Sex of older siblings and stress resilience

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Received November 2017 Revised September 2018) http://dx.doi.org/10.14301/llcs.v9i4.486

Abstract

The aim was to investigate whether older siblings are associated with development of stress resilience in adolescence and if there are differences by sex of siblings. The study used a Swedish register-based cohort of men (n=664 603) born between 1970 and 1992 who undertook military conscription assessments in adolescence that included a measure of stress resilience: associations were assessed using multinomial logistic regression. Adjusted relative risk ratios (95% confidence intervals) for low stress resilience (n=136 746) compared with high (n=142 581) are 1.33 (1.30, 1.35), 1.65 (1.59, 1.71) and 2.36 (2.18, 2.54) for one, two and three or more male older siblings, compared with none. Equivalent values for female older siblings do not have overlapping confidence intervals with males and are 1.19 (1.17, 1.21), 1.46 (1.40, 1.51) and 1.87 (1.73, 2.03). When the individual male and female siblings are compared directly (one male sibling compared with one female sibling, etc.) and after adjustment, including for cognitive function, there is a statistically significant (p<0.005) greater risk for low stress resilience associated with male siblings. Older male siblings may have greater adverse implications for psychological development, perhaps due to greater demands on familial resources or inter-sibling interactions.

Key words

Siblings; sex; psychological functioning; stress resilience; adolescence

Funding

This study was supported by *Nyckelfonden* and by grants from the UK Economic and Social Research Council (ESRC) to the International Centre for Life Course Studies (grants RES-596-28-0001 and ES/JO19119/1).

Introduction

The ability to cope with stress has consequences for disease risk, as demonstrated by associations of a measure of stress resilience, which was designed to assess suitability for military service in Sweden. To produce the score, the men underwent a psychological assessment of their potential ability to cope with stress, based on whether they could control and channel nervousness, their tolerance of stress and disposition to anxiety (Bergh et al., 2014; Bergh, Udumyan, Fall, Almroth and Montgomery, 2015; Crump, Sundquist, Winkleby and Sundquist, 2016; Hiyoshi et al., 2015; Kennedy et al., 2017). A low value for this measure of stress resilience in adolescence, which is often categorised in three groups, has been associated with a raised risk for a variety of diseases in subsequent adulthood, including type 2 diabetes, cancer, cardiovascular disease, anxiety and depression (Bergh et al., 2014, Bergh, et al. 2015; Crump et al., 2016; Hiyoshi et al., 2015; Kennedy et al., 2017). These studies indicate potentially lifelong health implications associated with stress resilience in adolescence, so it is important to identify precursors of low stress resilience to determine if preventative measures are desirable or feasible. Some types of stressful exposures in childhood have been linked with lower stress resilience (Kennedy et al., 2018) and this paper is concerned with identifying further familial factors in childhood that may influence development of stress resilience.

It has been argued that variation in psychologically relevant exposures makes siblings in the same family notably different from each other (Plomin and Daniels, 2011). Birth order has been linked with development of personality and intelligence, albeit inconsistently (Damian & Roberts, 2015; Rohrer, Egloff & Schmukle, 2015). The direction of association with birth order for aspects of mental health and development is not always consistent and older siblings do not always represent an adverse exposure: presence of older siblings has been reported as being associated with relatively better mental health than having younger siblings (Lawson & Mace, 2010). However, associations with intelligence consistently demonstrate an inverse association with presence of older siblings (Kristensen & Bjerkedal, 2007). While this may be in part due to confounding by socioeconomic circumstances, there does appear to be a genuine effect of social rank (social hierarchy) defined by birth order within the family, such that having older siblings, and thus being lower in the hierarchy, represents a risk for lower intelligence (Kristensen & Bjerkedal, 2007). We suggest that if social rank associated with having older siblings is relevant, then some characteristics of the older siblings may play a role in influencing the psychological development of their younger siblings. What is certain is that siblings have an important influence on development (Sulloway, 1996) and can potentially be a source of stressful exposures through inter-sibling aggression, which can be influenced by characteristics such as the sex of siblings (Tippett & Wolke 2015), therefore with possible implications for development of stress resilience.

