Adolescent social functioning in offspring at high risk for schizophrenia spectrum disorders in the Finnish Adoptive Family Study of Schizophrenia

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Abstract

Background: Children and adolescents with a genetic risk for schizophrenia are often found to have poorer social functioning compared to their controls. However, less is known about high-risk offspring who have not been reared by a biological parent with schizophrenia. The purpose of this study was to examine deficits in social functioning in adolescence as a possible factor related to genetic vulnerability to schizophrenia spectrum disorders, and also to examine possible gender differences in these associations.

Method: The present sample consisted of 88 genetic high-risk (HR) adoptees whose biological mothers were diagnosed with schizophrenia spectrum disorders and 83 genetic low-risk (LR) adoptees with biological mothers with non-schizophrenia spectrum disorders or no psychiatric disorders. Adoptees' social functioning at ages 16–20 was assessed using the UCLA Social Attainment Survey.

Results: Compared to LR adoptees, HR adoptees displayed statistically significant deficits in their peer relationships, involvement in activities and overall social functioning during adolescence. HR males were distinguished from LR males by their significantly poorer overall social functioning. Compared to HR females, HR males showed significant deficits in their romantic relationships. Of marginal significance was that HR females displayed more social functioning deficits relative to LR females, mainly in the areas of peer relationships, involvement in activities and overall social functioning.

Conclusions: These results from the adoption and high-risk study design suggest that deficits in social functioning in adolescence may be related to genetic vulnerability to schizophrenia spectrum disorders and that some of these deficits may be gender-specific.

Keywords: high-risk; adoptive family study; schizophrenia; vulnerability; social functioning

1 Introduction

Impaired social functioning has been recognized as one of the core features of schizophrenia since the initial definition of the disorder (Kraepelin, 1919,1971). It is thought that deficits in important social domains, such as social skills (reciprocity, eye contact, active listening), social cognition (emotion recognition, mentalizing) and social motivation (drive to initiate social interaction) contribute to the impaired social functioning seen in schizophrenia (Fulford et al. 2018). Consequently, patients with schizophrenia typically have reduced social networks and infrequently achieve important social milestones such as marriage or stable interpersonal relationships (for a review, see Harvey et al., 2012). Furthermore, findings suggest that impaired social functioning may be a marker of illness vulnerability in individuals at genetic risk for schizophrenia (Gibson et al., 2010; Gkintoni et al., 2017; Horton et al., 2014; Shim et al., 2008).

Studies have shown that children and adolescents who have a first-degree family member with schizophrenia display poorer social functioning compared to their low-risk controls. High-risk individuals have fewer hobbies and interests (Dworkin et al., 1994), poorer peer and opposite sex relationships characterized by greater frequency of problems and less positive involvement (Dworkin et al., 1994; Hans et al., 2000; Glatt et al., 2006; Noguera et al., 2018) as well as more deficits related to social reciprocity, and social motivation and initiative (Horton et al., 2014). In contrast to most of these studies, in a study by Horton et al. (2017), high-risk children and adolescents were not found to show more social deficits overall in relation to their controls but did show more internalizing problem behaviors. Although social functioning deficits are often documented in high-risk studies, little is still known about the quality of these deficits. Thus, there is a need for more specific analyses of the types of social deficits in children and adolescents at high risk for schizophrenia (Horton et al., 2014, 2017).

Also, given that social functioning deficits are often observed in high-risk studies, these studies have rarely investigated possible gender differences in these associations even in the light of gender differences being commonly found in schizophrenia (Barajas et al., 2015; Goldstein et al., 2013; Preston et al., 2002; Riecher-Rössler et al., 2018; Segarra et al., 2012). Olin et al. (1995) showed pre-schizophrenic high-risk males to be lonely, anxious, rejected and having disciplinary problems in school, whereas females were found to be quiet, passive, withdrawn and nervous. In a study by Gutt et al. (2008), high-risk females had a higher prevalence of aggressive behavior compared to males. Furthermore, in order to better understand impaired social functioning as an indicator of genetic vulnerability to schizophrenia spectrum disorders,

it is also necessary to investigate the types of social functioning deficits that might characterize genetic high-risk males and females. With respect to patients with schizophrenia, it is already well-established that males display poorer social functioning than females before and after the onset of illness (for a review, see Riecher-Rössler et al., 2018).

