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Childhood Trauma & Suicide: associations between impulsivity, executive functioning and stress

Crisis

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Running head: Childhood trauma and suicide

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Abstract

Background: Suicide is a leading cause of death worldwide and childhood trauma has been found to be an important risk factor. However, the mechanisms linking trauma to suicide risk remain unclear.

Aims: The current registered report sought to: i) investigate whether childhood trauma (and its subtypes) were related to suicide risk in adulthood and, ii) explore the potential mechanisms associating childhood trauma with suicide and wellbeing; specifically executive functioning, impulsivity and stress.

Method: A cross-sectional survey of 457 individuals who reported experiencing suicide ideation in the past 12 months.

Results: Childhood trauma and its subtypes were associated with an increased risk of reporting recent suicide thoughts, COVID-related suicide attempts and recent suicide attempts. There were also significant indirect effects of childhood trauma on recent suicide ideation and wellbeing through executive functioning and impulsivity.

Conclusion: These findings show that childhood trauma is associated with suicide risk in adulthood and suggest that poorer executive functioning and higher levels of impulsivity contribute to this increased risk. These results have implications for the development of future interventions to reduce suicide vulnerability.

Introduction

It is estimated that each year approximately 700,000 individuals worldwide die by suicide and that between 10-20 million more individuals make an attempt to die by suicide (World Health Organisation, 2021). For this reason, there have been continual efforts to elucidate the precise risk factors for suicidal behaviour. As a result, a plethora of risk factors have been identified, with roots in psychological, neurobiological and social domains (Franklin et al., 2017; O'Connor et al., 2016). However, predicting and preventing suicidal behaviour remains low, with predictive ability not improving in the past 50 years (Franklin et al., 2017; Zalsman et al., 2016). In addition, numerous theoretical models of suicidal behaviour have highlighted the complexity of the interaction of risk factors leading to suicidal behaviour (O'Connor & Kirtley, 2018). For example, the Integrated Motivational-Volitional (IMV) model (O'Connor & Kirtley, 2018) recognises the importance of understanding both proximal and distal risk factors, as well as the need to distinguish between suicide ideation and suicide attempt (Mann et al., 1999; O'Connor & Kirtley, 2018; van Orden et al., 2010).

Recent research has shown that childhood trauma is an important risk factor associated with suicide behaviour. O'Connor et al. (2018) found that approximately 80% of individuals who had attempted suicide in adulthood had reported experience of childhood trauma. Additionally, a meta-analysis by Angelakis et al. (2019) found all types of childhood maltreatment increased the risk for suicide attempts and ideation in adults. These authors suggested that one of the main outstanding challenges was to better understand the mechanisms which underpin the development of suicide

behaviour in individuals exposed to childhood trauma. Previous research and statistical techniques have focussed on identifying risk factors for suicide behaviour but have ignored the potential relationships between risk factors (De Beurs et al., 2019). Consequently the mechanisms by which childhood trauma may lead to the emergence of suicidal behaviour are unclear and multiple risk factors may interact to produce suicidal behaviour. Moreover, there are a number of theoretical models that suggest childhood trauma has the capacity to modify behaviour patterns that can lead to negative health outcomes (e.g., Lovallo, 2013). Therefore, the central aim of the current study was to investigate the potential mechanisms associating childhood trauma and suicide; namely the role of executive functioning, impulsivity and stress. In addition, this study examined the relationships between childhood trauma and mental wellbeing, as a secondary outcome, alongside the aforementioned potential mechanisms (McElroy & Hevey, 2014).

A study by Lovallo et al. (2013) demonstrated that early adversity (including childhood trauma) was related to a reduced stress response, poorer working memory (a facet of executive function) and increased impulsive behavioural style, all factors linked to suicide behaviour, in a sample of young adults with and without a family history of alcoholism. The relationship between childhood trauma, executive functioning, impulsivity and negative health outcomes is conceptualised in a model proposed by Lovallo (2013). The model posits that childhood trauma can cause modifications in frontolimbic brain function which may have the capacity to lead directly to reduced stress reactivity and altered cognition, impulsive behaviours and a focus on short term goals. Consistent with Lovallo's theorising, O'Connor et al. (2018) found evidence of blunted hypothalamic pituitary adrenal (HPA) axis activity in response to stress in individuals vulnerable to suicide who also had high levels of childhood trauma, thereby, providing evidence for the proposed reduced stress responsivity pathway. More recently, another study found that childhood trauma was associated with suicide vulnerability in adulthood and that this relationship was, in part, mediated by lower cortisol levels following awakening (O'Connor et al., 2020). However, in the broader context, much less work has investigated the precise mechanisms that link childhood trauma to suicide. Therefore researchers have argued that Lovallo's model should be extended to suicide behaviour to help understand how childhood trauma may lead to suicide behaviour. For example, is childhood trauma associated with having a more disinhibited lifestyle or impulsive behavioural style in adulthood? What is the relationship between childhood trauma, impaired executive function and suicide behaviour? McGirr et al. (2010) found that first degree relatives of individuals who had died by suicide had a blunted cortisol reactivity to stress compared to matched controls, suggesting that stress reactivity, as marked by blunted cortisol, could be a trait marker of suicide behaviour risk. However, to the best of our knowledge, no research has investigated whether, collectively, these variables, impulsivity and executive function, are mechanisms linking childhood trauma and suicide behaviour. Likewise, whether the effects of specific forms of childhood trauma influence the relationships between risk factors and suicide behaviour differently is unknown. For example, Angelakis, Gillespie and Panagioti

(2019) found that all types of childhood trauma conferred risk of suicide behaviour but sexual abuse produced the greatest risk followed by physical abuse and emotional abuse. Therefore, the current study aimed to further extend Lovallo's (2013) model and to examine the precise relationships between childhood trauma, its sub-types, impulsivity and executive functioning within the context of suicide behaviour.

Stress-diathesis models have a long history in the field of suicide research (O'Connor, Gartland & O'Connor, 2020). An early example was introduced by Schotte and Clum (1987) in the context of their diathesis-stress-hopelessness model of suicide behaviour. These authors found evidence that impaired social problem-solving, a specific cognitive vulnerability factor, acted as a diathesis and it was associated with suicide risk in the presence of stress. Another influential diathesis-stress model, developed by Mann and colleagues, was the clinical model of suicidal behaviour (Mann et al., 1999). In this model, risk was postulated to change as a function of the interaction between psychiatric disorder (recent stressor) and a trait-like diathesis. Diatheses are biological, others are cognitive in nature, and others still are personality factors, however, they are all important. Therefore, a secondary aim of the current study was to investigate whether the relationships between childhood trauma and impulsivity/executive functioning, and childhood trauma and suicide ideation, were moderated by recent stress.

Finally, the coronavirus disease 2019 (COVID-19) pandemic represents the greatest international biopsychosocial emergency the world has faced for a century (O'Connor et al., 2020). This pandemic has fundamentally changed how societies function, affecting how we work, educate, parent, socialise, shop, communicate and travel. Evidence is emerging to suggest that COVID-19 is increasing the severity of mental health challenges faced by many individuals. A recent national study has shown that the mental health and wellbeing of the UK adult population appears to have been substantially affected in the initial phase of the COVID-19 pandemic, especially for women, young adults, the socially disadvantaged and those with pre-existing mental health problems (O'Connor et al., 2021). Moreover, this national study also found concerning increased rates of suicidal thoughts especially among young adults, as well as changes in mental health and wellbeing outcomes. As a result, given the global reach, virulence and the on-going and longer-term impact of COVID-19, the current study operationalised suicide behaviour in three ways by assessing: 1) recent suicide ideation and attempt, 2) lifetime suicide ideation and attempt and 3) COVID-related suicide ideation and attempt, as well as including a measure of mental wellbeing.