The sex of older siblings may be relevant to stressful exposures in childhood, as there is evidence that the sex of children in families influences other outcomes, as one study found mothers were more likely to have heart disease if they had sons rather than daughters, possibly because of a greater domestic burden for the mother associated with having sons as they may help less with domestic tasks (D'Ovidio, d'Errico, Scarinzi & Costa, 2015). Therefore, if the sex of children has implications for maternal health, then the sex of older siblings may also be relevant to the development of their younger brothers and sisters, including for development of stress resilience. A component of the association between stress resilience and subsequent psychiatric disease is explained by cognitive function, indicating some shared risks for low cognitive function and low stress resilience (Hiyoshi et al., 2015). We therefore examined whether associations with stress resilience are independent of assessed cognitive function (to indicate intelligence), particularly as birth order has been linked with intelligence (Kristensen & Bjerkedal, 2007). This was undertaken as a separate step in the analysis as stress resilience and cognitive function may theoretically influence each other.

This study used longitudinal Swedish register data for a large number of males to examine the association of number of older male and female siblings with a measure of stress resilience in late adolescence.

Methods

Swedish registers identified all men born between 1970 and 1992 who were assessed for military conscription (1987 to 2010): conscription was compulsory for the majority of males during this period. A total of 843,291 men were identified and 664,403 (79%) remained after exclusions for missing values, mainly due to exemption from conscription, non-participation in the psychological functioning test or other tests by those deemed unsuitable for military service, and some linkage failures to identify parents. The assessment of stress resilience, is described in greater detail elsewhere (Bergh et al., 2015; Hiyoshi et al., 2015) and was designed to quantify suitability in terms of ability to cope with the stress of military action. It involved a 25–30 minute semi-structured interview performed by licensed psychologists with access to additional background information, including a self-completion questionnaire. The test produced a nine-point score covering four dimensions: mental energy, emotional control, social maturity and active/passive interests. A score of nine indicates high stress resilience, thus a greater ability to cope with stress. We previously identified that the functional form of this measure indicates categorisation into three groups rather than use as a continuous measure, as the least stress resilient category has a disproportionally higher magnitude association with a number of adverse outcomes and therefore, as in previous studies, it is categorised as low (1–3), intermediate (4–6) and high (7–9) (Bergh et al., 2015; Hiyoshi et al., 2015; Kennedy et al., 2017; Kennedy et al., 2018). Cognitive function (intelligence) was assessed by written tests covering inductive ability, linguistic understanding and spatial recognition (Carlstedt, 2000). A nine-point normally distributed score was produced, with a score of nine indicating high cognitive function.

The Multi-Generation Register (Ekbom, 2011) was used to provide information on older siblings and mothers. Parental socioeconomic circumstances nearest in time to the cohort member's birth were characterised using census data (1970–1985) and LISA (LISA, 2017), the *Longitudinal Database of Health, Insurance and Labour Market Studies*, after 1990. The highest-level parental occupation was used to produce a three-category version of the European Socioeconomic Classification (ESeC). Information on dates of birth, death and migration of the cohort members was provided by the Total Population Register (SCB, 2017).

The Uppsala regional ethics committee approved this study.