Since schizophrenia has been suggested to be multifactorial/polygenetic in nature (Cheng et al., 2016; Gottesman, 1991, 1994; Suvisaari et al., 2013; Tsuang, 2000; Wang et al., 2019), it is important to consider both genetic and environmental factors in the research of vulnerability indicators (Gottesman & Shields, 1967; Nuechterlein, 1987). This study uses an adoption and high-risk study design, where the genetic factors of the adoptees come from the biological parents and the environmental factors are determined by the adoptive parents. A child who is reared by adoptive parents and not by the biological mother may avoid the possible disturbing environmental influences of a psychiatric illness, thus making the genetic influences (genotype) more distinguishable (Tienari & Wynne, 1994; Tienari et al., 2000).

Thus, compared to traditional high-risk studies, the strength of the adoptive method lies in the fact that it makes it possible to exclude the possibility that the social functioning of the adoptee is environmentally affected by the biological parent with schizophrenia. However, only few studies have used such study design. In a study by MacCrimmon et al., (1980), adolescent high-risk subjects who were placed in foster homes at early age showed increased social isolation in relation to their controls. In the Danish Adoption study (Kety et al., 1968, 1994; Kendler et al., 1994), which has used the adoptees' relatives method, biological relatives of adoptees with schizophrenia were found to display more social withdrawal and antisocial behavior in childhood compared to the biological relatives of control adoptees (Kendler et al., 1982).

To the best of our knowledge, no studies to date have investigated the social functioning of adopted-away offspring of schizophrenic biological mothers, which is the purpose of this study. Considering that adolescence may be an important period for the emergence of social functioning deficits in high-risk individuals (Glatt et al., 2006; Hans et al., 2000; Horton et al., 2014; Noguera et al., 2018), the aim of this study was to investigate deficits in social functioning during adolescence as a possible characteristic related to the heritability of schizophrenia. It was hypothesized that genetic high-risk adoptees would show more social functioning deficits already in adolescence compared to the low-risk adoptees, especially in the areas of peer relationships and opposite sex relationships as they have been documented in earlier studies of high-risk individuals and patients with schizophrenia (Hans et al., 2000; Harvey et al., 2012;

Glatt et al., 2006; Noguera et al., 2018). It was further hypothesized that deficits in social functioning are emphasized in males, especially in the genetic high-risk group and in their opposite sex relationships (e.g. Barajas et al., 2015; Preston et al., 2002; Segarra et al., 2012).

2 Methods

2.1 Participants

The subjects in the present study were derived from the nationwide Finnish Adoptive Family Study of Schizophrenia (Tienari et al., 1981, 2000, 2003). Hospital records of 19 447 women were reviewed in order to identify those who had been hospitalized at least once for schizophrenia or paranoid psychosis during the years 1960–1979 and who had adopted away one or more offspring. The biological index mothers' diagnostic exclusion criteria included reactive (psychogenic) psychosis, manic-depression, depression, or any other disorder outside the broad schizophrenia spectrum (Kendler et al., 1996; Tienari et al., 2000, 2003). The control biological mothers were included as 'epidemiological' controls with the potential for a full array of psychiatric and physical illnesses characteristic of the general population. Adoptees were excluded if they had been adopted after the age of four years, adopted by a relative or adopted abroad (Tienari et al., 1987b, 2000, 2003). The adoptive parents were eligible for the study with no diagnostic exclusion criteria.

The final sample consisted of 190 high genetic risk (HR) adoptees whose biological mothers had verified DSM-III-R (American Psychiatric Association, 1987) diagnoses of schizophrenia, odd-cluster personality disorders (schizotypal, schizoid, and paranoid personality disorders plus avoidant personality disorder), non-schizophrenic nonaffective psychoses (schizoaffective, schizophreniform, and delusional disorders and psychotic disorder not otherwise specified) or affective psychoses (bipolar and depressive disorders with psychotic features) (Kendler et al., 1996; Tienari et al., 2000, 2003). The control sample included 192 adoptees at low genetic risk (LR) with biological mothers with non-schizophrenia spectrum disorders or no psychiatric disorders. The kappa coefficient for interrater reliability was found to be good (0.80). High diagnostic reliability was ascertained by preparing case summaries for randomly selected study subjects along with a subgroup with global mental health ratings at a serious level, checking for rater drift over time, and by re-examining possible diagnostic 'problem cases' (Tienari et al., 2000). The design, sampling, and diagnostic procedures of the adoption study have been described in detail earlier (Tienari et al., 1987a, b, 2000, 2003, 2004).

