

**ENVIRONMENTAL-RISK (E-RISK) LONGITUDINAL TWIN STUDY  
CONCEPT PAPER FORM**

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Provisional Paper Title: An individualised risk calculator for psycho-social functioning in young adults  
victimised during childhood.

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**Objective of the study:**

The objective of this study is to build an evidence-based risk calculator to assist practitioners in identifying victimized children who are at greatest risk of developing unfavourable psycho-social functioning in young adulthood. This work partly builds upon analyses to identify factors associated with psycho-social outcomes in victimized children already undertaken in published E-Risk papers. We will expand this work with the aim to generate a new prognostic tool – a 'risk calculator' – which we hope will accurately predict individualised risk for poor functioning in victimised children.

**Background:**

Child maltreatment is a severe infringement of human rights that impacts a substantial proportion of individuals worldwide. In the UK, research by the NSPCC has shown that nearly 1 in 5 children experience some form of maltreatment [1]. Evidence suggests that individuals who are exposed to various forms of victimisation during childhood are at a greater risk of functional impairment compared to their non-victimized peers. For example, children who have been physically abused have been found to complete fewer years of schooling compared to matched controls [2]. Moreover, there is some indication that individuals with a history of child maltreatment also have poorer occupational outcomes: being more likely to have menial/semi-skilled occupations, less likely to have skilled/professional occupations [3], more likely to be unemployed [4] and have lower earnings [5]. Studies also suggest an association between childhood maltreatment and an increased risk of subsequent criminal offending [6] and early (i.e. teenage) parenthood [7].

However, although victimized children have, on average, poorer psycho-social functioning in later life compared to non-victimized children, these group differences fail to capture the remarkable resilience that many victimized children display – indeed, there is significant within-group variation in functioning. This study will examine a comprehensive range of individual, family and community factors to better understand the determinants of risk and resilience in relation to psycho-social functioning in the face of childhood victimisation.

***Individual-level factors:*** Prospective longitudinal studies of maltreated children have identified personality characteristics to be important individual factors for promoting better psychosocial outcomes. For

example, individuals who were more reserved, controlled and rational have been found to show more adaptive functioning on a composite measure comprised of psychopathology, social competence and school adjustment [8]. Intellectual capacity has also been examined as a potential protective factor. A longitudinal study of the effects of childhood abuse and neglect found that being of – or above – average intelligence contributed to adolescents' resilient functioning in terms of educational success [9]. Similarly, a previous E-Risk study that examined resilience to antisocial behaviour following exposure to childhood maltreatment found that for boys (but not girls) high intelligence increased the likelihood of resilience [10]. However, this study also highlighted that such individual strengths were no longer protective when maltreatment occurred in the context of multiple family and neighbourhood stress.

Associations between a range of other individual-level factors and unfavourable psycho-social outcomes have been demonstrated in studies using samples drawn from the general population (rather than samples specifically comprised of individuals exposed to childhood victimisation). These include poor theory of mind at age 5 predicting being a victim of bullying in early adolescence [11]; conduct disorder being associated with a higher risk of later criminal offending, low life satisfaction, social isolation and early parenthood [12]; and early-onset mental health difficulties being related to lower educational attainment [13,14] and NEET status [15]. It is therefore of interest to test whether such individual-level factors are also predictive of poor psycho-social functioning in those exposed to childhood victimisation.

**Family-level factors:** Features of children's home environment may also confer risk and resilience to victimisation in terms of psycho-social outcomes. In the E-Risk cohort, maternal warmth, sibling warmth and a positive home atmosphere have previously been found to promote resilience against emotional and behavioural adjustment for bullied children [16]. Similarly, the Lehigh Longitudinal study found that maltreated children who showed better educational, emotional and social functioning had mothers who were more affectionate and supportive, and less hostile and controlling than mothers of maltreated children with poorer functioning [17].