Statistical analysis

Multinomial regression was used to examine associations with the three-category stress resilience measure as the dependent variable. High stress resilience was used as the reference category, so that relative risk ratios (with 95% confidence intervals) are produced for both intermediate and low stress resilience. In model 1, the associations with stress resilience were assessed separately for number of older male and female siblings; multiple birth (a particular sibling type); mother's age at delivery and ESeC (as markers of cultural and material circumstances). Each of these analyses was adjusted for age at conscription assessment and year of assessment (to tackle potential variation in assessment scores in adolescence by age and period). All of the measures were modelled as categorical, including mother's age at delivery as this measure has a non-linear association with stress resilience so cannot be modelled simply as a continuous variable. In model 2, all of the above measures are included in the same model simultaneously to assess the consequences of mutual adjustment. In model 3, the cognitive function measure was added to a model also adjusted for all of the above measures. Cognitive function was modelled as a continuous variable to provide the most effective adjustment. The inclusion of cognitive function was undertaken in a separate model, as including cognitive function may represent an over-adjustment due to its positive association with stress resilience and because it is hypothesised that stress resilience may in turn influence cognitive function. The cluster function was used to account for multiple cohort members coming from the same family, but did not influence the results at the level of precision presented.

A sensitivity analysis compared male and female older siblings directly with each other in category of number of siblings in separate multinomial regression models with stress resilience as the dependent variable. Having one older male sibling was compared with one older female sibling; two older male siblings was compared with two older female siblings; and three or more older male siblings was compared with three or more older female siblings. These models were adjusted for multiple birth, mother's age at delivery, ESeC, age at conscription assessment, year of assessment and cognitive function.

The analysis was performed using Stata MP version 14.2.

Results

Table 1 shows that male adolescents with lower stress resilience had a larger number of older siblings, had a lower average cognitive function score, lower parental ESeC, mothers who gave birth before age 18 years or mothers that were older than average. There is no notable or consistent association with being part of a multiple birth. Table 2 presents relative risk ratios and 95% confidence intervals for medium and low stress resilience compared with high stress resilience. Having a larger number of older male siblings has a higher magnitude association with low stress resilience than having female older siblings. These results showed a gradient of risk across intermediate and low stress resilience compared with high. There is some attenuation of magnitude of associations after adjustment in model 2, mostly due to inclusion of the ESeC variable. Further adjustment for cognitive function in model 3 resulted in attenuation of magnitude for the estimates, but did not eliminate statistical significance. The confidence intervals for older male and female siblings do not overlap, including after adjustment for the potential confounding factors and cognitive function. The higher magnitude association with low stress resilience for male siblings was further assessed in a sensitivity analysis comparing individual male and female siblings directly (having one male sibling compared with one female sibling; two male siblings compared with two female; and three or more male compared with three or more female). After adjustment for all of the potential confounding factors, including cognitive function, there is a statistically significant ($p<0.005$) greater risk for low stress resilience associated with older male siblings compared with female siblings, for each of the three comparisons (data not shown).

Low parental ESeC and having either mothers who were older or younger than average were statistically significantly associated with low stress resilience in all of the models. Higher cognitive function is associated with a statistically significant reduced risk of having contemporaneous low stress resilience. The Pearson correlation coefficient for these two measures is 0.368 ($p<0.001$) with covariance of 1.179. The magnitude of the association between stress resilience and cognitive function is only slightly reduced by adjustment for the other measures in model 3.

Discussion

Having a larger number of older male siblings was associated with lower stress resilience than having the equivalent number of female siblings, independent of measures of socioeconomic circumstances of the family and cognitive function. Having parents in the low ESeC category of the family of origin, indicating more adverse socioeconomic characteristics, is also a risk for low stress resilience.

To the best of our knowledge, this is the first study investigating associations of sex of older siblings with stress resilience, which was measured systematically in adolescence among a large and generally representative population of males. While there is good evidence that siblings can influence personality and other aspects of mental development, (Plomin and Daniels, 2011; Sulloway, 1996) the existing literature does not clearly predict the pattern of association with stress resilience observed here. We believe the association with siblings is due in part to exposure to psychosocial and other forms of stress. It has been suggested that first-born children may be more fearful, even if they have a greater tendency to be 'intellectually oriented' (Eisenman, 1992) and being a younger sibling may result in relatively better mental health (Lawson & Mace, 2010). Both of these studies would imply a greater risk of low stress resilience for first-borns, who may be different in several ways from other siblings. They spend more time alone with parents than younger siblings (Eisenman, 1992) and are more likely to accept the authority of parents than subsequent children (Sulloway, 1996). Other potentially contradictory aspects of having siblings are that, on one hand, sibling relationships offer protection from the effects of stressful life events (Gass, Jenkins & Dunn, 2007) but, on the other, there can be aggression and bullying between siblings that can be a significant source of adverse exposures in childhood (Tippett & Wolke, 2015).

