Relationships with Full, Half, and Stepsiblings in Adulthood: Does Coresidence Explain the Stepgap?

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Abstract

Objective. This paper aims to compare adult sibling ties of stepsiblings to the ties of full and half-siblings in divorced families, widowed families, and single-parent families.

Background. Siblings are one of the most stable sources of attachment and companionship over the life course and function as important providers of practical and emotional support when going through important life transitions. Due to a steep rise in divorce over the past decades and accompanied increases in remarriage and multipartner fertility, many adults nowadays not only have full siblings, but also half-siblings and stepsiblings.

Method. Using a new module on adult sibling relationships and random- and fixed-effects modelling (OKiN, N = 4,506 dyads nested in N = 1,742 respondents), we examine the quality of full, half, and stepsibling ties in adulthood and test the main mechanisms driving a potential stepgap in sibling ties: (1) the (absence) of a shared genetic relatedness and (2) the amount of time shared in the same parental household.

Results. The weaker bonds adults, on average, have with their stepsiblings compared to their biological (full and half) siblings are largely explained by the shorter period of time they have lived together during childhood. Nevertheless, a substantial gap remains.

Conclusion. Our results confirm that a stepgap in sibling closeness, contact, and support is visible, but substantially reduced once shared time is considered.

Keywords: divorce, remarriage, siblings, stepfamilies, biological relatedness, shared residence

INTRODUCTION

The bond between siblings is unique due to its length and the shared social (and genetic) origin. For many, siblings are one of the most stable sources of attachment and companionship over the life course and function as important providers of practical and emotional support when going through important life transitions (Goetting, 1986). For example, older siblings might perform specific caretaker tasks for their younger counterparts (Voorpostel et al., 2007). Moreover, siblings can serve as important sources of practical and emotional support during life course events, such as marriage, childbearing, and divorce (White, 2001). Later in life, siblings often share the task of caring for their elderly parents. Due to a rise in divorce over the past few decades, accompanied by increases in remarriage and multipartner fertility, sibling ties have become increasingly diversified (Tach, 2015; Thomson, 2014). This means that alongside full siblings (who share both biological parents) and half-siblings (who share one biological parent), many adults nowadays also have stepsiblings. Do stepsiblings function as equally important sources of siblingship compared to siblings who do share a biological bond? Or do we observe a so-called stepgap?

Although most prior research focuses on biological siblings, the body of literature on complex sibling constellations has been growing rapidly from the 2000s onwards (see Sanner et al., 2018 for a review). Comparing the relationships of full siblings to those of stepsiblings, scholars found that, on average, stepsiblings report lower levels of closeness (Anderson, 1999; Gyuris et al., 2020), conflict (Deater-Deckard & Dunn, 2002), contact frequency (White & Riedmann, 1992), and generally live at larger distances from one another in

adulthood (Ganong & Coleman, 2017). Despite these differences, stepsiblings do have the potential to be key actors in each other's development, adjustment, and well-being (Ahrons, 2007; Brown et al., 2015; Ganong & Coleman, 2017; Gatins et al., 2014; Harcourt et al., 2015). Two main arguments are generally given to explain the lower quality ties between stepsiblings compared to biological siblings: (1) the absence of shared genetic relatedness and (2) the shorter amount of time spent together in the same parental household. Taken together, these two arguments suggest that the duration of shared residence needs to be taken into account if we want an accurate estimation of the barriers for stepsiblings to function as full sources of siblingship.

This article describes the ties between full siblings, half-siblings, and stepsiblings in adulthood and examines if there exists a so-called stepgap in the quality of these ties. To achieve this, we compare full siblings to stepsiblings but also half-siblings to stepsiblings, both *before* and *after* taking into consideration the duration of shared time. Stepsiblings are not biologically related to one another, while full siblings and half-siblings share a set of genes (50% and 25% respectively). The comparison with half-siblings is an insightful and more conservative addition to our analyses, because (1) stepsiblings and half-siblings are both embedded within a nonintact family structure and (2) there likely is more variation in the length of shared residence among half-siblings than among full siblings. If a contrast between half- and stepsiblings is found – and persists when differences in shared residence are held constant – we can conclude with more confidence that biological relatedness is an important factor determining the quality of adult sibling ties. Focusing on a wide variety of sibling dyads in different residence arrangements, we are also able to examine whether the stepgap differs depending on the gender of the parent as well as the personal characteristics of the sibling dyad.

We use data from a large sample of people aged 25-45 from the Netherlands with an oversample of people who grew up in divorced and separated families (Kalmijn et al., 2018). The reconstruction of siblings who played a role during childhood is more complete than it was in prior datasets, allowing us to map all siblings with whom the respondent lived during childhood. We also have data on stepsiblings with whom the respondent did not live and stepsiblings of whom the biological parent is no longer together with the parent of the respondent, both of which are rarely present in previous studies. For all of these sibling types, we have a reliable scale of relationship quality based on three indicators: (1) contact frequency, (2) emotional closeness, and (3) support, along with a detailed measure of shared residence.

BACKGROUND

Two common explanations exist for contrasts in the strength of ties between biological siblings and between stepsiblings: variations in (1) biological relatedness and (2) shared residency. The first argument suggests that stepsibling bonds will be weaker due to the absence of a biological relation. Based on evolutionary logic and differences in the societal norms surrounding biological versus social relationships, people tend to be more likely to invest in people to whom they are biologically related (Emlen, 1995; Schnettler & Steinbach, 2011). Empirical research confirms a distinction in how people feel and behave toward family members with whom they share a genetic bond and family members with whom they do not. For example, people feel less obliged to support stepparents than biological parents when they require help (Van Houdt et al., 2018). And, adults generally see their biological siblings, nephews and nieces more frequently than non-biological extended kin (Tanskanen & Danielsbacka, 2014). Based on arguments about evolutionary preferences and weaker norms

regarding non-biological kin, we expect that the ties between stepsiblings are weaker than the ties between siblings who do share a biological bond (H1).