Research has also highlighted stability to be a key factor for promoting positive psycho-social outcomes following victimisation, in particular the presence of one or more caregivers throughout the child's life without frequent changes, as well as stability in terms of housing. For example, among adolescents exposed to maltreatment during childhood, the likelihood of successful functioning across domains including education, employment, social activity and number of arrests was found to be increased if individuals had grown up with two consistent caregivers and fewer house moves [18]. This mirrors previous findings that the presence of at least one caretaker throughout childhood was a protective factor for adolescent school achievement following childhood maltreatment [9] and findings that having fewer house moves and not living in foster placement/institution was associated with better psycho-social functioning for women exposed to childhood sexual abuse [19].

Children's relationships – within and outside of the family – have been shown to promote resilience to victimisation. Maltreated children who were relatively self-reliant within their families and able to form supportive relationships with other adults in their communities were found to score more highly on a composite measure of resilience [20]. Similarly, a study using a sample of women who had experienced childhood sexual abuse found that social support from someone special and significant in their life was associated with more successful interpersonal relationships, economic wellbeing and an absence of arrests [19]. We will therefore also examine the role of the presence of a supportive adult for victimised children's subsequent psycho-social outcomes.

**Community-level factors:** Supportive and trusting neighbourly relationships have been found to promote positive parenting practices which may protect against the adverse effect of maltreatment [21]. Indeed, in the E-Risk cohort, neighbourhoods characterised by lower crime and higher levels of social cohesion and high levels of informal social control were found to protect victimised children from antisocial behaviour [10]. Furthermore, a recent E-Risk study has reported higher levels of neighbourhood social cohesion to be protective of psychotic symptoms at age 12 amongst children exposed to victimisation in early life [22]. It is therefore of interest to examine whether such neighbourhood factors are also protective of victimised children's later psycho-social functioning.

### **Significance of the study:**

Although resilience to childhood victimisation has been described across multiple domains [23,24] and

there are indications that factors influencing resilience to maltreatment can be described within an ecological model [25] including individual, family, and community characteristics [24,26], several knowledge gaps remain which this study will address.

First, several previous studies have examined single characteristics of the child and of the child's environment independently to assess resilience. In contrast, this study will build on an ecological model of resilience [25,27] to measure individual, family, and community factors in the same individuals and capture bio-psycho-social processes of resilience in the face of childhood victimisation. Related to this, much of the previous research focuses on a single type of abuse. In contrast, this study will use a broad measure for victimisation and test the sensitivity of findings across multiple types of victimisation (e.g. physical abuse, sexual abuse, emotional abuse/neglect, physical neglect).

Second, several previous studies were based on cross-sectional designs and retrospective reports of child victimisation which prevents independent assessments of exposure to victimisation, functional outcomes, and resilience factors. Accordingly, this study will utilise prospectively-collected data from the Environmental (E-Risk) Longitudinal Twin Study where victimisation and resilience factors have been assessed as the participants grew up to prevent recall bias in assessment, and the outcomes have been measured after the exposure to victimisation in order to clarify the direction of the effects. E-Risk's prospective measure of child victimisation combines repeated measures and multiple informants, and has proven validity [28,29]. Despite the fact that retrospective and prospective reports of child maltreatment show only modest agreement in the Dunedin [30] and E-Risk cohorts [31], both sources may be clinically useful, albeit in different ways. Indeed, both types of report have been shown to be significantly associated with poor relationship quality [30]. Therefore, it is of interest to test the sensitivity of our findings in relation to psycho-social outcomes using both prospective and retrospective measures of victimisation.

Third, several previous studies were undertaken in highly selected samples of children who were likely not representative of the overall population and had restricted variation in background characteristics that could have contributed to resilience (e.g., socio-economic status and intelligence). In contrast, this research focuses on victimized individuals from a population-representative cohort of UK children, enabling generalisation of our findings to victimized children in the UK general population.