The association of older siblings with development of stress resilience is in part explained by socioeconomic circumstances as signalled by the influence of adjustment for parents' ESeC and by

Table 1. Characteristics of the cohort by a measure of psychological functioning (stress resilience) in adolescence

	High (7–9) stress resilience n=142 581	**Intermediate (4–6) stress resilience n=385 276**	**Low (1–3) stress resilience n=136 746**
Number of older male siblings, N (%)			
0	97 438 (68.3)	254 383 (66.0)	84 989 (62.2)
1	37 312 (26.2)	105 054 (27.3)	39 962 (29.2)
2	6 802 (4.8)	21 845 (5.7)	9 419 (6.9)
3 or more	1 029 (0.7)	3 994 (1.0)	2 376 (1.7)
Number of older female siblings, N (%)			
0	97 994 (68.7)	258 290 (67.0)	89 176 (65.2)
1	37 002 (26.0)	102 959 (26.7)	37 110 (27.1)
2	6 569 (4.6)	20 364 (5.3)	8 438 (6.2)
3 or more	1 016 (0.7)	3 663(1.0)	2 022 (1.5)
Multiple birth, N (%)			
Singleton	140 112 (98.3)	378 238 (98.2)	134 423 (98.3)
Multiple birth	2 469 (1.7)	7 038 (1.8)	2 323 (1.7)
Mother's age at delivery (years), N (%)			
Under 18	1 048 (0.7)	4 829 (1.3)	2 680 (2.0)
18–24	43 555 (30.6)	133 567 (34.7)	50 655 (37.0)
25–29	58 498 (41.0)	144 061 (37.4)	46 996 (34.4)
30–34	29 864 (21.0)	75 639 (19.6)	25 933 (19.0)
35–39	8 439 (5.9)	23 509 (6.1)	8 916 (6.5)
40–44	1 145 (0.8)	3 535 (0.9)	1 507 (1.1)
45+	32 (0.0)	136 (0.0)	59 (0.0)
ESeC, N (%)			
High	62 789 (44.0)	119 413 (31.0)	33 137 (24.2)
Intermediate	25 406 (17.8)	62 972 (16.3)	18 978 (13.9)
Low	54 386 (38.1)	202 891 (52.7)	84 631 (61.9)
Cognitive function[a]	6.1 (1.6)	5.3 (1.7)	4.2 (1.9)

Notes: [a]Mean (SD).
ESeC, European Socioeconomic Classification

Table 2. Risks of intermediate and low stress resilience in adolescence compared with high stress resilience