To summarise, the primary aim of this study was to explore the role of executive functioning and impulsivity in explaining the association between childhood trauma and suicide ideation (including COVID-related suicide measures). The secondary aims were to investigate whether the relationships between childhood trauma and impulsivity/executive functioning, childhood trauma and suicide ideation were moderated by recent stress.

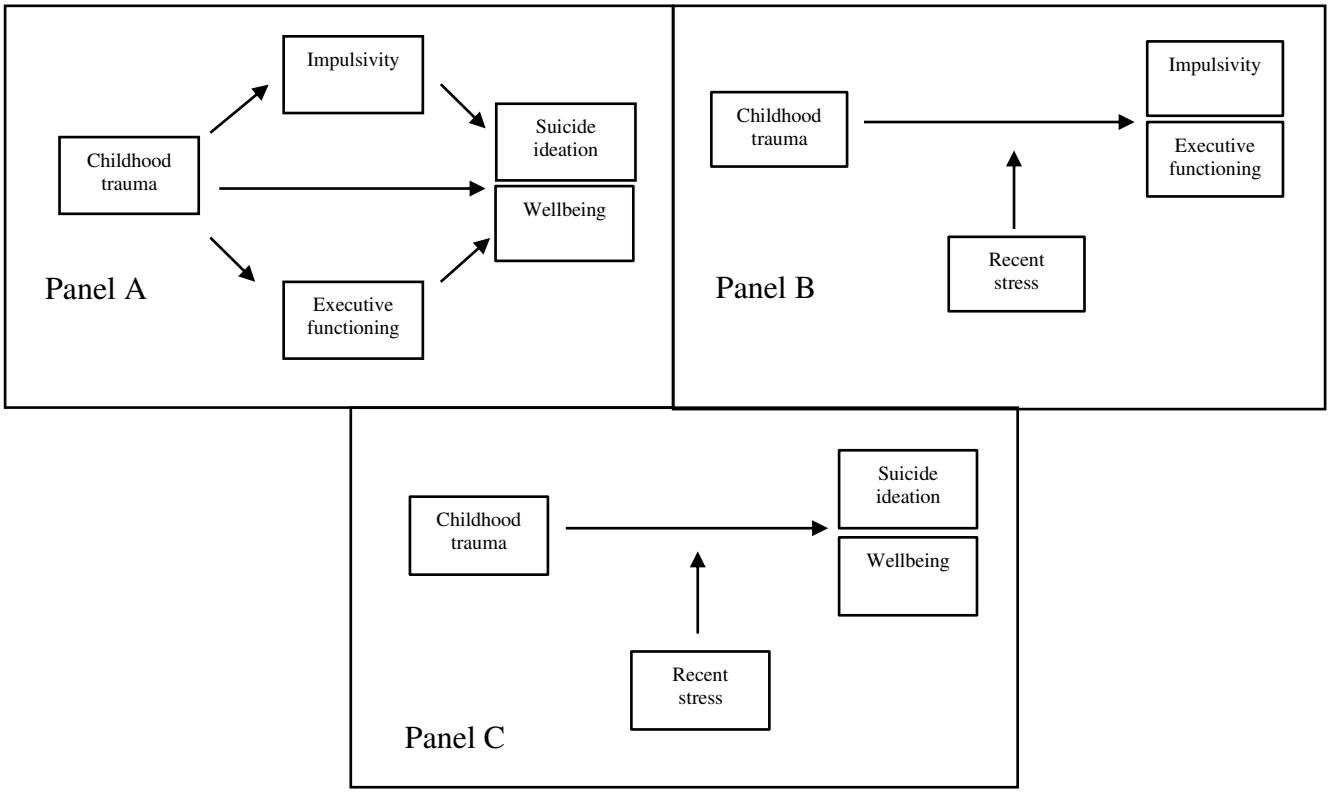
The hypotheses were:

H1: Childhood trauma (and sub-types) will be associated with both recent and lifetime suicide ideation and attempt (including COVID-related suicide measures).

H2: The effects of childhood trauma (and sub-types) on suicide ideation and wellbeing will be mediated by executive functioning and impulsivity (Panel A).

H3: The relationship between childhood trauma (and sub-types) and impulsivity/executive functioning will be moderated by recent stress (Panel B).

H4: The relationship between childhood trauma (and sub-types) and recent suicide ideation and wellbeing will be moderated by recent stress (Panel C).



Methods

Design and Participants

An online cross-sectional survey with individuals at risk of suicide ideation (see Stage 1 registered report: https://doi.org/10.17605/OSF.IO/GXU67). The inclusion criteria for participants were: individuals aged 18 years or older, understanding English language and having reported experiencing suicide ideation in the past 12 months. Understanding suicide risk was the primary concern of the current study, therefore, history of suicide ideation was the main inclusion criterion. However, it is important to note that previous research has established that there are high levels of exposure to childhood trauma in individuals with a recent history of suicide ideation (e.g., 56.7% in recent study by O'Connor et al., 2020). Therefore, adopting this approach ensured we had a good

range of scores on the Childhood Trauma Questionnaire, as well as for suicide ideation, thereby allowing us to robustly test our study hypotheses. Participants were recruited through advertisements on social media, Prolific, the University Psychology department participant pool and university emailing lists. Ethical approval for the study was granted (PSYC-150).

To estimate the sample size required for the current study a priori power analysis was conducted. The general approach adopted for the power analysis was to start with reasonable values of the parameters (e.g., effect size, correlations between predictors, base rates of outcomes) and estimate power as a function of *n*. As the parameters are not known with any degree of certainty, the values have been varied slightly around those reasonable starting points to gauge sensitivity to the key parameters and presented graphically (Hughes, 2017; see page 5, supplementary materials). For complex analyses the values for power are simulated and all analyses were undertaken in R 4.03 (R Core Team, 2020). All analyses assume *alpha* = .05 unless otherwise stated. In summary, the aim was not to arrive at a single number for each test but arrive at an overall sample size that will have good power (e.g., approximately 80% or more) for a wide range of plausible effect sizes. The desired sample size following the calculations was in the region of n = 400. However, to allow for missing data and any technical issues that may lower the power, we aimed to recruit 500 participants.

Measures[1]

Childhood Trauma: Childhood Trauma Questionnaire (CTQ; Bernstein et al., 2003). A 28-item self-report inventory assessing history of abuse and neglect in childhood. The CTQ asks people about their experiences growing up as a child and a teenager. Individuals are required to indicate how true each item is, an example being 'I felt loved', to be rated from 'never true' (1) to 'very often true' (5).

Impulsivity: Barratt Impulsiveness Scale-11 (BIS-11; Patton et al., 1995). A 30-item self-report questionnaire assessing impulsive behaviour. Individuals rate each item, such as 'I do things without thinking', from 'never' to 'almost always/always'.