A second and alternative reason for differences in stepsibling vis-à-vis biological sibling relationships concerns variations in shared residence during childhood. Siblings who have lived together in the same household for a longer period of time, have had more opportunities to invest in their relationship and more time to build a shared history. Consequently, the two have a better foundation for a strong sibling tie in adulthood (Tanskanen & Danielsbacka, 2019). But, such opportunities obviously differ per sibling type. Age differences between full siblings, especially in divorced families, are usually relatively small and siblings know each other from the birth of the youngest sibling onwards. In contrast, stepsiblings only enter the life of a child when parents remarry and the two siblings can be of any age when they enter each other's lives. As a result, the number of years stepsiblings live together during childhood will be smaller, if compared to full siblings. Childhood coresidence also serves as a cue for sibling detection. If there is uncertainty about biological relatedness, people might use coresidence history – just like facial resemblance – as a cue to determine whether they are genetically related or not (Tanskanen et al., 2021). The implication is that stepsiblings will have lower-quality relationships compared to biological siblings simply because they were less exposed to one another during childhood (Andersson, 2020). The hypothesis is that the gap between the ties of stepsiblings and the ties of siblings who share a biological bond will be reduced if we account for differences in shared time during childhood. In other words, shared residence should mediate the stepgap (H2).

A central theme with respect to these comparisons is parent gender, as children can have stepsiblings via their fathers' as well as their mothers' side. A first reason to expect the stepgap to differ between paternal and maternal siblings is the link between gender and shared time. Given the prominence of maternal custody after family instability, especially for

the cohort of adults studied in this paper, maternal siblings are assumed to have shared more time together in childhood than paternal siblings. A gap between the ties among stepsiblings and biological siblings is therefore particularly likely among paternal siblings (Pollet, 2007). A second reason moreover lies in parents' tendency to act as mediators between their biological children and (albeit to a lesser extent) their stepchildren. As family instability negatively affects children's ties with fathers more so than ties with mothers, the ability to take upon an active role in facilitating these ties is likely to differ by parent gender (Kalmijn et al., 2019). If so, gender differences might even persist once differences in shared residence are accounted for. In sum, we expect that the stepgap will be larger for paternal than maternal siblings (H3a) and that this gender difference in the stepgap is largely mediated by differences in the duration of shared residence (H3b).

The strength of stepsibling bonds is likely to vary depending on the characteristics of the sibling dyad. As similarity is argued to foster attraction, sibling bonds may firstly be stronger between siblings of the same gender (Tanskanen & Rotkirch, 2019; Voorpostel et al., 2007). Following the homophily principle, it will likely also be easier to overcome the lack of a biological bond if the two stepsiblings are of the same gender. In that case, we expect the stepgap to be larger among brother-sister dyads compared to sister-sister and brother-brother dyads (H4a). On the other hand, siblings who are similar to one another are more prone to feelings of rivalry (Pollet & Hoben, 2011). Being of the same gender may make siblings more likely to compare and feel competition with respect to their position in the family household. In addition, they may encounter similar parental expectations and share similar life experiences, making them more likely to compare themselves to one another as they navigate through life. From that viewpoint, the stepgap should be smaller among brother-sister dyads compared to same-sex sibling dyads (H4b).

Similar arguments can be applied to the role of age differences. Siblings who are closer in age have shared more experiences in childhood, and developmental timing of these experiences will be more similar. Being in the same life course phase creates opportunities for shared interests and joint activities (Tanskanen & Rotkirch, 2019; Voorpostel et al., 2007). As a result, these siblings may attach less value to the absence of a biological relation. The stepgap is thus expected to be smaller the closer siblings are in age (H5a). An alternative argument posits that feelings of rivalry are more prevalent among siblings who are closer in age. In childhood, these siblings might perceive more competition regarding their position and role in the family unit (Pollen & Hoben, 2011). To illustrate, if a stepsibling becomes the oldest sibling in the household, the original oldest sibling may experience this as a form of rivalry. As siblings progress through life, the inclination toward comparison also remains higher among those in similar life course phases. The absence of a biological relation may be more difficult to overcome for these siblings. In short, the stepgap is then expected to be larger the closer siblings are in age (H5b).

In testing these hypotheses, we build upon several prior studies that also aimed to establish the role of genetic relatedness for sibling ties. Table A1 gives an overview of all studies that compared stepsiblings to either full- or half-siblings. Studies comparing only full- to half-siblings are not included in the overview. So far, most prior evidence focuses on stepsibling dynamics in childhood (e.g., Anderson, 1999; Deater-Deckard & Dunn, 2002). Of the studies that examine stepsiblings as sources of kinship in adulthood, most are based on small and non-random samples of young adults (e.g., Bressan et al., 2009) or focus on particular outcomes, such as estrangement (Hank & Steinbach, 2022) or knowing whether or not the sibling is alive (Pollet & Nettle, 2009). Measures of sibling coresidence and its duration, if included, vary greatly in these studies. Some rely on comparisons of maternal siblings, who are assumed to have lived together in childhood, and paternal siblings, who are

assumed to have been brought up separately (Pollet, 2007; Pollet & Nettle, 2009; Tanskanen & Danielsbacka, 2014). Others use the number of sibling encounters as proxy (Gyuris et al., 2020) or check if the stepgap differs among siblings who have lived together for more than half of their childhood (Bressan et al., 2009). None of these studies moreover explore if the size of the stepgap varies depending on characteristics of the sibling dyad. In the following, we rather take a variety of adult siblings (full, half, step) and residence patterns (maternal, paternal) into consideration and use a detailed measure of the years of coresidence across childhood to fully disentangle the role of biological relatedness vis-à-vis shared time.

DATA AND METHODS

Data were used from the survey *Ouders en Kinderen in Nederland* (OKiN). The OKiN was gathered in 2017 among a sample of people aged 25-45 from the Dutch registers in 2017 (Kalmijn et al., 2018). The sample contained an oversample of people who were living with only one biological parent at age 15 and children who were living with one biological parent and the (new) partner of that parent. This resulted in a considerable share of adult respondents who grew up living with a divorced parent and a new partner. A mixed-mode was used where respondents were approached with an online questionnaire. Those who did not respond were approached for a face-to-face interview. The response rate was 62%. Details of the survey can be found in the data documentation (Kalmijn et al., 2017).

The current study used data from the second wave of the OKiN, which was held in 2020 (Kalmijn & Hornstra, 2020). In the second wave, a detailed set of questions on adult siblings, their relationships, and their residence histories was added to the questionnaire. Of those who were approached again, 59% responded (N = 3,070). Nonresponse analyses were performed to assess the selectivity of panel attrition. The probability of nonresponse was estimated for administrative and demographic variables, such as interview mode and marital

status, but also for subjective variables that were gathered in the first wave of the survey. The analyses showed that response was affected by some of the demographic variables (i.e., age, marital status, education, and employment) but not by the subjective measures on well-being (e.g., health, subjective wellbeing) and family characteristics (e.g., amount of contact with parents, conflict with parents, and pathway of family instability).