	Intermediate stress resilience			Low stress resilience		
	Model 1 RRR (95% CI)	Model 2 RRR (95% CI)	Model 3 RRR (95% CI)	Model 1 RRR (95% CI)	Model 2 RRR (95% CI)	Model 3 RRR (95% CI)
Number of older male siblings						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.08 (1.06 to 1.09)	1.10 (1.09 to 1.12)	1.03 (1.01 to 1.04	1.23 (1.21 to 1.25)	1.33 (1.30 to 1.35)	1.14 (1.22 to 1.17)
2	1.23 (1.19 to 1.26)	1.21 (1.18 to 1.25)	1.10 (1.07 to 1.14	1.58 (1.53 to 1.63)	1.65 (1.59 to 1.71)	1.33 (1.28 to 1.38)
3 or more	1.47 (1.37 to 1.58)	1.32 (1.23 to 1.41)	1.14 (1.06 to 1.23)	2.67 (2.48 to 2.87)	2.36 (2.18 to 2.54)	1.69 (1.56 to 1.83)
Number of older female siblings						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.05 (1.04 to 1.07)	1.08 (1.06 to 1.10)	1.01 (1.00 to 1.03)	1.10 (1.08 to 1.12)	1.19 (1.17 to 1.21)	1.04 (1.02 to 1.06)
2	1.17 (1.14 to 1,21)	1.15 (1.12 to 1.19)	1.04 (1.01 to 1.08)	1.41 (1.36 to 1.45)	1.46 (1.40 to 1.51)	1.17 (1.13 to 1.22)
3 or more	1.35 (1.27 to 1.46)	1.20 (1.12 to 1.29)	1.05 (0.98 to 1.13)	2.19 (2.03 to 2.36)	1.87 (1.73 to 2.03)	1.37 (1.26 to 1.49)
Multiple birth						
Singleton	Reference	Reference	Reference	Reference	Reference	Reference
Multiple	1.06 (1.01 to 1.11)	1.07 (1.02 to 1.12)	1.03 (0.98 to 1.08)	0.98 (0.92 to 1.04)	0.99 (0.93 to 1.05)	0.91 (0.86 to 0.97)
Mother's age at delivery (years)						
Under 18	1.85 (1.73 to 1.98)	1.46 (1.36 to 1.56)	1.21 (1.13 to 1.29)	3.41 (3.17 to 3.67	2.62 (2.43 to 2.82)	1.77 (1.63 to 1.91)
18–24	1.24 (1.22 to 1.26)	1.09 (1.07 to 1.10)	1.02 (1.00 to 1.03)	1.47 (1.45 to 1.50	1.26 (1.24 to 1.29)	1.09 (1.07 to 1.12)
25–29	Reference	Reference	Reference	Reference	Reference	Reference
30–34	1.03 (1.01 to 1.04)	1.05 (1.03 to 1.06)	1.08 (1.06 to 1.10)	1.05 (1.03 to 1.07	1.03 (1.03 to 1.06)	1.10 (1.08 to 1.13)
35–39	1.12 (1.09 to 1.15)	1.10 (1.07 to 1.13)	1.16 (1.12 to 1.19)	1.27 (1.23 to 1.32	1.12 (1.09 to 1.16)	1.25 (1.21 to 1.30)
40–44	1.24 (1.16 to 1.32)	1.14 (1.07 to 1.22)	1.23 (1.15 to 1.32)	1.63 (1.51 to 1.76	1.22 (1.13 to 1.33)	1.43 (1.32 to 1.56)
45+	1.68 (1.14 t0 2.47)	1.39 (0.94 to 2.05)	1.56 (1.05 to 2.31)	2.38 (1.54 to 3.66)	1.41 (0.91 to 2.19)	1.85 (1.17 to 2.93)
ESeC						
High	Reference	Reference	Reference	Reference	Reference	Reference
Intermediate	1.31 (1.29 to 1.33)	1.32 (1.29 to 1.34)	1.14 (1.12 to 1.16)	1.41 (1.38 to 1.45)	1.41 (1.38 to 1.45)	1.04 (1.01 to 1.06)
Low	1.98 (1.95 to 2.00)	1.93 (1.90 to 1.96)	1.52 (1.50 to 1.55)	3.06 (3.00 to 4.11)	2.81 (2.76 to 2.86)	1.64 (1.61 to 1.68)
Cognitive function						
	0.74 (0.74 to 0.75)	-	0.77 (0.76 to 0.77)	0.52 (0.53 to 0.53)	-	0.55 (0.54 to 0.55)