Finally, existing studies, including those using the E-Risk cohort, have examined psycho-social outcomes for victimised children but few have tested the predictive ability of these estimated models. Although logistic regression techniques can be used to generate a probability of being classified into a certain group (e.g. odds ratio), this still represents an explanatory rather than a predictive model, as any observed associations are limited to the specific data in which the model was derived. They also describe the average probability of the outcome for a group rather than the prediction for individuals. Therefore, although certain individual, family and community factors may show a significant association with an outcome within a regression model, the extent to which these predictors can then be extrapolated to classify individual risk in new or unseen cases remains unclear. The best explanatory model may differ from the best predictive model, and studies have demonstrated that the odds ratio does not necessarily quantify the ability of a predictor to accurately classify an individual [32]. In order to prevent 'overfitting' of a multivariable regression model to a specific sample, additional penalties can be applied in 'regularised' regression models to reduce the variability of the regression estimates. Furthermore, predictive accuracy can then be evaluated through internal validation by setting aside a subset of the data as a 'holdout' sample, which can then be used to validate the proposed prediction model. Particular attention is paid to calibration, the agreement between predicted and observed values, and discrimination, the ability to distinguish between victimised children who go on to develop poor psycho-social functioning in adulthood from those who do not [33].

Thus, although some aspects of the design and analysis of our study are similar to that of aetiological research on childhood victimisation, our primary aim is to advance existing knowledge about predictors of poor psycho-social functioning following exposure to victimisation by moving from the averaged associations of regression models to individualised prediction, in line with personalised medicine approaches. Within the field of general medicine, risk prediction tools that combine multiple predictor variables to determine an individual's level of risk for a specific outcome or diagnosis are widely used (e.g. the Framingham Risk Score to assess risk of cardiovascular disease). Their use in psychiatry and psychology, however, remains relatively novel but has the potential to assist practitioners and enhance informed decision-making regarding intervention and treatment.

**Aims of the study:**

This study will examine a variety of potential factors that confer vulnerability for, and/or resilience against, poor psycho-social functioning in the face of childhood victimisation. The resulting multivariable prognostic model will be used to build a risk calculator, a practical tool to help clinicians and professionals identify children who are at greatest risk of unfavourable psycho-social functioning in young adulthood following childhood experiences of victimisation. These potentially modifiable factors could then be targeted by practitioners to increase resilience among victimised children. Consequently, the study's three main aims are:

1. To examine the role of individual-, family- and community-level factors as determinants of vulnerability and resilience for a range of psycho-social functional outcomes (at age 18) including occupational functioning (NEET status, educational level, job preparedness), social functioning (social support/ social isolation, loneliness), quality of sleep, subjective life satisfaction, early parenthood, criminal offending (police records), and adolescent victimisation in children exposed to (i) any victimisation or (ii) specific types of victimisation by 12 years of age.
2. Based on the resilience and vulnerability factors we identify, generate a risk calculator and evaluate its ability to discriminate between victimized children with and without unfavourable psycho-social functioning outcomes.
3. Test whether the protective or risk factors we identify within the group of victimized children are particularly important in explaining heterogeneity in functional outcomes of victimized children compared to non-victimized children.

**Statistical analyses:**

Analyses will be conducted in STATA version 15 and corrected for familial clustering.

1. We will create a cumulative index of poor psycho-social functioning at age 18 (see Wertz et al., in press [11]) and also conduct an exploratory factor analysis to examine the structure of the psycho-social outcomes.
2. A series of univariate regression models will be conducted to examine whether there are group differences in age-18 psycho-social functional outcomes between (i) victimized children (those exposed to physical abuse, sexual abuse, emotional abuse/neglect, physical neglect, bullying, or domestic violence) vs. non-victimized children; and then (ii) children exposed to specific types of victimisation vs. non-victimized children.
3. Heterogeneity in age-18 psycho-social functional outcomes among children exposed to (i) any victimisation, and then (ii) specific types of victimisation, will then be explored using scatterplots/bar graphs as appropriate.
4. A series of bivariate regression models will then be conducted to examine whether different individual-, family- and community-level factors are associated with differences in age-18 psycho-social functional outcomes within subsets of children exposed to (i) any victimisation, or (ii) specific types of victimisation.
5. Significant predictors will then be included in multivariate explanatory regression models to predict differences in psycho-social functional outcomes in (i) victimized individuals and (ii) those exposed to specific types of victimisation, to examine the relative contribution of different factors within our ecological model.
6. The predictive accuracy of these explanatory models will then be tested. To ensure that a proposed model is not over-fitted to our specific data and can classify unseen cases, we will use internal validation methods (e.g. *k*-fold cross validation or bootstrapping) to 'train' and 'test' the

model using separate subsets of the overall sample. Specifically, we will test: (i) discrimination (the model's ability to separate victimised youth with and without poor psycho-social outcomes at age 18), based on the *c*-statistic; and (ii) calibration (the agreement between the observed and predicted outcomes), by examining the intercept and slope of the calibration plot.