The subsample used in this study consisted of 171 adoptees (88 HR and 83 LR) with a minimum age of 16 years (for the ages of HR and LR adoptees at the time of the interview, see Table 1) and for whom the information on the UCLA Social Attainment Survey was available for at least four out of seven items of the survey.

2.2 Assessment of social functioning

Social functioning of the adoptees at ages 16–20 years was assessed by experienced psychiatrists at the initial phase of the study, beginning in 1977. All the interviews were conducted at the homes of the adoptive families. The assessment was made using the UCLA Social Attainment Survey (UCLA SAS) (Goldstein, 1978), a seven-item scale evaluating peer and romantic relationships, and participation in activities and organizations during adolescence.

Each item has a 1–5-point rating and the total scores range from 7 (low functioning) to 35 (high functioning). The seven items include: 1. Same-sex peer relationships, 2. Leadership in same-sex peer relationships, 3. Opposite-sex relations, 4. Dating history, 5. Sexual experience, 6. Outside activities and 7. Participation in organizations. The ratings of these items were based on a semi-structured interview, intended to promote optimally good contact (Tienari et al., 1987b). All the interviews were tape-recorded for blind re-classifications.

Consistent with prior research (e.g. Horan et al., 2006; Subotnik et al., 2000; Weinstock & Miller, 2008), the seven items of UCLA SAS were divided into three content areas: Peer Relationships (items 1–2), Romantic Relationships (items 3–5), and Involvement in Activities (items 6–7). The means of the items for each of the three content areas were examined in order to understand important individual areas of adoptees' social functioning. Total scores were also examined as a measure of overall social functioning.

2.3 Statistical methods

Statistical significance of group differences in categorical variables was assessed with Pearson's Chi-square test or Fisher's Exact test and, in continuous variables with Student's t-test and one-way analysis of variance. Two-way ANOVA was used to examine the association of genetic risk (main effect), gender (main effect), and their interaction with UCLA SAS scores. All tests were two-tailed and the limit for statistical significance was set at $p<0.05$. IBM SPSS Statistics 25 software was used in analyses.

3 Results

3.1 Demographic characteristics

Demographic characteristics are presented in Table 1. There were no statistically significant differences in the demographic characteristics between HR and LR adoptees.

/Insert Table 1 about here/

3.2 HR & LR adoptees' social functioning at ages 16–20 years

As seen in Table 2 and visualized in Figures 1–2, HR adoptees scored lower in all the domains when compared to the LR adoptees, indicating poorer social functioning. HR adoptees scored significantly lower in Peer Relationships (p=0.019), Involvement in Activities (p=0.022) and Total score (p=0.007) compared to LR adoptees.

In male adoptees, HR males' Total score (p=0.036) was found to be significantly lower than in LR males. In female adoptees, a marginally significant difference was observed in Peer Relationships (p=0.065), Involvement in Activities (p=0.093), Total score (p=0.091), with HR females scoring more poorly than LR females.

/Insert Table 2 about here/

/Insert Figures 1-2 about here/

3.3 Gender differences in adoptees' social functioning

As presented in Table 3, in the total sample of the adoptees a marginally significant difference was found in Involvement in Activities (p=0.062) between all males and females, with males receiving poorer scores than females. Within HR adoptees, HR males scored significantly lower in Romantic Relationships than HR females (p=0.041), while no gender-difference was observed within LR adoptees.

/Insert Table 3 about here/

3.4 Genetic risk and gender interaction in adoptees' social functioning

Table 4 shows the results of two-way ANOVA, in which the genetic risk, gender and their interaction were simultaneously regressed against the variables for UCLA SAS scores. The results emphasized the impact of the genetic risk (as main effect) to social functioning, particularly to Peer Relationships (p=0.019), Involvement in Activities (p=0.027), and Total score (p=0.007), while gender (as main effect) and interaction between the genetic risk and gender were not associated to the UCLA SAS scores.

/Insert Table 4 about here/

4 Discussion

The purpose of this study was to examine social functioning deficits at age 16–20 years as a possible factor related to genetic vulnerability to schizophrenia. To the best of our knowledge, this is the first adoption study investigating the relationships between adolescent social functioning and genetic risk for schizophrenia spectrum disorders. In our study, poorer social functioning already in adolescence was emphasized in HR adoptees compared to LR adoptees, especially in Peer Relationships and Involvement in Activities.