Notes: Model 1: adjusted for year of conscription assessment and age at assessment. Model 2: further adjusted for all measures in the table, except cognitive function. Model 3: further adjusted for cognitive function. All measures are categorical, except for the continuous cognitive function variable. N=664 603 for all models; RRR: relative risk ratio; 95% CI: 95% confidence interval associations with maternal age at delivery. However, socioeconomic characteristics do not fully explain sibling associations with stress resilience and this is consistent with other studies indicating that birth order has an influence on intelligence not fully explained by socioeconomic factors (Kristensen & Bjerkedal, 2007). Further, familial socioeconomic characteristics are unlikely to explain the higher magnitude associations with stress resilience for having male, rather than female, siblings. It is unlikely that there is a larger proportion of male children due to a larger number of male births in more socioeconomically disadvantaged families. Disadvantage has been linked to a small excess of *female* births (Magnuson, Bodin & Montgomery, 2007) possibly because adversity leads to loss of male foetuses early in pregnancy. More plausible explanations for the association of older male siblings with low stress resilience include the possibility that male siblings make greater demands on available resources – both in terms of time with parents and material factors – within the family (D'Ovidio et al., 2015). As the first child receives more parental attention before the birth of younger children (Eisenman, 1992), and possibly subsequently, this may influence resource availability for younger siblings. It is also conceivable that previous births (older siblings) have an influence on the *in utero* environment, as foetal characteristics have been linked with this measure of stress resilience (Nilsson, Nyberg & Ostergren, 2001), but a study of influences on intelligence found that *living* siblings (rather than those who did not survive beyond pregnancy) and the resulting sibling hierarchy arising from birth order were more relevant to cognitive development than *in utero* effects (Kristensen & Bjerkedal, 2007).

We hypothesise that the presence of older male siblings increases the risk of low stress resilience by a combination of influences such as greater use of resources, including parental attention. Also, as aggression between siblings has stressful sequelae (Tippett & Wolke, 2015), it seems plausible that older male siblings may be in the most dominant position to bully their younger siblings, creating a more threatening environment, with possible implications for stress resilience. These exposures could influence aspects of development relevant to how individuals cope with stress, though psychological and possibly neuroendocrine pathways. One, but not necessarily the most important, aspect of this could be the physiological stress response, which has been most comprehensively described in animal models, such that early exposure to stress is more likely to lead to a tendency to greater stress reactivity and lower stress resilience, thus greater risk of prolonged stress arousal (Liu et al., 1997; Sapolsky 1997). Biological pathways include exposure to stress reducing the expression of glucocorticoid receptors in areas of the brain such as the hippocampus and thus limiting the effectiveness of the negative feedback mechanism to downregulate physiological stress responses. Such processes could also have implications for cognitive function: higher levels of circulating glucocorticoids can have a neurotoxic effect, but this can occur at all ages, as trauma and psychosocial stress is linked with lower hippocampal volume (Woon, Sood & Hedges, 2010), which is relevant to learning and memory. Lower hippocampal volume may result from stressful exposures, but in turn low volume is associated with greater *susceptibility* to exposures increasing the risk of some psychiatric outcomes (van Rooij et al., 2015). This study indicates that associations of older siblings with stress resilience are not explained entirely by a pathway acting though cognitive function, even though higher cognitive function is associated with a reduced risk of low stress resilience (Hiyoshi et al., 2015). Due to the association of stress resilience with cognitive function, we chose to add cognitive function to our models in a separate step to help estimate the extent to which cognitive function may be involved in the association of older siblings with stress resilience. We can only speculate on the mechanisms, but poor stress resilience may have damaged cognitive function, as described above.

Stress resilience indicates the ability to cope with stress: while the measure used here was designed to assess how well someone will cope with combat and other situations faced by the military, it was based on experiences in normal daily life and thus relevant to stress in the general population. This helps to explain why it is associated with a variety of mental and physical health outcomes in adulthood (Bergh et al., 2014; Bergh et al., 2015; Crump et al., 2016; Hiyoshi et al., 2015; Kennedy et al., 2017) and we believe that low resilience is likely to signal a greater tendency to chronic stress arousal with both behavioural and metabolic consequences that are harmful to health.