Executive Dysfunction: Dysexecutive Questionnaire (DEX; Wilson, Alderman, Burgess, Emslie & Evans, 1996). A 20-item scale to identify executive difficulties whereby each statement, such as 'I have difficulty thinking ahead or planning for the future', had to be rated from 'never' (0) to 'often' (4).

Stress: Perceived Stress Scale (PSS-Brief; Cohen, Kamarck & Mermelstein, 1983). A 4-item self-report measure for perception of stress, individuals are required to indicate how little or often they

[1] For Cronbach's alpha, see supplementary materials

have felt or thought the items over the past 4 weeks, such as the extent to which they are unable to control the important things in their life.

Mental Wellbeing: The Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS; Stewart-Brown et al., 2009). A 7-item measure to determine wellbeing of individuals over the past 4 weeks (modified from 2 weeks). An example item asks individuals to consider whether 'I've been thinking clearly' from 'None of the time' (1) to 'All of the time' (5).

Depressive symptoms: Beck Depression Inventory-II (BDI-II; Beck et al. 1996). A 21-item measure established to determine a range of depressive symptoms over the past 4 weeks (modified from 2 weeks). An example item in the measure is for sadness where individuals choose one of the following responses to indicate the way they have been feeling in the past four weeks: 'I do not feel sad', 'I feel sad much of the time', 'I am sad all the time', 'I am so sad or unhappy that I can't stand it'.

Suicide behaviour measures

Lifetime suicide behaviour: two items were used from the Adult Psychiatric Morbidity Scale (APMS) "Have you ever seriously thought of taking your life, but not actually attempted to do so?" and "Have you ever made an attempt to take your life, by taking an overdose of tablets or in some other way?" Responses to these questions allowed participants to be categorised: 1. Experience of suicidal ideation but not an attempt; 2. Experience of a suicide attempt.

Recent suicide behaviour: the Scale for Suicidal Ideation (SSI, Beck et al., 1979) was used to determine the presence of suicidal thoughts over the previous 4 weeks (modified from the previous 7 days), a 21-item measure to determine individual thoughts towards thinking about suicide. Each of the items has three responses, an example being; 'I have no wish to die', 'I have a weak wish to die', 'I have a moderate to strong wish to die.

COVID-related suicide behaviour: given the current developments in COVID-19, two questions were added "In the past 12 months, have you had any thoughts of taking your life as a consequence of the COVID-19 pandemic?" and "In the past 12 months, have you attempted to end your life as a consequence of the COVID-19 pandemic?". For both questions individuals indicated 'Yes' or 'No', and "if yes, how many times?".

Results

Descriptive statistics

A total of 502 individuals were recruited. We found only 457 out of the 502 participants reported suicide ideation in the last 12 months and a lifetime history of suicide ideation. 45 participants were excluded due to inconsistent reporting whereby they reported suicide ideation in the past 12 months *but* no lifetime history of suicide ideation. The number of individuals reporting lifetime history of suicide ideation (n = 238) and suicide attempts (n = 219) resulted in similarly distributed groups. Table S2 shows the means and standard deviations for outcomes for the total sample as well as by suicide history group. All study variables were significantly associated with one another apart from perceived stress, Pearson's *r* correlation is reported in Table S3.

Inferential statistics[2]

Hypothesis 1: Childhood trauma (and sub-types) will be associated with both recent and lifetime suicide ideation and attempt.

For the outcome recent suicide ideation, a hierarchical linear regression was conducted. As outlined in Table S4, childhood trauma was significantly associated with recent suicide ideation, in both the unadjusted model and in the adjusted model (which controlled for gender, age and depressive symptoms). Each subscale of the CTQ was significantly associated with recent suicide ideation, in both unadjusted and adjusted models. The model for the emotional neglect subscale appeared to account for the greatest proportion of variance. For recent suicide attempt, an ordinal logistic regression was conducted. We found that in both the adjusted and unadjusted models childhood trauma was associated with a greater likelihood of reporting a recent suicide attempt in the past month (OR = 1.57, 95% CI [1.33, 1.75]), that is a meaningful unit change in CTQ score (14.3 units) was associated with 57% increased likelihood of reporting a recent suicide attempt in the past month.

For the combined outcome variable, lifetime suicide ideation and attempt, a binary logistic regression was utilised. Table S5 shows the binary logistic regression results of associations between childhood trauma, and its subtypes, with the outcome lifetime suicide ideation and attempt. Greater levels of childhood trauma were associated with lifetime history of suicide attempt (OR = 1.70, 95% CI [1.53, 2.01]). This relationship is shown in *Figure 1* whereby the predicted probability of lifetime suicide attempts varies according to CTQ score. A binary logistic regression showed that all subtypes of childhood trauma were associated with lifetime history of suicide attempt in both the unadjusted and adjusted models (Table S5). In addition, childhood trauma was not associated with an increased likelihood of reporting thoughts to die by suicide as a consequence of the COVID-19 pandemic, but

[2] For the full confirmatory analysis plan, and odds ratio adjustment calculation for CTQ scale, see supplementary material

there was a statistically significant increase in the odds of reporting a suicide attempt as a result of the COVID-19 pandemic (see *Figure 1*, (OR = 1.38, 95% CI [1.15, 1.75])).

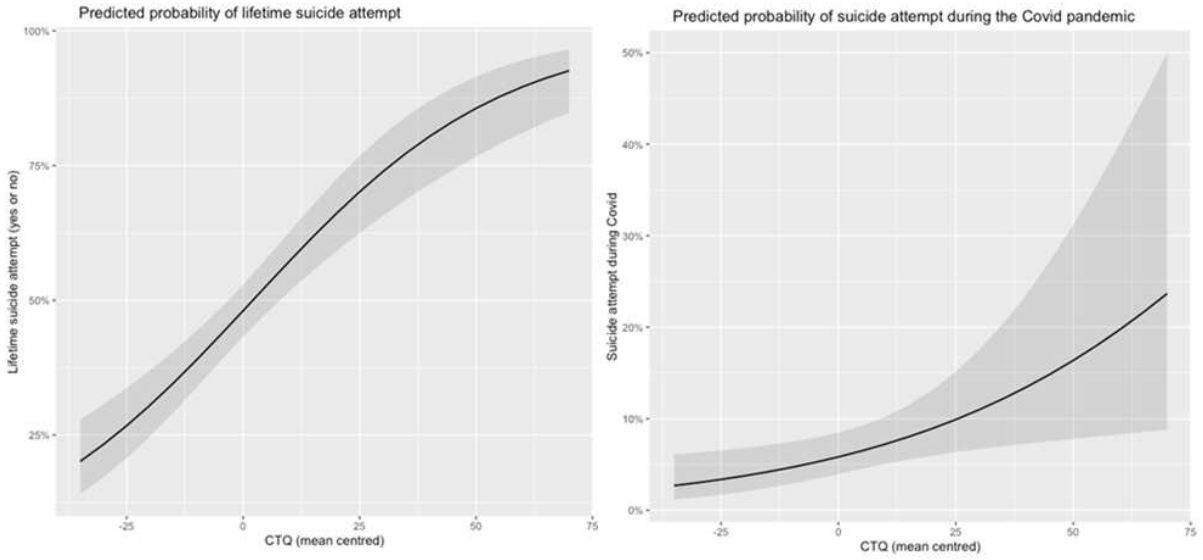


Figure 1. Predicted probability of lifetime suicide attempts (left panel) and COVID suicide attempts (right panel) as a function of CTQ with a 95% CI band.