Specifically, HR adoptees reported notably less initiative-taking in their peer relationships, fewer close peer relations as well as less self-initiated participation in social activities outside the home. Together with the observation of HR adoptees' poorer overall social functioning, these findings replicate the earlier finding of high-risk adolescents' poorer peer relationships, decreased hobbies/interests and poorer overall social functioning (Dworkin et al., 1994). However, contradictory to some earlier findings (Glatt et al., 2006; Hans et al., 2000), HR adoptees were not found to have poorer romantic relationships with the opposite sex relative to LR adoptees.

This finding of HR adoptees' less social initiative-taking and self-initiated participation in social activities is supported by an earlier finding of high-risk adolescents' deficits in social motivation and initiative (Horton et al., 2014). Fulford et al. (2018) have proposed that social motivation can be differentiated from social skills and social cognition based on drive for social interaction, including the effort and initiative needed to establish and maintain social relationships. Importantly, diminished motivation to initiate social interactions (or amotivation), is also

seen in schizophrenia and may be related to reduced sensitivity to social reward (Fulford et al., 2018; Lee et al., 2018). Although high-risk studies have not investigated this connection, the present findings indicate that deficits related to initiative-taking in peer relationships and self-initiated participation in social activities, which are typical for schizophrenia, may also characterize adolescent HR adoptees.

Within our study sample, HR males' overall social functioning in adolescence was observed to be poorer compared to the LR males, indicating lower levels of initiative-taking, interaction and emotional involvement in interpersonal relationships, and less self-initiated participation in social activities. Although not statistically significant, HR females also were shown to have less initiative-taking in their peer relationships, less self-initiated participation in social activities, and poorer overall social functioning in adolescence relative to LR females. These findings are in concordance with the study by Olin et al. (1995), who reported pre-schizophrenic high-risk females to be passive, quiet and withdrawn, as opposed to pre-schizophrenic high-risk males who were found to be lonely, rejected, anxious and antisocial.

With respect to gender differences, HR male adoptees were found to score significantly lower in the Romantic Relationships domain compared to HR females. Specifically, HR males reported lower emotional involvement and less interaction with the opposite sex and less dating experience in adolescence. In general, when comparing HR and LR males with their corresponding females, males reported somewhat less self-initiated participation in social activities than females and had slightly but clearly poorer overall social functioning.

Given that the direction of scores was similar between male and female adoptees in HR and LR groups, the results might, at least to some extent, reflect age-related differences between males and females (e.g. females' earlier interest in dating). However, since gender differences in adolescent social functioning were found only in the HR group, these results cannot be fully explained based on such differences. Hans et al. (2000) have proposed that high-risk adolescents characterized by problems in social relationships may be at risk of not achieving competence in interactions with the opposite sex, which is one of the central developmental tasks of adolescence. It seems that this may be related especially to HR male adoptees. These findings are reinforced by results from a three-generation study (Svensson et al., 2007), in which male offspring of patients with schizophrenia were found to demonstrate reduced fertility rates, whereas female offspring were found to demonstrate normal fertility rates relative to the general population.

These findings are also supported by studies of patients with schizophrenia: male patients display more difficulties in establishing relationships with the opposite sex and are less likely to be married before the onset of illness (Preston et al., 2002; Thorup et al., 2007; Segarra et al., 2012), and demonstrate lower fertility rates than females relative to general population (Bundy et al., 2011; Svensson et al., 2007). In general, the onset of schizophrenia is earlier in males, usually in early or late adolescence, as opposed to females who often begin to manifest their first symptoms in their early or late twenties (Häfner et al., 1989; Riecher-Rössler et al., 2018). This might offer females a better opportunity to develop intimate relationships or get married before the onset of illness, for instance (Leung & Chue, 2000). However, in order to determine if the deficits in social functioning during adolescence observed in this study are signs of future illness onset, further research on the adoptees' later psychiatric morbidity is necessary.

4.1 Strengths and limitations

The subsample investigated in this study was derived from the globally well-known and nationwide Finnish Adoptive Family Study of Schizophrenia. In the future, the collection of equivalent nationwide data is most likely impossible. The adoption study design made it possible to examine genetic and environmental factors separately. Although the measures of the adoptive family environmental variables were not included in this study, studying social functioning of high-risk adoptees who have not been reared by a biological parent with schizophrenia is a major strength given that the effect of living with a parent with such an disorder was avoided and the development of the social functioning is associated to the rearing environment shaped by the adoptive parents.