From the sample in wave 2 (N = 3,070), we selected respondents whose biological parents were divorced, widowed, or who had never lived together during youth (N = 26,037) and who had at least one (living) sibling (N = 1,858, M_{age} = 36; 56% female).

Definitions and Design

Full siblings were defined as (living) children of both biological parents. The definition of half-siblings was straightforward: children of one biological parent and their new partner. We did not use shared residence with the respondent as an element in the definition of half-siblings, as we wanted to treat 'sharing a household' as a variable in the analysis rather than as a selection criterion. We did exclude maternal (half-)siblings with age differences of more than 20 years since these are unlikely (5 siblings). Age differences of 20 and higher for other siblings were recoded to 20 (1.1%) to avoid outlier effects.

The definition of stepsiblings – and stepfamilies generally – is complex (Ganong & Coleman, 2017). Stepchildren were defined as the children of a new partner of the biological parent. As for half-siblings, the survey did not use shared residence with the respondent as an element in the definition of stepsiblings. A problem with this definition is that the group of stepsiblings becomes too broad and diverse. For example, when a parent repartners at a later age, the adult children of the parent and the adult children of the new partner will usually not be regarded as each other's siblings. Similarly, when the parent's new partner has children who live with an ex-partner, there will also be very little, if any, contact with these

'stepsiblings.' For these reasons, we used shared residence with the biological parent as an extra criterion. Specifically, we defined stepsiblings as children of a biological parent's new partner who (ever) lived with that biological parent. In these cases, there was at least some connection between the respondent and the sibling via the biological parent's household.

Detailed relationship characteristics were obtained for the siblings. In the questionnaire, a distinction was made between paternal and maternal step- and half-siblings. For each of the five types of siblings – full siblings, paternal half-siblings, paternal stepsiblings, maternal half-siblings, and maternal stepsiblings – respondents reported about their relationships and residence histories with up to three siblings. We assessed the number of siblings for each type and found that our coverage of stepsiblings and half-siblings was over 98%.

The data were transformed into a dyadic structure, with the dyads being the relationship between the respondent and each of the siblings. The total number of respondent-sibling dyads in the analyses was N = 4,506, belonging to N = 1,742 respondents. Of these, 2,076 were full siblings, 1,217 were half-siblings, and 1,213 were stepsiblings. Note that in the dyad file, full siblings are underrepresented as a consequence of our decision to obtain reports on no more than three siblings per type. Only respondents from dissolved marriages/cohabitations were included, so the numbers of step- and half-siblings are high.

*** insert Table 1 about here ***

Measurement

Three relationship characteristics were assessed: the frequency of contact (on a 7-point scale), the degree of closeness (on a 5-point scale), and the extent to which the sibling was a source of *support* (on a 5-point scale). Closeness was measured by asking "*How close are you with*

this brother/sister at the moment?" (5-point Likert scale). Contact frequency was measured as face-to-face contact, asking "*How often have you seen, called or had contact via social media (WhatsApp, SMS, etc.) with this brother/sister in the past 12 months?"* (7-point Likert scale). Finally, whether or not the respondent perceived the sibling as a source of support was measured by asking "*Would you ask this sibling for advice or help if you had a problem? For example, a problem with your health, something personal that concerns you, something at work, or more practical issues"* (5-point Likert scale).

The coding of items was linear and transformed into z-scores (M = 0, SD = 1). As expected, the three indicators were correlated. For full siblings, these were .72 (contact and closeness), .62 (contact and support), and .75 (closeness and support). For stepsiblings, they were .83, .72, and .81 respectively, and for half-siblings, .80, .71, and .80. Given the high correlations among indicators, it was decided to create one scale by taking the mean of the standardized variables (Cronbach's α = .92). For conceptual clarity, we do provide descriptive information for each outcome separately in Table 1.

Duration was measured by asking respondents if they lived with the stepsibling or half-sibling and if so, when this began and when this ended. The measure was operationalized as the exact number of years lived with the half- or stepsibling. For full siblings, the measure was based on the years of birth and the ages of leaving home of the respondent and the sibling. With this information, the 'overlap' of the full siblings can be measured as the earliest year of leaving home minus the latest year of birth. The age of leaving home was not measured for the full sibling and assumed to be equal to the age of leaving home of the respondent. We applied an estimated gender correction of 0.91 year earlier for sisters (and male respondents) and 0.91 year later for brothers (and female respondents). This number was obtained by comparing the average age at leaving home of men and women in the OKiN data. As Table 1 shows, there was still considerable variation in the duration variable for full

siblings, although the variation was larger for stepsiblings and half-siblings. Shared residence ranged from 0-21 years and was included with a linear and a quadratic term. The quadratic term was always significant, justifying its inclusion in the model.

The following independent variables were used in the analyses. First, the gender composition of the dyad was included, with mixed-gender dyads serving as the reference category. Second, the absolute age difference between respondent and sibling was included. Age differences for stepsiblings were slightly larger than for full siblings and much larger for half-siblings (Table 1). Because these differences may also affect relationships between siblings, and because they are correlated with the length of shared time, age differences were treated as a parallel mediating variable. In practice, the effect of age differences was never statistically significant.

A number of respondent characteristics was included: (a) level of education (scaled in ISEI; Schröder & Ganzeboom, 2014), (b) whether the respondent works for pay, (c) whether the respondent is living with a partner, (d) whether the respondent has children living at home, (e) self-rated health (ranging from 1 for very poor to 5 for very well), (f) and migrant background (1^{st} or 2^{nd} generation = 1, native origin = 0). No parallel measures for the siblings were available. To address the family level, we included three variables that are known to affect family ties (Grundy & Read, 2012; Silverstein et al., 2019; Yu et al., 2010): (a) whether one or both parents belonged to a religious denomination when the respondent was growing up (yes = 1, no = 0), (b) how much conflict parents had when the child was growing up, measured with three items (e.g., how often parents didn't talk to each other), (c) the number of (step)siblings of the respondent (ranging from 1 to 10 or more). The three conflict items were measured on scales from 1 (never) to 4 (always) and were averaged into one scale (Cronbach's $\alpha = .85$). Means for the key outcome and mediator variables in the original

metric are presented in Table 1 by type of sibling. Means and standard deviations of all variables are presented in Table 2.