Childhood experiences signalled by the presence of older siblings and other sources of potentially stressful exposures may have important implications for both stress resilience and cognitive function, and thus for adult health. The differences by sex of siblings likely demonstrates that the older siblings themselves play a role in influencing development, rather that signalling other characteristics of the family. While older male siblings appear to represent a greater risk for low stress resilience, we hypothesise that the risk is not raised by all male siblings, but that it is due to the greater likely of aggressive, bullying or domineering behaviour exhibited by males. Therefore, the stressful aspects of family life, including inter-sibling interactions should be examined and, if possible, reduced for children, as they may have lifelong consequences.

Potential limitations are that the study is limited to males, but the cohort is broadly representative of the male general population. The cohort also comprises ostensibly healthy men, and this is likely to exclude more of those with low stress resilience, perhaps blunting our estimates. There is only a single measurement of stress resilience in late adolescence but, as it has been linked with outcomes in middle age (Hiyoshi et al., 2015), there is evidence of persistence and thus indicates relevance of this measure in adolescence for health in later life. The measure will reflect a combination of inherited characteristics and childhood exposures, but we cannot identify inherited susceptibility factors that may modify the consequences of childhood exposures.

In conclusion, older siblings, particularly males, appear to influence development of stress resilience, highlighting the importance of familial conditions in childhood. This may be due to stressful inter-sibling interactions and unequal allocation of familial resources between siblings.

References

Bergh, C., Udumyan, R., Fall, K., Almroth, H. & Montgomery, S. (2015). Stress resilience and physical fitness in adolescence and risk of coronary heart disease in middle age. *Heart*, *101*(8), 623–629. https://doi.org/10.1136/heartjnl-2014-306703

Bergh, C., Udumyan, R., Fall, K., Nilsagard, Y., Appelros, P., & S. Montgomery (2014). Stress resilience in male adolescents and subsequent stroke risk: cohort study. *J Neurol Neurosurg Psychiatry*, *85*(12), 1331–1336. https://doi.org/10.1136/jnnp-2013-307485

Carlstedt, B. (2000). *Cognitive Abilities*. Göteborgs Universitet.

Crump, C., Sundquist, J., Winkleby, M. A., & Sundquist, K. (2016). Stress resilience and subsequent risk of type 2 diabetes in 1.5 million young men. *Diabetologia*, *59*(4), 728–733. https://doi.org/10.1007/s00125-015-3846-7

D'Ovidio, F., d'Errico, A., Scarinzi, C., & Costa, G. (2015). Increased incidence of coronary heart disease associated with "double burden" in a cohort of Italian women. *Soc Sci Med*, *135*, 40–46. https://doi.org/10.1016/j.socscimed.2015.04.015

Damian, R. I. & Roberts, B. W. (2015). Settling the debate on birth order and personality. *Proc Natl Acad Sci USA*, *112*(46), 14119–14120. https://doi.org/10.1073/pnas.1519064112

ESeC. SOC2010 volume 3: the National Statistics Socio-economic classification (NS-SEC rebased on SOC2010) https://www.ons.gov.uk/methodology/classificationsandstandards/standardoccupationalclassificationsoc/soc2010/soc2010volume3thenationalstatisticssocioeconomicclassificationnssecrebasedonsoc2010 Retrieved 15 September 2017.

Eisenman, R. (1992). Birth order, development and personality. *Acta Paedopsychiatr*, *55*(1), 25–27.

Ekbom, A. (2011). The Swedish Multi-generation Register. *Methods Mol Biol*, *675*, 215–220. https://doi.org/10.1007/978-1-59745-423-0_10

Gass, K., Jenkins, J., & Dunn, J. (2007). Are sibling relationships protective? A longitudinal study. *J Child Psychol Psychiatry*, *48*(2), 167–175. https://doi.org/10.1111/j.1469-7610.2006.01699.x

Hiyoshi, A., Udumyan, R., Osika, W., Bihagen, E., Fall, K., & Montgomery, S. (2015). Stress resilience in adolescence and subsequent antidepressant and anxiolytic medication in middle aged men: Swedish cohort study. *Soc Sci Med*, *134*, 43–49. https://doi.org/10.1016/j.socscimed.2015.03.057