The adoptees' adolescent social functioning was assessed at their adoptive family homes by trained psychiatrists during the initial phase of the study along with multiple other individual and family measures. The assessment was conducted using the UCLA SAS which has proven to be a valid and a useful instrument in the assessment of current and pre-illness social functioning in first-episode (Horan et al., 2006; Ventura et al., 2019), chronic (Caton et al., 1999) and fully recovered (Torgalsbøen, 1999) patients with schizophrenia. It is noteworthy that UCLA SAS does not measure romantic relationships with members of the same sex, which is a limitation of the present study and UCLA SAS. Also, interviewing adoptees who had already passed the time period examined in UCLA SAS (ages 16–20 years) raises the possibility of recall bias. However, it may be assumed that the adoptees were able to remember the aspects

of their social relationships quite well, since they were still relatively young (mean age approximately 25 years) at the time of the interview.

Finally, the size of the sample used in this study was relatively small. A small sample size may lead to a lack of power in the statistical analyses and further to findings not being detected (Type II error). Also, since several statistical tests were performed, a possibility of chance findings exists (Type I error).

4.2 Conclusion

The present findings suggest that social functioning deficits already in adolescence, including fewer peer relations and especially decreased initiative-taking in peer relationships, may be related to genetic vulnerability to schizophrenia spectrum disorders together with decreased self-initiated participation in social activities. Although the differences between HR and LR females were not as pronounced as the differences between their corresponding males, it seems possible that the social functioning of HR females may be characterized by decreased initiative-taking in peer relationships and less self-initiated participation in social activities, whereas HR males might display a wider range of deficits related to interpersonal relationships and social activities. The findings also suggest that HR males may be distinguished from HR females by their poorer romantic relationships with the opposite sex. Given that HR and LR adoptees were found to differ in relation to their social functioning, our next study will focus on the adoptive family environmental factors (Myllyaho et al., 2019; Roisko et al., 2011; Siira et al., 2007; Tienari et al., 2005; Wahlberg et al., 2004) in order to understand how these factors may contribute to the development of the adoptees' social functioning.

The present findings may offer important information about the types of social functioning deficits experienced by high-risk adolescents as well as the possible gender differences related to genetic vulnerability to schizophrenia spectrum disorders. These findings could also be useful for early identification as they underline the deficits in genetic high-risk adolescents and by offering new gender-specific information to be included in interventions.

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Appendix

Table 1. Demographic characteristics

Variable	Adoptees		
	High risk (HR) n = 88	Low risk (LR) n = 83	Sig.
Mean age±SD at UCLA SAS assessment [a]	26.1±9.2 years	23.6±8.5 years	0.063
Mean age±SD at placement [a]	18.4±13.4 months	14.5±12.7 months	0.053
Gender M:F (%) [b]	40:48 (45.5:54.5%)	37:46 (44.6:55.4%)	0.909
* Social class of the adoptive family (%) [b]	I-II: 57 (64.8%) III-IV: 31 (35.2%)	I-II: 57 (68.7%) III-IV: 26 (31.3%)	0.589
Initial psychiatric status; Psychiatric diagnosis: no psychiatric diagnosis (%) [b]	37:51 (42:58%)	29:54 (34.9:65.1%)	0.340
Psychiatric diagnoses of the biological mothers (n)	Schizophrenia (61), Schizoaffective disorder (2), Schizophreniform psychosis (6), Schizotypal PD (1), Schizoid PD (1), Psychosis NOS (2), Delusional disorder (5), Bipolar psychosis (4), Depressive psychosis (3), Avoidant PD (3)	Border-line PD (1), Narcissistic PD (1), Alcohol use (3), Obs-comp PD (1), PD NOS (1), Major depressive disorder (1), Dysthymic disorder (3), Depression NOS (1), Anxiety disorder (3), Somatoform disorders (1) Other diagnoses (3), No diagnosis (29), No hospitalization (33)	

*Social class of the adoptive family was determined according to the four-level Finnish socioeconomic classification, a low number indicating a high social class (Statistic Finland, 17, 1983).

[a] T-test analyses were used for mean age differences.

[b] Chi-square analyses were used for gender, social class and psychiatric status differences.