Hypothesis 2: The effects of childhood trauma (and sub-types) on suicide ideation and wellbeing will be mediated by executive functioning and impulsivity

2.1 *Suicide ideation*

A mediation analysis was run to test the hypothesis using estimates of the indirect effect obtained via percentile bootstrap. The analysis indicated that childhood trauma was significantly associated with executive functioning and executive functioning was significantly associated with suicide ideation (Table S5, Model 2.1). Moreover, there was a significant indirect effect of childhood trauma on recent suicide ideation through executive functioning (b = 0.02, CI [0.01, 0.04]). See *Figure 2.* For four of the five subscales, there were significant indirect effects on recent suicide ideation through executive functioning (Table S6, 2.4.1 – 2.4.5); the exception was the sexual abuse subscale.

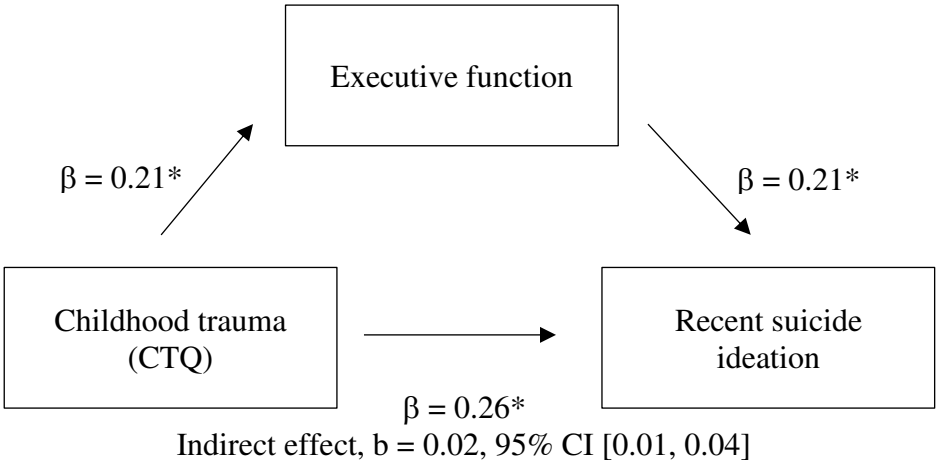


Figure 2. Indirect effects of childhood trauma on recent suicide ideation through executive functioning

The analysis indicated that childhood trauma was significantly associated with impulsivity and impulsivity was significantly associated with suicide ideation (Table S5, Model 2.2). There was a significant indirect effect of childhood trauma on recent suicide ideation through impulsivity (β = 0.02, CI [0.01, 0.03]). See *Figure 3.* For all of the five subscales, there were significant indirect effects on recent suicide ideation through impulsivity (Table S6, 2.3.1 – 2.3.5).

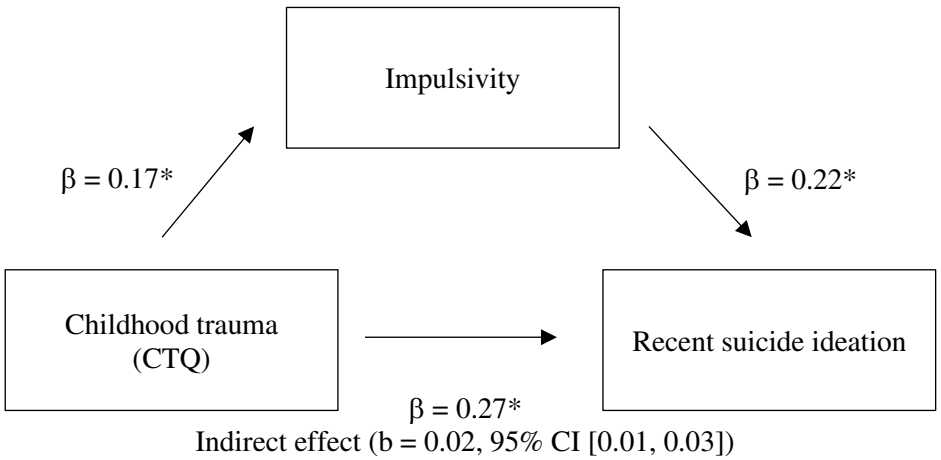


Figure 3. Indirect effects of childhood trauma on recent suicide ideation through impulsivity

2.2 *Wellbeing*

The analysis indicated that childhood trauma was significantly associated with executive functioning and executive functioning was significantly associated with wellbeing. There was a significant indirect effect of childhood trauma on wellbeing through executive functioning (*b* = -0.01, CI [-0.01, -0.00]). See *Figure 4.* For all subscales, except sexual abuse, there were significant indirect effects on wellbeing through executive functioning (Table S7, 3.4.1 – 2.4.5).

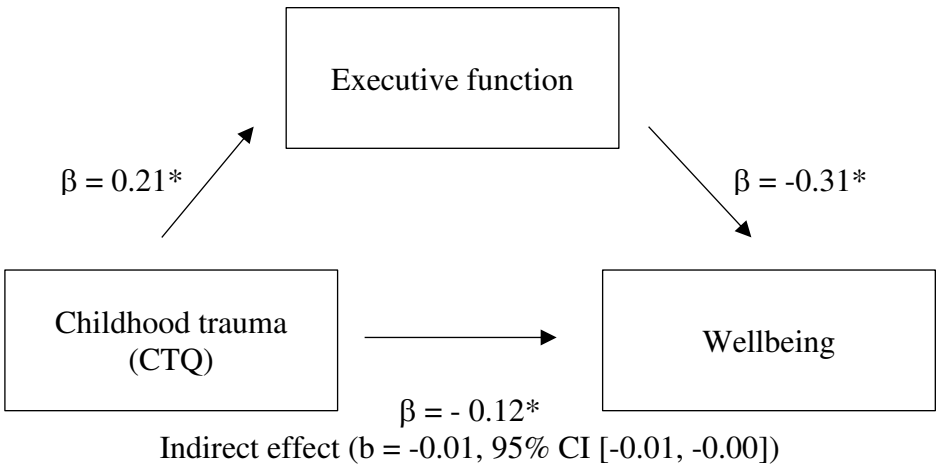


Figure 4. Indirect effects of childhood trauma on wellbeing through executive functioning

The analysis indicates that childhood trauma was significantly associated with impulsivity and impulsivity was significantly associated with wellbeing. There was a significantly indirect effect of childhood trauma on wellbeing through impulsivity (*b* = -0.01, CI [-0.01, -0.00]). See *Figure 5*. For all of the five subscales, there were significant indirect effects on wellbeing through impulsivity (Table S6, 3.3.1 – 3.3.5).

