80	4	.066	0.00	0	<.001	8.80	4	>.05

Note. R^2 = .20 for mother-adolescent relationship satisfaction (t = 2.43, p = .015); R^2 = .64 for adolescent behavioral problems (t = 9.70, p < .001). In the model fit indices, TM refers to theoretical model and AM refers to the alternative model.

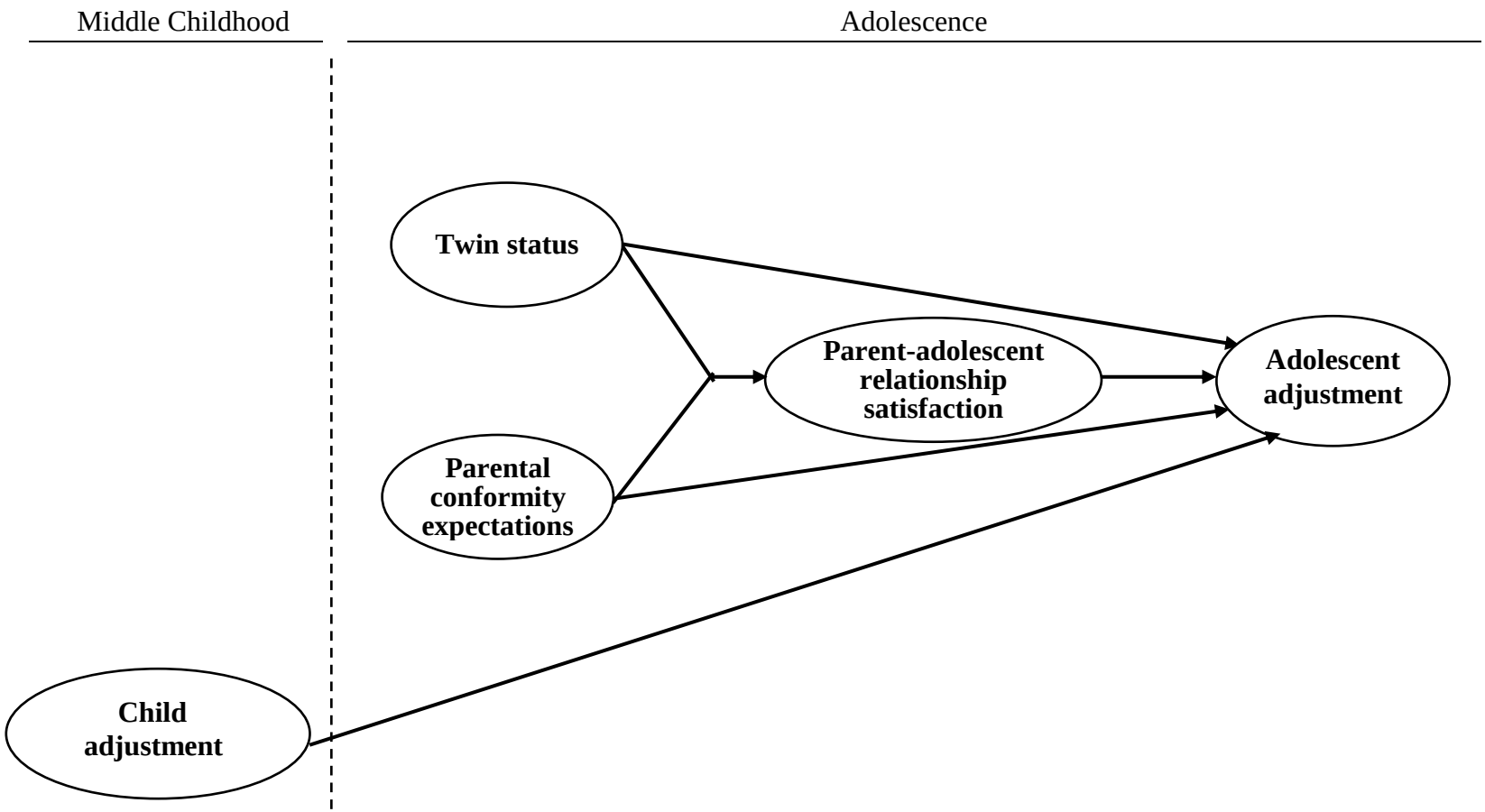

Figure 2.1. *Theoretical Model Explaining Twins' and Singletons' Adjustment from Middle Childhood to Adolescence*

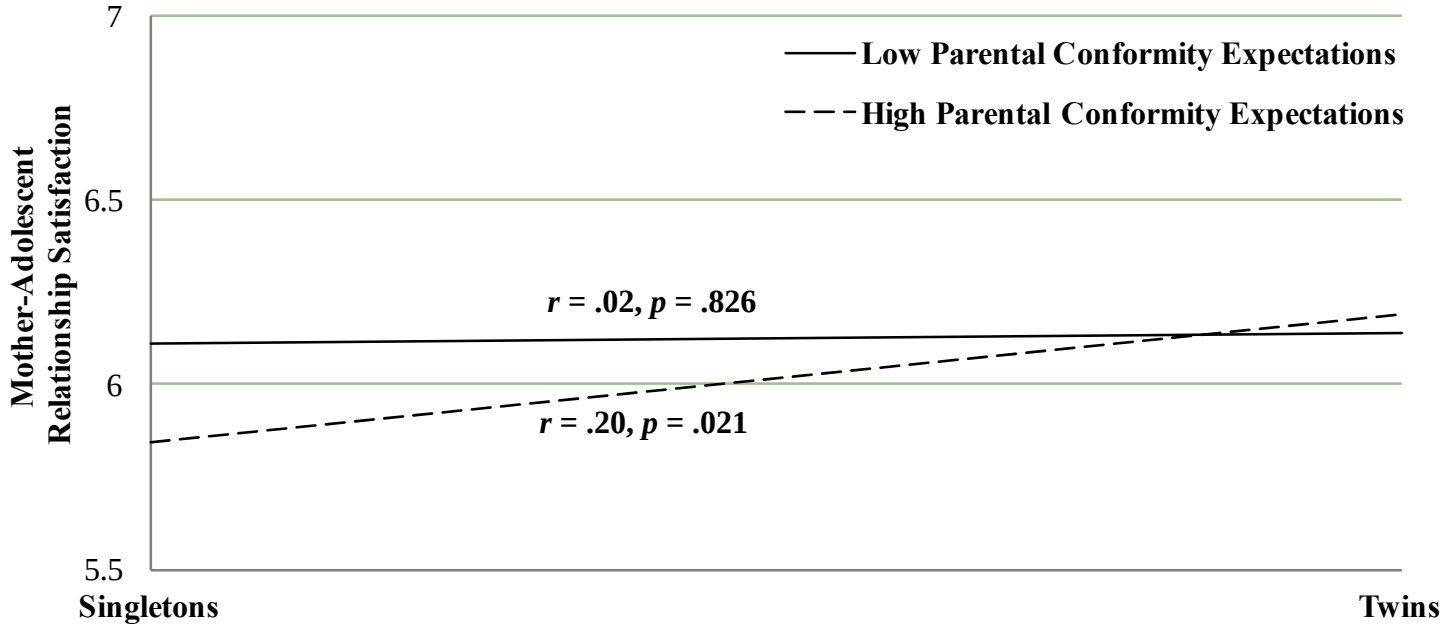

Figure 2.2. *Interaction Effect of IVF Twin Status by Conformity Expectations on Mother-Adolescent Relationship Satisfaction*

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