Table 2. HR & LR adoptees' UCLA Social Attainment Scale scores

	Mean (SD)	min-max	Mean (SD)	min-max	F (df)	p
All adoptees	HR (n = 88)		LR (n = 83)			
Peer Relationships	6.4 (2.1)	2-10	7.2 (1.9)	2-10	5.7 (1,151)	0.019
Romantic Relationships	11.0 (3.6)	3-15	11.6 (3.4)	3-15	1.0 (1,127)	0.317
Involvement in Activities	6.4 (2.3)	2-10	7.2 (2.1)	2-10	5.3 (1,156)	0.022
Total score	22.4 (6.1)	8-33	25.4 (5.8)	7-35	7.5 (1,115)	0.007
Male	HR (n = 40)		LR (n = 37)			
Peer Relationships	6.6 (2.1)	2-10	7.3 (2.0)	2-10	2.2 (1,70)	0.141
Romantic Relationships	9.9 (3.9)	3-15	11.5 (3.4)	4-15	2.7 (1,53)	0.109
Involvement in Activities	6.1 (2.5)	2-10	6.9 (2.0)	3-10	2.2 (1,71)	0.145
Total score	21.4 (6.6)	8-33	25.0 (5.5)	11-35	4.6 (1,51)	0.036
Female	HR (n = 48)		LR (n = 46)			
Peer Relationships	6.2 (2.1)	3-10	7.1 (1.8)	2-10	3.5 (1,79)	0.065
Romantic Relationships	11.8 (3.3)	4-15	11.7 (3.5)	3-15	0.01 (1,72)	0.932
Involvement in Activities	6.7 (2.1)	3-10	7.5 (2.2)	2-10	2.9 (1,83)	0.093
Total score	23.2 (5.6)	12-33	25.8 (6.2)	7-34	2.9 (1,62)	0.091

Note: HR=high genetic risk; LR=low genetic risk. One-way analysis of variance (ANOVA) was used for mean differences between UCLA SAS scores.

Table 3. Gender differences in HR & LR groups

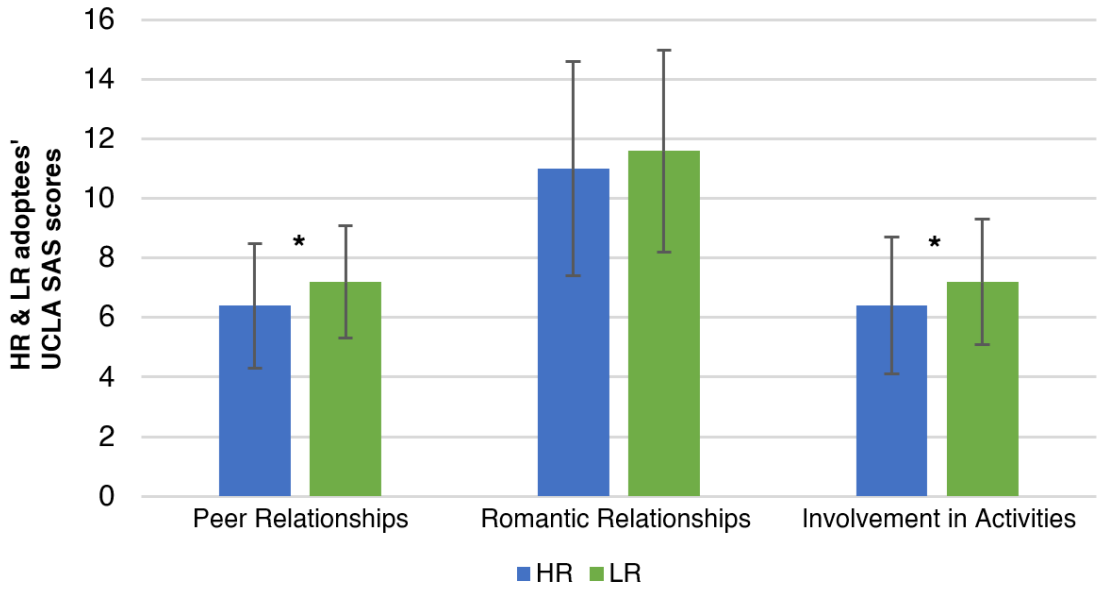
	Mean (SD)	min-max	Mean (SD)	min-max	F (df)	p
All adoptees	Female (n = 94)		Male (n = 77)			
Peer Relationships	6.6 (2.0)	2-10	6.9 (2.1)	2-10	0.8 (1,151)	0.362
Romantic Relationships	11.8 (3.3)	3-15	10.8 (3.7)	3-15	2.6 (1,127)	0.108
Involvement in Activities	7.1 (2.2)	2-10	6.5 (2.3)	2-10	3.5 (1,156)	0.062
Total score	24.5 (6.0)	7-34	23.2 (6.3)	8-35	1.4 (1,115)	0.246
HR	Female (n = 48)		Male (n = 40)			
Peer Relationships	6.2 (2.1)	3-10	6.6 (2.1)	2-10	0.5 (1,74)	0.464
Romantic Relationships	11.8 (3.3)	4-15	9.9 (3.9)	3-15	4.4 (1,63)	0.041
Involvement in Activities	6.7 (2.1)	3-10	6.1 (2.5)	2-10	1.5 (1,77)	0.230
Total score	23.2 (5.6)	12-33	21.4 (6.6)	8-33	1.3 (1,55)	0.259
LR	Female (n = 46)		Male (n = 37)			
Peer Relationships	7.1 (1.8)	2-10	7.3 (2.0)	2-10	0.3 (1,75)	0.559
Romantic Relationships	11.7 (3.5)	3-15	11.5 (3.4)	4-15	0.05 (1,62)	0.831
Involvement in Activities	7.5 (2.2)	2-10	6.9 (2.0)	3-10	1.9 (1,77)	0.178
Total score	25.8 (6.2)	7-34	25.0 (5.5)	11-35	0.3 (1,58)	0.604