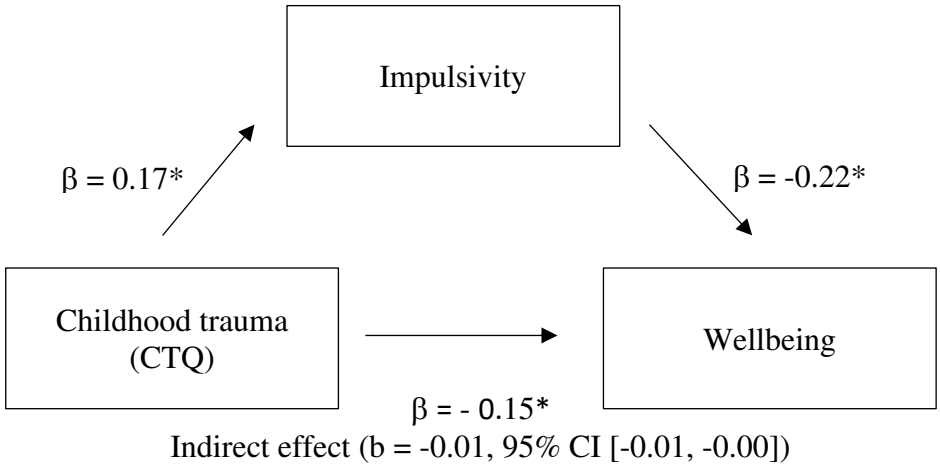


Figure 5. Indirect effects of childhood trauma on wellbeing through impulsivity

Hypothesis 3: The relationship between childhood trauma (and sub-types) and impulsivity/executive functioning will be moderated by recent stress

Contrary to our predictions, the relationships between childhood trauma, and its subtypes, and executive functioning and impulsivity were not found to be moderated by recent stress (Table S8).

Hypothesis 4: The relationship between childhood trauma and recent suicide ideation and wellbeing will be moderated by recent stress

Similarly, the relationships between childhood trauma and recent suicide ideation and childhood trauma and wellbeing were not found to be moderated by recent stress (Table S9).

Discussion

The current study found that experiencing childhood trauma was associated with increased risk of reporting recent suicide ideation and suicide attempts and these associations held when

controlling for gender, age and depressive symptoms. Importantly, we also found a significant indirect relationship between childhood trauma on recent suicide ideation and wellbeing through executive functioning; all childhood trauma subtypes apart from sexual abuse also had a significant indirect effect on recent suicide ideation and wellbeing through executive functioning. A similar indirect relationship was found for childhood trauma, and subtypes, on recent suicide ideation and wellbeing through impulsivity. Overall, recent stress did not moderate the relationships between childhood trauma and its subtypes and executive functioning, impulsivity, suicide ideation or wellbeing.

Previous research has established the relationship between childhood trauma and suicide (O'Connor et al., 2018) and argued that poorer executive functioning may be a risk factor that increases the likelihood of suicide behaviour (McGirr et al. 2010). The current study adds to, and confirms this knowledge, finding an indirect effect of childhood trauma on suicide ideation through executive functioning. This adds to the existing evidence base that has shown that childhood abuse and neglect are associated with difficulties in executive functioning (Tinajero et al., 2020) and that cumulative exposure to trauma can predict poorer executive functioning; with effects remaining after controlling for psychopathology symptoms (Letkiewicz, Funkhouser & Shankman, 2021). However, the current study extends our understanding further to reveal a pathway whereby childhood trauma contributes to increased *suicide risk* through poorer executive functioning.

These findings are important as they suggest that experience of childhood trauma may predispose individuals to an increased risk of suicide ideation in adulthood through disrupted cognitive functioning; both poorer executive functioning, as discussed, and greater impulsivity. Previous research acknowledges that impulsivity is related to both childhood trauma and suicide behaviour separately (O'Connor, Gartland & O'Connor, 2020), however the current findings show that the relationship between childhood trauma and suicide behaviour is also mediated through impulsivity. Previous meta-analytic investigations have found the relationship between impulsivity and suicide behaviour was significant but small in magnitude, suggesting impulsivity's relationship with suicide behaviour is likely to be indirect rather than causal (Anestis et al., 2014). Overall, suggesting there are both direct, and indirect pathways, between childhood trauma, and its subtypes, with suicide ideation and attempt.

In conclusion, the current study provides additional evidence that experiencing childhood trauma is associated with increased risk of reporting recent suicide ideation and suicide attempts in adulthood, and these associations hold when controlling for gender, age and depressive symptoms. The study also contributes new knowledge to understanding the mechanisms that are associated with increased suicide risk in adulthood in individuals who have experienced childhood trauma. The challenge for researchers is to elucidate how these factors interact across time, and to develop interventions to target these known vulnerability factors affected by childhood trauma to help reduce suicide risk in adulthood.

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Supplementary material

Confirmatory analysis plan

Preliminary correlation analyses will be used to investigate the relationships between childhood trauma, impulsivity, executive functioning, stress, depression, wellbeing and suicide ideation and lifetime history of suicide. Logistic and hierarchical linear regression will be used to investigate whether childhood trauma (and its sub-types) are associated with lifetime suicide ideation and attempt or recent suicide ideation (H1). Next the PROCESS macro tool for SPSS will be utilised to test the models of mediation (H2: model 4 (Hayes, 2013)) and moderation (H3 & H4: model 1 (Hayes (2013)) using regressions and the percentile bootstrap technique to estimate the confidence intervals (Yzerbyt et al., 2018). All analyses will be run with and without covariates (age, gender and depression) as recommended by Simmons, Nelson and Simonsohn (2011) and all continuous predictor variables will be mean centered to allow better interpretation. Missing data will be handled using multiple imputation (or an equivalent such as full information maximum likelihood).

Odds ratio adjustment

The odds ratios presented in the manuscript appear to be small but need to be taken in context with the range of the CTQ scores (25 – 125). For such a wide range of scores a 1-unit change does not accurately reflect the increased risk of childhood trauma for most participants on the outcome variables. We therefore decided a meaningful unit change would be to compute the average difference in CTQ score between the categories of risk (None/minimal, low/moderate, moderate/severe, severe). An alternative scaling would be the present the *OR* for a 1 *SD* change in CTQ. As the *SD* of the CTQ is 19.4 this would lead us to present an *OR* for an even larger change in CTQ.

To compute the average difference the following procedure was adopted: taking the midpoint for each of the five subscales, for each risk category. For instance, for the None (or minimal risk) category, the following midpoints for each subscale were calculated; emotional abuse = 6.5, physical abuse = 6, sexual abuse = 5, emotional neglect = 7 and physical neglect = 6. Next, for each of the four risk categories, the average midpoint was calculated. The difference between each risk category average midpoint was computed. Finally, the average difference was calculated which resulted in 14.3; the value adopted to be the meaningful unit of change to contextualise the odds ratios.

Measures

Childhood Trauma Questionnaire (CTQ; Bernstein et al., 2003): 28-item self-report inventory assessing history of abuse and neglect in childhood. The CTQ asks people about "some of your experiences growing up as a child and a teenager". The total and sub-scale scores will be calculated following the recommendations by Bernstein et al. (2003). Cronbach's α = 0.64.

Impulsivity: Barratt Impulsiveness Scale-11 (BIS-11; Patton et al., 1995) self-report questionnaire assessing impulsive behaviour, consisting of 30-items describing impulsive/non-impulsive behaviours. Participants rate the frequency of engaging in each item/behaviour (rarely (1) – always (4)). Greater the total score, greater impulsive behaviours. Cronbach's $\alpha = 0.66$.