7. We will then test for statistical interactions between identified risk or protective factors and (i) any victimisation and (ii) specific types of victimisation exposure in predicting the psycho-social outcomes of interest using the overall E-Risk sample to see if these factors are particularly important for victimized compared to non-victimized children.
8. Finally, sensitivity analyses will be conducted; we will re-run the above analyses using the age-18 retrospective measure of child maltreatment to identify maltreated individuals.

Variables Needed at Which Ages (names and labels):

Study: E-Risk

<b>Age 5</b>	
FAMILYID	Unique family identifier
ATWINID	Twin A ID
BTWINID	Twin B ID
RORDERP5	Random Twin Order
RISKS	Sample Groups
COHORT	Cohort
SAMPSEX	Sex of Twins
ZYGOSITY	Zygoty
HOHSCM5	Head of household social class (highest mum/dad)
ED56M5	Total household income from all sources
HHIEM5	Head of household highest educational qual (highest mum/dad)
SETHNIC	Ethnicity of twins
EXFUNCE5	Executive function – mean of Mazes, DayNight & SWM – Elder
TOMTOTE5	TOM total score – Elder
ADJE5	Temperament – P5 – Elder (derived by Sara Jaffee)
TOTEXTE5	Total Mum & Teacher Externalising Scale – Elder twin
TOTPROE5	Total Mum & Teacher prosocial scale – Elder twin
INTISOE5	Internalising scale – ex soc iso items (mum & teacher average) – P5 Elder
SISOE5	Social isolation scale (mum & teacher average) – P5 – Elder (derived by Tim)
PARM5	Current partnership status – mother
WARME5	Warmth towards elder twin
P5CACORN	ACORN neighbourhood SES
NCRIMM5	Neighbourhood personal victimisation
SOCCM5	Neighbourhood informal social control
SCOHM5	Neighbourhood social cohesion
NPROBM5	Perception of local environment
<b>Age 7</b>	
TOTEXTE7	Total Mum & Teacher Externalising Scale - Elder twin
TOTPROE7	Total Mum & Teacher Prosocial Scale – Elder Twin
SISOE7	Social isolation scale (mum & teacher average) – P7 – Elder
SIBWRMM7	Sibling warmth – Derived by Sara Jaffee
ATHOME7	Atmosphere at home (under 'variables by collaborators' in data dictionary)
FSEC7M7	Food situation – 7 scale recoded
INTISOE7	Internalising scale – ex soc isol items (mum & teacher average) in line with score derived by Tim at age 5