*** insert Table 2 about here ***

Method

We have data on multiple sibling dyads for each respondent. To analyze the dyadic data, we used both random- and fixed-effects regression models. The fixed-effects regression models compared types of siblings for the same respondent in the same family. The fixed-effects models implicitly controlled for unmeasured respondent characteristics. In part, these models also controlled for unmeasured family characteristics but only of the origin family (i.e., the family of the two biological parents), not of the new family or families in which respondents lived. We compared our findings with estimates of random-effects models which are based on differences within and between families. In these models, we controlled for respondent characteristics and the three family characteristics.

To estimate differences between dyads, alternative reference categories were used in parallel regression models. We focused on two kinds of stepgaps: stepsiblings versus full siblings and stepsiblings versus half-siblings. This was done separately for the maternal and paternal side of the family, leading to four contrasts in total.

Three random-effects models and three fixed-effects models were estimated to test our hypotheses (Table 3). The first model did not control for duration; the second model added duration and duration squared, and the third model excluded siblings with whom the respondent never lived while keeping the duration effect in the model. Using the KHB module in STATA (Kohler & Karlson, 2012), we calculated the percentage of the total effect (the stepgap) that was mediated by duration, duration squared, and the absolute age

difference between siblings. Because no formal mediation test is available for fixed-effects models, the KHB module was based on a linear regression model where all variables were transformed into deviations from the family mean. Models for de-meaned data provide the same coefficients as a fixed-effects model (Petersen, 2004).

FINDINGS

Before discussing the regression results, we reflect on how the types of siblings differed in terms of the time they shared while growing up. A description of shared residence and the years in shared residence by sibling type can be found in Table 1. Sharing a residence was most common among maternal siblings (half-siblings 89%; stepsiblings 82%) and less common for paternal siblings (half-siblings 40%; stepsiblings 53%). The length of shared time (given any coresidence) was also largest for maternal half-siblings (10 years) and smaller for stepsiblings and paternal half-siblings (approximately 6-7 years). This is likely due to the fact that living at the maternal residence after divorce was still the norm, especially when this generation of adults was growing up (Poortman & van Gaalen, 2017). For full siblings, this was about 17 years (of the 21-years maximum). Upon first inspection of the descriptive data, respondents are shown have less contact with stepsiblings than with full siblings, feel less close to them, and are expecting less support from them. Although the gap in relationship-quality seems to be smaller, we also see that respondents feel less close, have less contact with, and expect less support from their stepsiblings than their half-siblings. Based on these descriptions, the influence of biological relatedness seems to adhere to a rather uniform pattern across sibling closeness, contact, and support, providing us valuable insights into the nature of sibling ties compared to other kinship connections.

*** insert Table 3 about here ***

Stepsiblings and Full Siblings

We started with the comparisons between the ties of stepsiblings and full siblings without controlling for duration (Table 3, Model 1). According to the fixed-effects model, respondents had weaker ties with stepsiblings than with full siblings. The effect sizes were strong, clearly confirming our first hypothesis (H1). For maternal stepsiblings, the effect was $d = 1.19$, for paternal stepsiblings, the effect was $d = 1.38$. Since the dependent variable was standardized, the effect of these dichotomous variables are equal to effect sizes. The difference between the paternal and maternal stepgap was in the expected direction but small in magnitude, in contrast to expectation (H3a). The random-effects models yield virtually the same stepgaps in sibling ties (1.14 and 1.33) but provide additional effects. Having paid work, a higher education, and no children was associated with stronger ties to siblings. Sibling ties were stronger in families characterized by parental conflict. Religiosity and sibsize had no effect on sibling ties.

Controls for duration were then added: duration, duration squared, and the absolute age difference (Table 3, Model 2). The main effect of duration was positive and the quadratic term was negative. The estimated top of the curve, calculated as $-\beta_1 / 2\ \beta_2$ where β_1 is the main effect and β_2 is the quadratic effect, was at a duration of 21 years (Model 2). In other words, there was an increase in the strength of sibling ties with duration and this slowed down (but did not reverse) at higher durations. When duration was added, the stepgap vis-à-vis full siblings declined , in line with our hypothesis (H2). Duration mediated a considerable part of the stepgap in sibling ties. The contrast for maternal stepsiblings was mediated with 37%. The paternal stepgap was mediated for 41%. According to the KHB analysis, these declines were statistically significant ($p < .01$). The declines were surprisingly similar for the maternal and paternal stepgap in sibling ties, refuting our expectation (H3b). Although shared

residence strongly reduced the stepgap, significant gaps between the ties of stepsiblings and those of full siblings remained after taking duration into account and these gaps were often still substantial in magnitude. To illustrate, the maternal stepgap was still -.74 and the paternal stepgap was still -.80 after taking duration into account. When limiting the sample to siblings with whom the respondent has lived (Table 3, Model 3), the stepgap did not decline further and even increased, although slightly. The effects of absolute age differences were never significant (Table 3). The random-effects models yield approximately the same amount of mediation and the same net effect of the stepgap.

Stepsiblings and Half-siblings

The comparison with half-siblings yielded partly similar and partly different findings. We observed strong gaps when comparing the ties with stepsiblings and half-siblings on the maternal side. Respondents had weaker ties with maternal stepsiblings than with maternal half-siblings. The effect was similar in magnitude in the comparison with full siblings. Specifically, the difference between maternal stepsibling ties and maternal half-sibling ties was d = -1.03, compared to a difference of d = -1.19 between maternal stepsibling ties and full sibling ties. On the paternal side, there was also a gap found in the comparison with half-siblings, but this stepgap, although significant, was smaller in magnitude. The effect size was d = -1.03 on the maternal side and d = -.33 on the paternal side (Table 3, Model 1).

Controlling for the duration of shared residence reduced the stepgap with half-siblings (Table 3, Model 2). The strength of this mediation was smaller than it was in the comparison with full siblings. The contrast between stepsiblings and half-siblings on the maternal side was mediated by duration for 21%. This mediation was statistically significant ($p < .01$). The contrast between stepsiblings and half-siblings on the paternal side was not mediated by duration: the effect after adjusting for duration was the same as it was before adjusting for

duration. In general, whereas duration did explain the stepgap between stepsiblings and full siblings, it appears that duration explained less (maternal) or nothing (paternal) of the stepgap between stepsiblings and half-siblings. Regardless of how much mediation there was, in all cases did we find remaining stepgaps.