Stress: Perceived Stress Scale (PSS-Brief; Cohen, Kamarck & Mermelstein, 1983). A 4-item self-report measure for perception of stress over the past 4 weeks, individuals are required to indicate how often participants had felt or thought this way requiring participants to respond to each question from 0 (never) to 4 (very often). Items 2 and 3 are reverse scored. Cronbach's $\alpha = 0.72$.

Executive Dysfunction: Dysexecutive Questionnaire (DEX; Wilson, Alderman, Burgess, Emslie & Evans, 1996). A 20-item scale to identify executive difficulties whereby each statement had to be rated from 0 (never) to 4 (often). It is part of a larger test battery – the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson et al., 1996) and can be administered in a self-report format, taking around 10 minutes to complete. There is evidence that the DEX can be decomposed into multiple factors, but the global score is of interest in this study. Higher the score, greater impairment of executive functioning or greater executive dysfunction (Shaw et al., 2015). Cronbach's $\alpha = 0.88$.

Depressive symptoms: Becks Depression Inventory-II (BDI-II; Beck et al., (1996)). A 21-item measure established to determine a range of depressive symptoms over the past 4 weeks. It has been shown to yield reliable, internally consistent and valid scores in in adult (Beck et al., 1996) and adolescent populations (Osman et al., 2008). Cronbach's $\alpha = 0.90$.

Wellbeing: the Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS), a 7-item measure to determine wellbeing of individuals over the past 4 weeks. Cronbach's $\alpha = 0.81$.

Transformations

Lifetime suicide behaviour: for the APMS score, the following coding procedure would be introduced , 1 – ideation but no attempt and 2 – attempts.

Suicide ideation: the SSI (Beck et al., 1979) would be scored whereby each of the 21 items have a score from 0 – 2, suicide ideation is taken from the first 19 items with a resulting total score ranging from 0-38. The final two items measure number of suicide attempts and intent to die during the last attempt. Cronbach's $\alpha = 0.88$.

COVID-19 suicide behaviour: two items which reflect the extent of suicide behaviour as a result of COVID-19.

CTQ: two approaches will be used, following Bernstein (2003) whereby a summed score from 5 - 25 is created for each of the five subscales, allowing analysis of both individual scales and global childhood trauma score. As a result, individual scale scores for the CTQ ranged from 5 – 25 and global scores for the CTQ ranged from 25 - 125.

Impulsivity: summed score, greater score, greater impulsivity. The BIS-11 can be decomposed to 2nd Order factor components – attentional (comprised of items 5, 9, 11, 20, 28, 6 ,24 & 26), motor (items 2, 3, 4, 16, 17, 19, 21, 22, 23, 25 & 30) and non-planning (items 1, 7, 8, 10, 12, 13, 14, 15, 18, 27 & 29).

Stress: greater summed score, greater perceived stress. The scale is comprised of items 2, 4, 5 and 10 from the 10-item PSS scale.

For the executive dysfunctioning, depression and wellbeing measures, the greater the summed score, the greater executive dysfunctioning, depressive symptoms and overall wellbeing.

Table 1. *Proposed univariate analyses*

Hypothesis	Proposed Statistical Analysis	Interpretation given different outcomes	Sampling plan
H1: Childhood trauma (and	H1: hierarchical	No evidence of a difference	See

sub-types) will be associated with both recent and lifetime suicide ideation and attempt.	linear regression (DV: recent suicide ideation and attempt) and ordinal logistic regression analysis (DV: lifetime suicide ideation and attempt).	between childhood trauma and suicide ideation and attempt.	power analysis summary (below)
H2: The effects of childhood trauma (and sub-types) on suicide ideation and wellbeing will be mediated by executive functioning and impulsivity	H2: hierarchical linear regression analysis with a mediation component (model 4; Hayes, (2013))	No evidence of a difference of childhood trauma on suicide ideation and wellbeing.	
H3: The relationship between childhood trauma (and sub-types) and impulsivity/executive functioning will be moderated by recent stress	H3: hierarchical linear regression analysis with a moderation component (model 1; Hayes, (2013))	No evidence of a difference between childhood trauma and impulsivity/executive function. No evidence of this relationship being moderated by recent stress.	
H4: The relationship between childhood trauma and recent suicide ideation and wellbeing will be moderated by recent stress	H4: hierarchical linear regression with a moderation component (model 1; Hayes, (2013))	No evidence of a difference between childhood trauma and recent suicide ideation/wellbeing. No evidence of this relationship being moderated by recent stress.	

Magnitude of the indirect effects

2.1 There was a significantly indirect effect of childhood trauma on recent suicide ideation through executive functioning, *b* = 0.02, CI [0.01, 0.04]. This represents a relatively small effect k^2 = 0.04, 95% CI [0.02, 0.08]. The mediation represented a relatively small effect for all subscales; Emotional Abuse (k^2 = 0.08, CI (0.04, 0.14); Physical abuse (k^2 = 0.02, CI (0.00, 0.05); Sexual abuse (k^2 = 0.023, CI (0.001, 0.050); Emotional neglect (k^2 = 0.04, CI (0.01, 0.07); Physical neglect (k^2 = 0.04, CI (0.02, 0.07). There was no significant indirect effects for sexual abuse on recent suicide ideation through impulsivity.

There was a significantly indirect effect of childhood trauma on recent suicide ideation through impulsivity, *b* = 0.02, CI [0.01, 0.03]. This represents a relatively small effect k^2 = 0.04, 95% CI [0.01, 0.07]. The mediation represented a relatively small effect for four subscales; Emotional Abuse (k^2 = 0.04, CI (0.02, 0.07)); Physical abuse (k^2 = 0.02, CI (0.00, 0.05); Sexual abuse (k^2 = 0.02, CI (0.00, 0.05), Emotional neglect (k^2 = 0.03, CI (0.01, 0.06); physical neglect (k^2 = 0.03, CI (0.00, 0.05).

2.2 There was a significantly indirect effect of childhood trauma on wellbeing through executive functioning, *b* = -0.01, CI [-0.01, -0.00]. This represents a relatively small effect k^2 = -0.06, CI [-0.10, -0.03]. The mediation represented a relatively small effect for four subscales; Emotional Abuse (k2 = -0.08, CI (-0.12, -0.04); Physical abuse (k^2 = -0.03, CI (-0.06, -0.00); Emotional neglect (k^2 = -0.05, CI (-0.08, -0.02); physical neglect (k^2 = -0.06, CI (-0.09, -0.02). However, there was no significant indirect effects of sexual abuse on recent suicide ideation through executive functioning.

There was a significantly indirect effect of childhood trauma on wellbeing through impulsivity. *b* = -0.01, CI [-0.01, -0.00]. This represents a relatively small effect k^2 = -0.04, CI [-0.07, -0.01]. The mediation represented a relatively small effect for four subscales; Emotional Abuse (k^2 = -0.04, CI (-0.07, -0.01)); Physical abuse (k^2 = -0.02, CI (-0.05, -0.00); Sexual abuse (k^2 = -0.02, CI (-0.05, -0.00), Emotional neglect (k^2 = -0.03, CI (-0.06, -0.01); physical neglect (k^2 = -0.07=2, CI (-0.05, -0.00).