Note: HR=high genetic risk; LR=low genetic risk. One-way analysis of variance (ANOVA) was used for mean differences between UCLA SAS scores.

Table 4. The association of genetic risk, gender and their interaction to UCLA SAS scores.

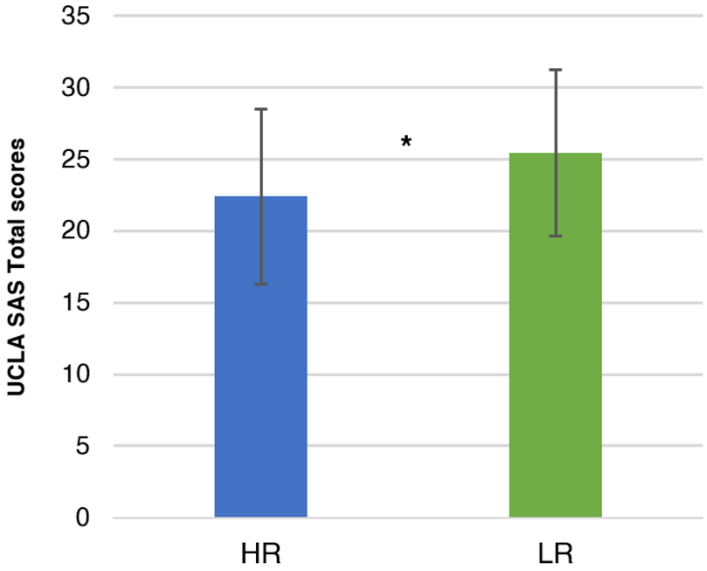
UCLA SAS domain		F	df	p	Partial Eta Squared
Peer Relationships	Gender	0.9	1	0.348	0.006
	Genetic risk	5.6	1	0.019	0.036
	Gender x genetic risk	0.02	1	0.877	0.000
Romantic Relationships	Gender	2.7	1	0.102	0.021
	Genetic risk	1.5	1	0.218	0.012
	Gender x genetic risk	1.8	1	0.181	0.014
Involvement in Activities	Gender	3.3	1	0.072	0.021
	Genetic risk	5.0	1	0.027	0.031
	Gender x genetic risk	0.00	1	0.984	0.000
Total score	Gender	1.4	1	0.237	0.012
	Genetic risk	7.6	1	0.007	0.063
	Gender x genetic risk	0.2	1	0.638	0.002

Note: Two-way ANOVA was used to examine the association of genetic risk (main effect), gender (main effect) and their interaction with UCLA SAS scores.



* $p < 0.05$

Figure 1. Mean differences in Peer Relationships, Romantic Relationships and Involvement in Activities scores between adoptees at high risk (HR) and low risk (LR) for schizophrenia.



* $p < 0.05$

Figure 2. Mean differences in Total scores between adoptees at high risk (HR) and low risk (LR) for schizophrenia.