To provide an overview of our main findings, Figure 1 presents the margins as implied by the model controlling for duration. A clear stepgap was found for all four comparisons: comparing stepsiblings to full siblings and comparing stepsiblings to half-siblings on both sides. The comparisons split out by paternal and maternal sibling showed that differences by parent gender are limited. The clear exception is that the stepgap was somewhat smaller when comparing paternal stepsiblings and paternal half-siblings than when comparing maternal stepsiblings and maternal half-siblings. Note, however, that the main reason for this deviation was the relatively weak position of paternal half-siblings. Whereas ties to maternal half-siblings were as strong as – and sometimes even stronger – than ties to full siblings, ties to paternal half-siblings were relatively weak.

*** insert Figure 1 about here ***

Gender and Age Differences

We continued with an investigation of the role of characteristics of the sibling dyad and the extent to which these moderate the stepgap. To examine the role of differences by gender and age, we added interactions to the random-effects model (Model 2, Table 4). Past research has shown that sibling dyads between sisters are stronger than those between brothers or in brother-sister dyads (Voorpostel et al., 2007). This was confirmed by our own models (Table 3). Compared to mixed dyads, dyads between sisters were stronger (d = .348). Dyads between brothers were comparable to mixed dyads.

We interacted the gender composition of the sibling dyad with the maternal and paternal stepgaps. Inspection of the interactions in Table 4 revealed a significant interaction of sisters (vs. mixed-gender dyads) and the maternal stepgap (b = -.268) and no significant interaction of brothers (vs. mixed) and the maternal stepgap (b = .013). To illustrate the effects, we present the margins of the model in Figure 2. The figure shows that the stepgap in sibling ties was larger for sisters than for brothers or mixed-gender dyads. In other words, even though the bond between sisters was the strongest, it was also affected the most by biological relatedness. This does not mean that stepsisters had the weakest tie, only that the stepgap was strongest for this type of dyad. For the paternal stepgap, the interactions were not significant nor were they significant in the comparison between stepsiblings and half-siblings. In sum, the findings do not confirm the homophily principle (H4a) but do partially confirm the notion of rivalry (H4b).

Table 4 also includes interactions by the absolute age difference between siblings. Although most of these interactions were not significant, there was one marginally significant interaction which was also substantial in magnitude. Specifically, we found that the maternal stepgap was weaker the larger the age difference between siblings. Figure 2 illustrates the effect. When stepsiblings were close in age, the stepgap was largest. The larger the difference, the smaller the stepgap. This was in line with the rivalry hypothesis (H5b) and in contrast to the homophily hypothesis (H5a). For the paternal stepgap, no interaction was found so the evidence for rivalry was incomplete at best.

*** insert Table 4 and Figure 2 about here ***

DISCUSSION AND CONCLUSION

In this paper, we examined the stepgap in sibling ties and compared the ties between adult stepsiblings to the ties between full siblings or half-siblings. Two main explanations were

theorized to drive this stepgap: (1) (the absence of) shared genes and (2) the amount of shared time in the same household. Most previous studies on family composition are lacking data on stepsiblings, their time spent in a shared household, and the relationship between siblings to examine the role of shared genes and coresidence in sibling ties. In this study, we used the OKiN data, which contains a complete overview of all sibling ties during childhood, their coresidence histories and the level of closeness, contact, and support in adulthood.

On a general level, our results indicated that there is a substantial stepgap in sibling ties. Controlling for shared residence reduced the stepgap significantly, showing that an important explanation for differences between full and half-sibling ties and stepsibling ties lies in the shorter time stepsiblings live together in childhood. Nevertheless, a substantial gap remained. In other words, adults have on average weaker bonds with their stepsiblings compared to their biological siblings, even when they lived together for the same amount of time. These results deviate from the literature on children's relationships to biological parents and stepparents. A similar analysis on the parental stepgap showed that it reduces to a minimum or disappears after controlling for shared residence, whereas our findings show that a significant stepgap remains for sibling ties (Becker et al., 2013; Kalmijn et al., 2019). This suggests that a biological bond may be more important for sibling ties than it is for intergenerational ties (but see the alternative explanations outlined below that apply to sibling ties but not parent ties).

We base our conclusion on two comparisons: ties with stepsibling versus full siblings and ties with stepsiblings versus half-siblings. The first comparison showed similar results for paternal and maternal siblings; compared to full siblings, adults feel less close with stepsiblings, less frequently have contact with stepsiblings, and would less often consider stepsiblings as a source of support in times of need. This complied with the few earlier studies comparing stepsiblings and full siblings, which reported a clear distinction between

siblings ties with and without shared genes (Gyuris et al., 2020; Pollet, 2007). However, the comparison with full siblings might be imbalanced, as full siblings are much less likely to be affected by divorce and family complexity than stepsiblings. We therefore also compared the ties of stepsiblings to those of half-siblings. Half-sibling ties are, just as stepsibling ties, inherent to a minimum level of family complexity and therefore function as a relevant reference group. Naturally, half-siblings share fewer genes than full siblings, which means that the comparison between half-siblings and stepsiblings is less strict. Although this is important for genetic research, for individuals' perceptions of the sibling bond, the full-half distinction has been shown to be less relevant. Half-siblings generally consider each other as siblings, with the concept "half-sibling" not carrying much meaning (Anderson, 1999; Bernstein, 1990). It is therefore unlikely that people will invest half as much in a half-sibling compared to a full sibling simply because they share only one biological parent. Also for the comparison between stepsiblings and half-siblings, our results suggest a stepgap that is strongly reduced, but not fully explained, by differences in shared residence histories.

We find few gender differences in the stepgap of siblings once differences in shared residence are taken into account. One exception is that the gap in relationship quality between half- and stepsiblings is smaller for paternal siblings. This is shown to mainly be the result of the relatively weak position of paternal compared to maternal half-siblings, even when shared time is taken into account. After family instability, children's bonds with biological fathers are generally weaker than their bonds with biological mothers (Kalmijn et al., 2019). As a result, mothers might be better able than fathers to stimulate the relationship between her biological child with a former partner and biological child with a current partner. After all, halfsibling are likely to be more disconnected when the biological father has a disrupted relationship with one of the two half-siblings (i.e., likely his child from a former marriage). This might be further enhanced by the fact that mothers often fulfil a kinkeeping role in the

family and therefore are naturally more involved in stimulating family cohesion, whereas fathers are less likely to be involved in such behavior (Di Leonardo, 1987; Rosenthal, 1985). Such triadic interdependencies are an interesting area of interest for future research on sibling ties after family instability.