Table 2. *Demographics of the sample*

	Total sample	**Suicide ideation group**	**Suicide attempt group**
		Mean (SD)	
N	457	238	219
Age	32.43	31.78 (11.40)	33.13 (11.00)

		(11.22)		
Sex (n) (%)				
	Female	345 (75.5%)	173 (72.7%)	172 (78.5%)
	Male	104 (22.8%)	60 (25.2%)	44 (20.1%)
	Not disclosed	8 (1.8%)	5 (2.1%)	3 (1.4%)
Ethnicity				
	White	431 (89.9%)	213 (89.5%)	198 (90.4%)
	Mixed	16 (3.5 %)	8 (3.4%)	8 (3.7%)
	Asian	18 (4%)	11 (4.6%)	7 (3.2%)
	Black	8 (1.7 %)	4 (1.7%)	4 (1.8%)
	Arabic	1 (0.2%)	0	1 (0.5%)
	Other	3 (0.7%)	2 (0.8%)	1 (0.5%)
Depression		36.16 (13.10)	33.51 (12.97)	39.05 (12.65)
Recent Suicide Ideation		11.49 (9.28)	8.83 (8.37)	14.39 (9.37)
Executive Function		38.35 (13.04)	37.13 (12.82)	39.67 (13.17)
Total CTQ		56.13 (19.37)	50.12 (15.90)	62.66 (20.68)
CTQ subscales				
	Emotional abuse	14.72 (5.97)	13.17 (5.56)	16.39 (5.95)
	Physical abuse	7.90 (4.42)	6.77 (3.14)	9.13 (5.21)
	Sexual abuse	9.08 (6.29)	7.53 (5.11)	10.76 (7.00)
	Emotional neglect	15.22 (5.38)	14.04 (5.01)	16.50 (5.50)
	Physical neglect	9.22 (3.98)	8.61 (3.54)	9.88 (4.32)
Wellbeing		17.09 (2.76)	17.48 (2.79)	16.65 (2.67)
Impulsivity		70.31 (11.89)	68.11 (11.48)	72.69 (11.89)

Perceived stress	10.73 (2.63)	10.46 (2.73)	11.03 (2.49)

1

Table 3: *correlations with confidence intervals*

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Depressive symptoms											
2. Recent suicide ideation	.52**										
	[.45, .58]										
3 Impulsivity	.35**	.26**									
	[.27, .43]	[.17, .34]									
4. Childhood trauma	.29**	.30**	.17**								
	[.20, .37]	[.22, .39]	[.08, .26]								
5. Emotional abuse	.25**	.26**	.17**	.83**							
	[.16, .33]	[.17, .34]	[.08, .26]	[.80, .86]							
6. Emotional neglect	.23**	.29**	.15**	.80**	.67**						
	[.14, .31]	[.20, .37]	[.06, .24]	[.77, .83]	[.62, .72]						
7. Physical abuse	.23**	.24**	.10*	.74**	.54**	.45**					
	[.14, .31]	[.16, .33]	[.01, .19]	[.69, .78]	[.47, .60]	[.37, .52]					

8. Physical neglect	.17**	.17**	.11*	.74**	.50**	.67**	.51**				
	[.08, .26]	[.08, .26]	[.01, .20]	[.69, .78]	[.43, .56]	[.61, .71]	[.44, .57]				
9. Sexual abuse	.19**	.17**	.09*	.62**	.33**	.24**	.35**	.23**			
	[.10, .28]	[.08, .26]	[.00, .18]	[.56, .68]	[.25, .41]	[.15, .33]	[.27, .43]	[.15, .32]			
10. Executive functioning	.44**	.27**	.67**	.21**	.25**	.16**	.10*	.17**	.08		
	[.37, .51]	[.18, .35]	[.61, .71]	[.12, .29]	[.16, .33]	[.07, .25]	[.01, .19]	[.08, .26]	[-.01, .17]		
11. Perceived stress	.64**	.39**	.24**	.09	.09	.08	.09	.04	.04	.35**	
	[.57, .70]	[.32, .47]	[.15, .33]	[-.01, .18]	[-.00, .18]	[-.02, .17]	[.00, .17]	[-.06, .12]	[-.05, .13]	[.26, .43]	
12. Wellbeing	-.69**	-.46**	-.24**	-.18**	-.13**	-.21**	-.16**	-.10*	-.09*	-.33**	.09*
	[-.74, -.64]	[-.53, -.39]	[-.33, -.15]	[-.27, -.09]	[-.22, -.04]	[-.29, -.12]	[-.25, -.07]	[-.19, -.00]	[-.18, -.00]	[-.41, -.25]	[.00, .18]

Table 4: *Hierarchical linear regression for recent suicide ideation*

Adjusted Model							
		***b* (95% CI)**	**SE *b***	**Beta**	***t***	**R^2**	**ΔR^2**
Step							
1	Age	-0.01 [-0.08, 0.05]	0.03	-0.02 [-0.10, 0.06]	-0.39		
	Gender	-0.67 [-2.32, 0.99]	0.84	-0.03 [-0.11, 0.05]	-0.79		
	Depression	0.37** [0.31, 0.42]	0.03	0.52 [0.44, 0.60]	12.88	R^2 = .270** [0.20, 0.33]	
Predictor: CTQ							
2	Age	-0.04 [-0.10, 0.03]	0.03	-0.05 [-0.13, 0.03]	-1.15		
	Gender	-1.28 [-2.92, 0.36]	0.84	-0.06 [-0.14, 0.02]	-1.53		
	Depression	0.33** [0.28, 0.39]	0.03	0.47 [0.39, 0.55]	11.42		
	CTQ	0.09** [0.05, 0.13]	0.02	0.19 [0.10, 0.27]	4.40	R^2 = .300** [0.23, 0.36]	ΔR^2 = 0.030** [0.00, 0.06]
Predictor: Emotional abuse							
2	Age	-0.02 [-0.09, 0.04]	0.03	-0.03 [-0.11, 0.05]	-0.71		
	Gender	-1.06 [-2.70, 0.59]	0.84	-0.05 [-0.13, 0.03]	-1.26		
	Depression	0.34**[0.29, 0.40]	0.03	0.49 [0.41, 0.57]	11.83		
	Emotional abuse	0.23** [0.10, 0.35]	0.06	0.15 [0.06, 0.23]	3.51	R^2 = .289** [0.22,0.35]	ΔR^2 = .019** [-0.00, 0.04]
Predictor: Physical abuse							
2	Age	-0.05 [-0.11, 0.02]	0.03	-0.05 [-0.14, 0.03]	-1.30		