<b>Age 10</b>	
TOTEXTE10	Total Mum & Teacher Externalising Scale - Elder twin
TOTPROE10	Total Mum & Teacher Prosocial Scale – Elder twin
SISOE10	Social isolation scale (mum & teacher average) – P10 – Elder
LOWSC510E	Low Childhood Self-Control, 5-10, E-Twin
SIBWRM10	Sibling warmth (same as Bowes et al 2010)
ATHOME10	Atmosphere at home)
BIOPARENTL10	Bio-parent living situation (to age 10)
FSEC7M10	Food situation – 7 scale recoded
MONEM10	Parental Monitoring – Elder Twin
KNOWEM10	Parental Monitoring (Knowledge Subscale) – P10 – Elder
CONTEM10	Parental Monitoring (Control Subscale) – P10 – Elder
NMOVE510	N residence moves between ages 5 & 10
KIDSINFAMILY10	Number of children in the family, LHC siblings + 2
WARME10	Warmth towards elder twin
INTISOE10	Internalising scale – ex soc isol items (mum & teacher average) in line with score derived by Tim at age 5
<b>Age 12</b>	
IQ12E	Pro-rated IQ (INF & MR), 12E
TOTEXTE12	Total Mum & Teacher Externalising Scale - Elder twin
TOTPROE12	Total Mum & Teacher Prosocial Scale – Elder twin
SISOE12	Social isolation subscale (mum & teacher average) – P12 – Elder
INTISOE12	Internalising scale – ex soc isol items (mum & teacher average) in line with score derived by Tim at age 5
BFIOE12	Openness to experience (BFI) – Elder Twin
BFICE12	Conscientiousness subscale (BFI) – Elder Twin
BFIEE12	Extroversion subscale (BFI) – Elder Twin
BFIAE12	Agreeableness subscale (BFI) – Elder Twin
BFINE12	Neuroticism subscale (BFI) – Elder Twin
HOMEM12	State of the home – Mum Intv
CHSTIM12	Child stimulation – Mum Intv
HAPPHM12	Happy home – Mum Intv
CHAOSM12	Chaos in the home – Mum Intv
PSYSYMP01E12	Psychosis Symptom Count - Verified Coding - 0, 1+ - Elder
SUB2EC12	Substance Use – Option 2 (Downgrade of Items 03 and 07) – Elder
SHARMSUICE12	Self-Harm/Suicidal Behaviour – P12 – Elder
CDIE12	Depression Scale – CDI – Elder
MASCE12	Anxiety Scale – MASC – Elder
ADHDANYE512	Any ADHD dx [incl meds] - P5-12 – Elder
ANYCDDX_EMT512	Any CD dx from 5 to 12, mum/tchr, Elder
FHANYPM12	Proportion of family members with valid data who have any disorder
CTQCTOTM12	CTQ combined - types of abuse or neglect at mod/severe level (0-5)
NSOCCOHL12	Number of social parents cohabiting with bio-parent (to age 12)
ADULTEC12	Adult Involvement – Elder
MONEM12	Parental Monitoring (full scale – self report) P12 – Elder Twin
KNOWEM12	Parental Monitoring (Knowledge Subscale – self report) – P12 – Elder
CONTEM12	Parental Monitoring (Control Subscale – self report) – P12 – Elder
FCEVIDE12	Foster care or non-parental care through age 12
Item LC5 from age 12 study booklet ‘How many times have you changed addresses since twins turned 10?’ (to be used to derive number of house moves up to 12)	
Item LE31 from Life Events section of age 12 study booklet ‘New step children joined the family?’	
Item LE 32 from Life Events section of age 12 study booklet ‘Had a baby?’ (to be used to extend number of children in the home to age 12)	
<b>Victimisation variables:</b>	
EANSEVE12	Severity of emotional abuse/neglect of Elder twin, thru age 12, 2014
PABSEVTYE12	Physical abuse by 12, severity, Elder