How do we interpret the remaining stepgap that we found? There are two main explanations present in the literature: (1) evolutionary theory and (2) cultural norms. Evolutionary theory states that people have a natural instinct to prefer biological ties to non-biological ties to secure the continuation of one's own genes. This could explain the difference in adult sibling ties between biological siblings (full and half) and non-biological siblings as reported in this paper. Alternatively, the literature on cultural norms suggests that the lower investments in stepsiblings result from the ambiguous normative framework surrounding stepkin ties. While there is a cultural norm to take care of biological family members when they are in need of help, the rights and responsibilities toward non-biological family members are less clearly defined (Cherlin, 1978; Van Houdt et al., 2018). In the case of siblings, a supportive tie between full siblings fits our normative framework, whereas similar norms are less well established with respect to stepsibling. In other words, it is a bonus when you get along with your stepsibling but the expectations and feelings of obligation to form a close bond or provide support are much weaker or even absent.

We add three other potential explanations for the stepgap in sibling ties, all of which connect to the notion of family complexity. First, the multi-household family structure of stepsiblings extends the sibling group. Children in stepfamilies often spend time in different households: the household of their father and the household of their mother. Since not all siblings have the same biological parents, a multi-household structure emerges. As a result, children have a diverse group of full, half- and stepsiblings in multiple households to form ties with. The large and diverse group of siblings in stepfamilies might result in people being

more ‘picky’ in the selection of siblings they bond with. In other words, there is no need to have a strong bond with stepsiblings due to the presence of other sibling types.

Second, full and half-siblings know each other from the birth of the youngest sibling onwards while stepsiblings meet only later during childhood. Although we control for the years in shared residence, it is possible that this does not capture the difference in ties developed from birth onwards and ties that are only formed later in life. Attachment theory suggests that children form an attachment relationship to those who respond to their primary needs in the first year (Bowlby, 1969). If attachment goes well, the relationship with the primary caregiver will form a secure emotional base to discover the world in the subsequent years. Attachment is not unique to primary caregivers but happens also to other relevant social individuals around a child, such as a sibling (Whiteman et al., 2011). Empirical research shows that siblings often turn to each other for emotional support, which suggests that siblings are inherent part of the secure base discussed in attachment theory (Kim et al., 2006; Voorpostel & Blieszner, 2008). The unique bond between siblings is believed to be formed in the first years of a child’s life. Since stepchildren meet only later in life, their bond might be different from the bond between full and half-siblings, who know each other from birth onwards. In sum, it may not be the duration of shared residence that matters most but the timing.

A third alternative explanation lies in the differential treatments of full siblings, half-siblings and stepsiblings by parents. There is literature suggesting that parents will invest more time facilitating the bonds between their biological children than between their biological children and stepchildren (Danielsbacka & Tanskanen, 2015; Schnettler & Steinbach, 2011). If so, this could also in part explain the remaining gaps that were found.

As (step)siblings who are similar tend to develop stronger bonds, the size of the stepgap can vary depending on characteristics of the sibling dyad. We find evidence for this

phenomenon with respect to gender composition. Research has demonstrated the significance of gender commonality for full siblings, particularly highlighting the strength of sister-sister bonds (Tanskanen & Rotkirch, 2019; Voorpostel et al., 2007). Our results confirm that sister-sister ties are stronger than other ties, but also reveal that the stepgap is the largest among sisters. In short, even though the stepsister bond is relatively strong, the importance of biological relatedness is also more pronounced for sisters. The influence of stepsibling similarity on the size of the stepgap is gendered. This can be interpreted in light of the gendered perceptions of family dynamics (Ganong & Coleman, 2017). Normative views of family roles and relationships differ depending on gender, with notions of sisterly bonds possibly being more rigidly defined and therefore less easily adaptable to nonstandard family structures (as has been previously noted regarding the stepmother role; Kalmijn et al., 2019).

For future work on (step)sibling ties, we suggest several directions for exploration that we were unable to pursue ourselves. First, where we have focused on positive indicators of sibling ties, there also exists a rich literature on sibling conflict and rivalry that could be extended to the field of stepsibling ties (e.g., see Steinbach & Hank, 2018). To illustrate, one could explore whether the lack of a biological relation fuels conflict (i.e., as the norm to be close is less well established) and enhances rivalry (i.e., as the biological sibling may feel he or she deserves more attention from the biological parent than the stepsibling). Second, future studies could focus on the personal traits of the two siblings and how this affects stepsibling closeness, contact, and support. Given that kinship ties evolve over time, there is particular merit in exploring if sibling ties are shaped by life events, such as marital status, parenthood status, and socioeconomic position (Jensen et al., 2018). We did not have access to such information for the siblings in the respondent-sibling dyads in our data. Future inquiries could test whether such life events predict stepsibling ties in a manner similar to biological sibling ties and to what extent they moderate the found stepgap.

To conclude, we described in this article the quality of adult sibling ties in complex family structures. The combination of a complete overview of potential sibling ties and detailed measures on the years siblings lived together, enabled us to make a valuable contribution to the literature. This study provides an overview of sibling ties in complex family structures and could therefore motivate more in-depth analyses on stepsibling ties across other countries and contexts.

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Table 1. Summary statistics by type of sibling

	Brothers	Sisters	Monthly contact	Contact frequency		Closeness		Support	
	%	%	%	Mean	SD	Mean	SD	Mean	SD
Full	22.1	29.2	71.0	2.96	1.32	3.35	1.14	3.33	1.34
Maternal half	20.7	29.8	70.2	2.87	1.36	3.23	1.15	2.89	1.30
Maternal step	20.8	30.6	24.2	1.50	1.28	2.09	1.06	1.93	1.14
Paternal half	20.8	27.8	33.7	1.71	1.34	2.36	1.14	1.98	1.14
Paternal step	24.6	25.2	13.3	1.13	1.10	1.82	0.98	1.66	1.00
Total	21.9	28.6	50.7	2.30	1.50	2.80	1.27	2.65	1.42
	Age		Age difference		Duration		Duration (shared only)	Coresidence	N
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	
Full	34.71	5.79	4.32	3.31	16.80	3.22	16.81	1.000	2076
Maternal half	29.49	5.99	7.46	4.35	8.95	5.55	10.07	0.889	503
Maternal step	33.86	6.35	5.46	3.99	5.64	4.49	6.90	0.817	553
Paternal half	28.93	6.46	9.85	5.19	2.70	4.43	6.76	0.399	722
Paternal step	33.19	6.19	4.99	4.03	3.21	3.98	6.01	0.534	667
Total	32.88	6.48	5.79	4.45	10.31	7.42	12.88	0.800	4521

Note: Source is OKiN 2020. Only respondents from separated, never-married or widowed families.