Kennedy, B., Chen, R., Valdimarsdottir, U., Montgomery, S., Fang, F., & Fall, K. (2018). Childhood Bereavement and Lower Stress Resilience in Late Adolescence. *J Adolesc Health*, *63*(1),108-114. https://doi.org/10.1016/j.jadohealth.2018.02.002

Kennedy, B., Fang, F., Valdimarsdottir, U., Udumyan, R., Montgomery, S., & Fall, K. (2017). Stress resilience and cancer risk: a nationwide cohort study. *J Epidemiol Community Health*, *71*(10), 947–953. https://doi.org/10.1136/jech-2016-208706

Kristensen, P. and Bjerkedal, T. (2007). Explaining the relation between birth order and intelligence. *Science*, *316*(5832), 1717. https://doi.org/10.1126/science.1141493

Lawson, D. W. & Mace, R. (2010). Siblings and childhood mental health: evidence for a later-born advantage. *Soc Sci Med*, *70*(12), 2061–2069. https://doi.org/10.1016/j.socscimed.2010.03.009

Liu, D., Diorio, J., Tannenbaum, B., Caldji, C., Francis, D., Freedman, A., Sharma, S., Pearson, D., Plotsky P. M., & Meaney, M. J. (1997). Maternal care, hippocampal glucocorticoid receptors, and hypothalamic-pituitary-adrenal responses to stress. *Science*, 277(5332), 1659–1662. https://doi.org/10.1126/science.277.5332.1659

Magnuson, A., L. Bodin and S. M. Montgomery (2007). Father's occupation and sex ratio of offspring. *Scand J Public Health*, *35*(5), 454–459. https://doi.org/10.1080/14034940701246066

Nilsson, P. M., Nyberg, P., & Ostergren, P. O. (2001). Increased susceptibility to stress at a psychological assessment of stress tolerance is associated with impaired fetal growth. *Int J Epidemiol*, *30*(1), 75–80. https://doi.org/10.1093/ije/30.1.75

Plomin, R. & Daniels, D. (2011). Why are children in the same family so different from one another? *Int J Epidemiol*, *40*(3), 563–582. https://doi.org/10.1093/ije/dyq148

Rohrer, J. M., Egloff, B., & Schmukle, S. C. (2015). Examining the effects of birth order on personality. *Proc Natl Acad Sci USA*, *112*(46), 14224–14229. https://doi.org/10.1073/pnas.1506451112

Sapolsky, R. M. (1997). The importance of a well-groomed child. *Science*, *277*(5332), 1620–1621. https://doi.org/10.1126/science.277.5332.1620

SCB: The Swedish Total Population Register http://www.scb.se/Statistik/_Publikationer/OV9999_2015A01_BR_BE96BR1501.pdf Retrieved 20 March 2017.

Sulloway, F. J. (1996). *Born to rebel: birth order, family dynamics, and creative lives*. New York: Pantheon Books.

Tippett, N. & Wolke, D. (2015). Aggression between siblings: Associations with the home environment and peer bullying. *Aggress Behav*, *41*(1), 14–24. https://doi.org/10.1002/ab.21557

van Rooij, S. J., Kennis, M., Sjouwerman, R., van den Heuvel, M. P., Kahn, R. S. & Geuze, E. (2015). Smaller hippocampal volume as a vulnerability factor for the persistence of post-traumatic stress disorder. *Psychol Med*, *45*(13), 2737–2746. https://doi.org/10.1017/S0033291715000707

Woon, F. L., Sood, S. & Hedges, D. W. (2010). Hippocampal volume deficits associated with exposure to psychological trauma and posttraumatic stress disorder in adults: a meta-analysis. *Prog Neuropsychopharmacol Biol Psychiatry*, *34*(7), 1181–1188.