PNSEVERITYE12	Physical neglect by 12, severity, Elder
SASEVTYE12	Sexual abuse by 12, severity, Elder
POLYVE512C	Extent of Polyvictim (Truncated @3), 5-12, E-Twin
EXPV_DV510	Exposure to domestic violence, 5 to 10, 012 coding (from HonaLee)
BULLSEVE12	Bullying victim to Age 12 – Elder
EX_SVE12	Exposed to severe victimization (0/1), 5-12, E-Twin
<b>Age 18</b>	
<b>Psycho-social outcomes</b>	
NEETE18	NEET: not in educ emplymt or training – P18 - Elder
EDUCACHVE18	Highest educational achievement (based on QCF) – P18 - Elder
JPREPSE18	Job preparedness (Skills) scale – P18 – Elder
JPREPAE18	Job preparedness (Attributes) scale – P18 – Elder
OPTME18	Optimism scale – P18 – Elder
SOCISOE18	Social Isolation scale - P18 - Elder
LONELYE18	Loneliness scale – P18 – Elder
PSQIE18	PSQI - global score – P18 – Elder
LIFSATE18	Life satisfaction (average) P18 – Elder
PREGE18	Pregnant at visit – P18 – Elder
PARENTE18	Is the twin a parent at 18? (Combine with above variable as per Jasmin)
CRIMCNTE18	MOJ – number of criminal offences – P18 – Elder
NONVIOCNTTE18	MOJ – number of non-violent offences – P18 - Elder
VIOCNTTE18	MOJ – number of violent offence – P18 – Elder
NVIOSTATE18	MOJ – non-violent/violent offence status – P18 - Elder
POLYVCTZCE18	Poly-victimisation 4 cat (0,1,2,3+) - P18 - Elder
<b>Victimisation variables:</b>	
CTQPNCCCE18	Physical Neglect CTQ +/- P18 - Elder
CTQPACCCE18	Physical Abuse CTQ +/- P18 - Elder
CTQENCCE18	Emotional Neglect CTQ +/- P18 - Elder
CTQEACCCE18	Emotional Abuse CTQ +/- P18 - Elder
CTQSACCCE18	Sexual Abuse CTQ +/- P18 - Elder
CTQCTOTE18	CTQ combined - types of abuse or neglect at mod/severe level (0-5) - P18 – Elder

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## Data Security Agreement

Provisional Paper Title	An individualised risk calculator for psycho-social functioning in young adults victimised during childhood
Proposing Author	Rachel Latham
Today's Date	11 December 2017

***Please keep one copy for your records***

(Please initial your agreement)

\_RL\_ I am current on Human Subjects Training (CITI ([www.citiprogram.org](http://www.citiprogram.org)) or training in human subject protection through my post or courses.

\_RL\_ My project is covered by Duke or King's IRB OR I have /will obtain IRB approval from my home institution.

\_RL\_ I will treat all data as "restricted" and store in a secure fashion.

\_RL\_ I will not share the data with anyone, including students or other collaborators not specifically listed on this concept paper.

\_RL\_ I will not post data online or submit the data file to a journal for them to post. Some journals are now requesting the data file as part of the manuscript submission process. The E-Risk Study cannot be shared because the Study Members have not given informed consent for unrestricted open access. Speak to Terrie or Avshalom for strategies for dealing with data sharing requests from Journals.

\_RL\_ Before submitting my paper to a journal, I will submit my draft manuscript and scripts for data checking, and my draft manuscript for co-author mock review, allowing three weeks.

\_RL\_ I will submit analysis scripts and new variable documentation to project data manager after manuscript gets accepted for publication.

\_RL\_ I will return all data files to the Data Manager after the project is complete. Collaborators and graduates of DPPP may not take a data file away from the DPPP office. The data remains the property of the Study and cannot be used for further analyses without express, written permission.

\_RL\_ I will ensure geographical location information, including postcodes or geographical coordinates for the E-Risk study member's homes or schools, is never combined or stored with any other E-Risk data (family or twin-level data)

Signature:  .....

## CONCEPT PAPER RESPONSE FORM

### A. To be completed by the proposing author

Proposing Author:

✓ I have read the E-Risk data-sharing policy guidelines and agree to follow them

Provisional Paper Title: An individualised risk calculator for psycho-social functioning in young adults victimised during childhood.

Potential co-authors: Helen Fisher, Andrea Danese, Alan Meehan, Louise Arseneault, Terrie Moffitt, Avshalom Caspi, Daniel Stahl

Potential Journals:

Intended Submission Date (month/year): June 2018

***Please keep one copy for your records and return one to Louise (louise.arseneault@kcl.ac.uk)***

### B. To be completed by potential co-authors:

Approved     Not Approved     Let's discuss, I have concerns

Comments:

Please check your contribution(s) for authorship:

- Conceptualizing and designing the longitudinal study
- Conceptualizing and collecting one or more variables
- Data collection
- Conceptualizing and designing this specific paper project
- Statistical analyses
- Writing
- Reviewing manuscript drafts
- Final approval before submission for publication
- Acknowledgment only, I will not be a co-author

**Signature:** .....