Table 2. Means and standard deviations of variables

Variable	N	Mean	SD	Min	Max
Strength index	4521	0	1	-1.479	1.782
Education	4521	70.088	15.568	22.98	87.13
Paid work	4521	.878	.327	0	1
Has children	4521	.54	.498	0	1
Partnered	4521	.807	.394	0	1
Self-rated health	4521	4.128	.723	1	5
Migration background	4521	.061	.24	0	1
Parental religiosity	4518	1.859	1.371	1	6
Parental conflict youth	4057	1.893	.93	1	4
Sibsize	4521	4.32	2.16	1	10
Mean age	4521	32.876	6.483	12.5	52.5
Absolute age difference	4521	5.791	4.453	0	20
Male-male dyad	4521	.219	.414	0	1
Female-female dyad	4521	.286	.452	0	1
Time together	4521	10.306	7.421	0	21
Time together squared	4521	161.267	150.96	0	441

Note: Source is OKiN 2020. Only respondents from separated, never-married or widowed families

Table 3. Random- and fixed-effects regression models of strength of ties to adult siblings

	M1: RE	M2: RE	M3: RE	M1: FE	M2: FE	M3: FE
Maternal step vs. full	-1.1356**	-.6948**	-.7254**	-1.1859**	-.7404**	-.8298**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Paternal step vs. full	-1.3308**	-.7427**	-.8001**	-1.3798**	-.7972**	-.9272**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Maternal step vs. half	-.9318**	-.7390**	-.7595**	-1.0345**	-.8215**	-.8920**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Paternal step vs. half	-.3151**	-.3346**	-.4493**	-.3323**	-.3340**	-.4940**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Mean age	-.0096**	-.0133**	-.0139**	-.0076	-.0154**	-.0058
	(.000)	(.000)	(.000)	(.152)	(.003)	(.490)
Male-male dyad	.0686*	.0630*	.0860*	.0584	.0505	.0799
	(.035)	(.047)	(.017)	(.147)	(.200)	(.092)
Female-female dyad	.3288**	.3233**	.3556**	.3477**	.3450**	.3813**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Time together		.0917**	.0938**		.0804**	.0716**
		(.000)	(.000)		(.000)	(.000)
Time together squared		-.0024**	-.0025**		-.0019**	-.0019**
		(.000)	(.000)		(.000)	(.002)
Absolute age difference		.0063	.0134**		.0025	.0048
		(.062)	(.003)		(.517)	(.414)
Education	.0033**	.0029**	.0023			
	(.003)	(.009)	(.060)			
Paid work	.1696**	.1618**	.1472*			
	(.002)	(.002)	(.011)			
Has children	-.0766*	-.0449	-.0365			
	(.041)	(.221)	(.369)			
Partnered	-.0106	-.0304	-.0254			
	(.811)	(.483)	(.592)			
Self-rated health	.0426	.0366	.0610*			
	(.086)	(.130)	(.020)			
Migration background	.0879	.1076	.1443			
	(.207)	(.114)	(.058)			

Parental religiosity	.0071	.0069	.0050			
	(.578)	(.580)	(.707)			
Parental conflict youth	-.0596**	-.0421*	-.0471*			
	(.001)	(.018)	(.015)			
Sibsize	-.0127	-.0064	-.0007			
	(.118)	(.416)	(.931)			
Constant	.3753*	-.3520*	-.4489*	.6691**	.1359	-.0754
	(.020)	(.035)	(.020)	(.000)	(.467)	(.787)
N dyads	4057	4057	3230	4521	4521	3618
N persons	1592	1592	1527	1800	1800	1725
R2 total	.334	.374	.288	.307	.347	.253
R2 within	.415	.443	.347	.402	.432	.327

Note: OKiN 2020. M3 excludes siblings with no shared residence. P-values in parentheses. Contrasts estimated in separate models using alternative reference categories. Mixed-gender dyads reference.

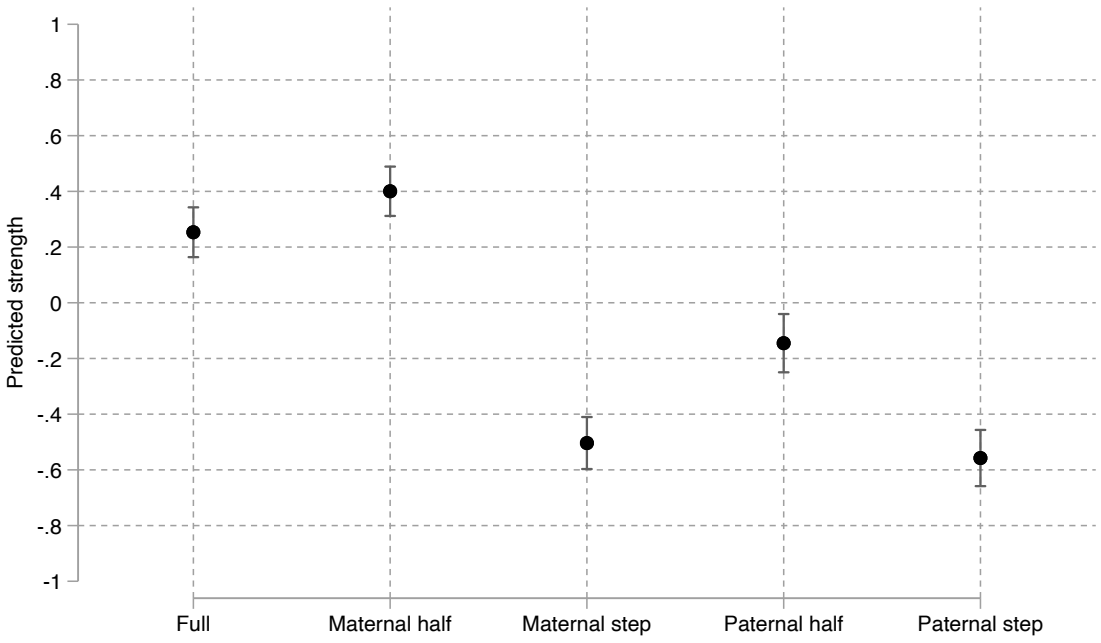
* $p < 0.05$, ** $p < 0.01$

Table 4. Random-effects regression models of ties to adult siblings with interactions

	Strength index		Strength index
Maternal step vs. full	-.5863**	Maternal step vs. half	-.6273**
	(.000)		(.000)
x age difference	.0193~	x age difference	.0054
	(.067)		(.688)
x brothers	.0129	x brothers	.0214
	(.894)		(.871)
x sisters	-.2681**	x sisters	-.2136~
	(.002)		(.068)
Paternal step vs. full	-.6317**	Paternal step vs. half	-.3448**
	(.000)		(.000)
x age difference	-.0127	x age difference	-.0046
	(.179)		(.629)
x brothers	-.0777	x brothers	-.0136
	(.361)		(.896)
x sisters	-.2978**	x sisters	-.0911
	(.000)		(.354)
Absolute age difference	.0076		
	(.189)		
Male-male dyad	.0909*		
	(.044)		
Female-female dyad	.4446**		
	(.000)		
N dyads	4057		
N persons	1592		
R2 total	.377		
R2 within	.450		

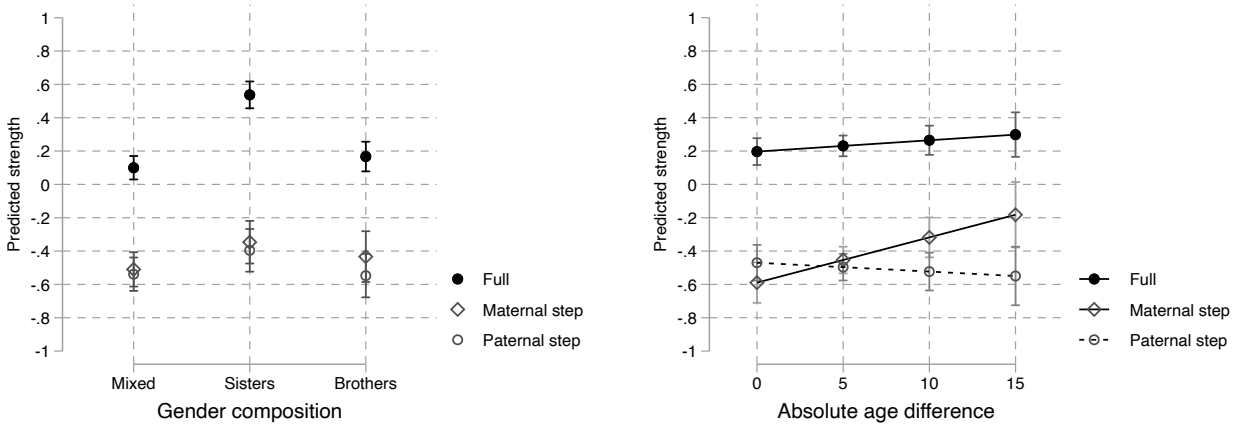
Note: OKiN 2020. P-values in parentheses. Age difference centered. Mixed gender dyads reference. Control variables included (see Table 3).
~ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Figure 1. Relationship outcomes by type of sibling



Note: Margins from fixed-effects models controlled for duration at the average.

Figure 2. Stepgap interacted by gender and age composition of the sibling dyad



Note: Margins from random-effects models controlled for duration at the average.

Appendix

Table A1. Overview of literature comparing the relationships of stepsiblings to the relationships of full or half-siblings.

Publication	Siblings	Data	Outcome of interest	Timing	Shared residence
White & Riedmann, 1992	Full, Half Full, Step	N = National Survey of Families and Households	Face-to-face contact	Adulthood	Length of time within stepfamily
Anderson, 1999	Full, Half Full, Step	N = 516 Nonshared Environment in Adolescent Development	Positivity Negativity	Childhood	n/a
Deater-Deckard, & Dunn, 2002	Full, Half Full, Step	N = 192 Avon Brothers and Sisters Study	Positivity Negativity	Childhood	n/a
Lieberman et al., 2017	Full/Half, Step	N = ~600 undergraduates from university in the US	Altruism	(Young) Adulthood	Coresidence duration between respondent age 0-18 (years)
Pollet & Nettle, 2009	Full, Half Full, Step	N = 7610 Netherlands Kinship Panel Study (NKPS)	Knowledge on sibling being alive/dead	Adulthood	Comparisons paternal and maternal siblings.
Bressan, Colarelli, Cavalieri, 2009	Full, Half Full, Step	N = 170 Undergraduates from university in Midwest US	Altruism	(Young) Adulthood	Measured as (1) never, (2) about 5 years, (3) about 11 years, (4) about 18 years
Sznycer et al., 2016	Full/Half, Step	Five samples of undergraduates from universities in the US (N = 158 and 109), Hawaii (N = 122), Dominica (73), Belgium (N = 139), and Argentina (N = 201)	Altruism	(Young) Adulthood	Coresidence duration between respondent age 0-18 (years)
Steinbach & Hank, 2018	Full, Half Full, Step	N = 5482 German Family Panel	Closeness Contact Conflict	(Young) adulthood	Coresided (1) never, (2) a short time, (3) less than half, (4) more than half (5) entire time

					of the time till age 18 By default, full siblings in pairfam are assumed to have co-resided in childhood.
Gyuris, Kozma, Kisander, Láng, Ferencz, Kocsor, 2020	Full. Half Full, Step	N = 330 Sibling Relationship Questionnaire via Psytoolkit	Relationship-quality Conflict	(Young) adulthood	Frequency of encounters: (1) occasionally (2) monthly (3) weekly (4) lived together
Hank & Steinbach, 2022	Full, Half Half, Step	N = 5729 German Family Panel	Sibling estrangement	(Young) adulthood	Measured as: coresided (1) less than half, (2) at least half, (3) more than half of the time till age 18 By default, full siblings in pairfam are assumed to have co-resided in childhood.