	Gender	-0.83 [-2.47, 0.80]	0.84	-0.04 [-0.12, 0.04]	-1.00		
	Depression	0.35** [0.29, 0.40]	0.03	0.49 [0.41, 0.57]	12.04		
	Physical abuse	0.31** [0.14, 0.49]	0.09	0.15 [0.07, 0.23]	3.51	R^2 = .289** [0.22,0.35]	ΔR^2 = .019** [-.00, .04]
Predictor: Sexual abuse							
2	Age	-0.02 [-0.08, 0.05]	0.03	-0.02 [-0.10, 0.06]	-0.48		
	Gender	-1.00 [-2.68, 0.68]	0.86	-0.05 [-0.13, 0.03]	-1.17		
	Depression	0.36** [0.30, 0.41]	0.03	0.51 [0.42, 0.59]	12.33		
	Sexual abuse	0.12* [0.00, 0.24]	0.06	0.08 [0.00, 0.16]	1.97	R^2 = .276** [0.20, 0.33]	ΔR^2 = .006* [-0.01, 0.02]
Predictor: Emotional neglect							
2	Age	-0.04 [-0.11, 0.03]	0.03	-0.05 [-0.13, 0.03]	-1.20		
	Gender	-1.15 [-2.77, 0.48]	0.83	-0.06 [-0.13, 0.02]	-1.38		
	Depression	0.34** [0.28, 0.40]	0.03	0.48 [0.40, 0.56]	11.86		
	Emotional neglect	0.33** [0.19, 0.47]	0.07	0.19 [0.11, 0.27]	4.71	R^2 = .304** [0.23, 0.36]	ΔR^2 = .034** [0.01, 0.06]
Predictor: Physical neglect							
2	Age	-0.02 [-0.09, 0.05]	0.03	-0.02 [-0.10, 0.06]	-0.58		
	Gender	-0.76 [-2.41, 0.89]	0.84	-0.04 [-0.12, 0.04]	-0.91		
	Depression	0.36** [0.30, 0.42]	0.03	0.51 [0.43, 0.59]	12.41		
	Physical neglect	0.20* [0.02, 0.39]	0.10	0.09 [0.01, 0.17]	2.15	R^2 = .277** [0.21, 0.34]	ΔR^2 = .007** [-0.01, 0.02]

Table 5: *Binary logistic regression showing the coefficients of the model predicting lifetime history of suicide ideation or attempts [95% bootstrap confidence intervals based on 1000 samples]*

		Unadjusted				***Adjusted***			
		b	**95% CI for odds ratio**			***b***	**95% CI for odds ratio**		
Step		95% CI	**Lower**	**Odds**	**Upper**	**95% CI**	**Lower**	**Odds**	**Upper**
Step 1	Age					0.01 [-0.01, 0.03]	0.99	1.01	1.03
	Sex					0.36 [-0.12, 0.84]	0.90	1.43	2.26
	Depressive symptoms					0.03 [0.02, 0.05]	1.02	1.03	1.05
Step 2	Age					0.00 [-0.02, 0.02]	0.98	1.00	1.02
	Sex					0.17 [-0.30, 0.65]	0.74	1.19	1.92
	Depressive symptoms					0.02 [0.01, 0.04]	1.01	1.02	1.04
	Childhood trauma	0.04 [0.03, 0.05]	1.03	1.04	1.05	0.03 [0.02, 0.05]	1.02	1.04	1.05
Step 2	Age					0.01 [-0.01, 0.02]	0.99	1.01	1.02
	Sex					0.24 [-0.23, 0.71]	0.80	1.27	2.04
	Depressive symptoms					0.03 [0.01, 0.04]	1.01	1.03	1.04
	Emotional abuse	0.10 [0.06, 0.13]	1.06	1.10	1.14	0.08 [0.05, 0.12]	1.05	1.09	1.13
Step 2	Age					-0.00 [-0.02, 0.02]	0.98	1.00	1.02
	Sex					0.34 [-0.16, 0.86]	0.88	1.41	2.26
	Depressive symptoms					0.03 [0.01, 0.04]	1.01	1.03	1.04
	Physical abuse	0.14 [0.09, 0.20]	1.09	1.15	1.21	0.13 [0.08, 0.20]	1.08	1.14	1.20
Step 2	Age					0.01 [-0.01, 0.03]	0.99	1.01	1.03

	Sex					0.16 [-0.32, 0.63]	0.73	1.17	1.88
	Depressive symptoms					0.03 [0.01, 0.04]	1.01	1.03	1.05
	Sexual abuse	0.09 [0.06, 0.13]	1.06	1.09	1.13	0.08 [0.04, 0.12]	1.05	1.08	1.12
Step 2	Age					0.00 [-0.02, 0.02]	0.99	1.00	1.02
	Sex					0.28 [-0.19, 0.76]	0.83	1.32	2.10
	Depressive symptoms					0.03 [0.01, 0.04]	1.01	1.03	1.05
	Emotional neglect	0.09 [0.06, 0.13]	1.05	1.09	1.13	0.08 [0.04, 0.12]	1.04	1.08	1.12
Step 2	Age					0.01 [-0.01, 0.03]	0.99	1.01	1.03
	Sex					0.34 [-0.13, 0.83]	0.89	1.41	2.23
	Depressive symptoms					0.03 [0.02, 0.05]	1.02	1.03	1.05
	Physical neglect	0.08 [0.04, 0.13]	1.03	1.09	1.14	0.07 [0.02, 0.12]	1.02	1.07	1.12

Table 6: *mediation analysis with recent suicide ideation as the outcome variable*

Outcome: recent suicide ideation				
Models of individual predictions	***b* (unstandardised)**	***t***	***p***	**95% CI**
Associations of models tested				
2.1				
childhood trauma → executive function	0.14	4.49	< .001	0.08, 0.20
executive function → recent suicide ideation	0.15	4.82	< .001	0.09, 0.22
2.2				
childhood trauma → impulsivity	0.10	3.65	< .001	0.05, 0.16
impulsivity → recent suicide ideation	0.17	4.88	< .001	0.10, 0.24
2.3				
2.3.1 emotional abuse → impulsivity	0.34	3.67	<.001	0.16, 0.52
impulsivity → recent suicide ideation	0.18	5.00	< .001	0.11, 0.24
2.3.2 physical abuse → impulsivity	0.27	2.19	.029	0.03, 0.52
impulsivity → recent suicide ideation	0.19	5.38	< .001	0.12, 0.25
2.3.3 sexual abuse → impulsivity	0.17	1.98	.048	0.00, 0.35
impulsivity → recent suicide ideation	0.19	5.51	< .001	0.12, 0.26
2.3.4 emotional neglect → recent suicide ideation	0.33	3.22	.001	0.13, 0.53
impulsivity → recent suicide ideation	0.17	5.04	< .001	0.11, 0.24
2.3.5 physical neglect → recent suicide ideation	0.32	2.28	.023	0.04, 0.59
impulsivity → recent suicide ideation	0.19	5.46	< .001	0.12, 0.26

2.4				
2.4.1 emotional abuse → executive function	0.54	5.44	< .001	0.35, 0.74
executive function → recent suicide ideation	0.16	4.78	< .001	0.09, 0.22
2.4.2 physical abuse → executive function	0.29	2.12	.034	0.02, 0.56
executive function → recent suicide ideation	0.18	5.57	< .001	0.11, 0.24
2.4.3 sexual abuse → executive function	0.17	1.75	.081	-0.02, 0.36
executive function → recent suicide ideation	0.18	5.72	< .001	0.12, 025
2.4.4 emotional neglect → executive function	0.40	3.55	< .001	0.18, 0.62
executive function → recent suicide ideation	0.17	5.12	< .001	0.10, 0.22
2.4.5 physical neglect → executive function	0.56	3.69	< .001	0.26, 0.86
executive function → recent suicide ideation	0.18	5.41	< .001	0.11, 0.24

indirect effects	***b***	**SE**	**Boostrapped 95% CI (N)**	
2.1				
childhood trauma → executive function → recent suicide ideation	0.02	0.01	0.01	0.04
2.2				
childhood trauma → impulsivity → recent suicide ideation	0.02	0.01	0.01	0.03
2.3				
2.3.1 emotional abuse → impulsivity → recent suicide ideation	0.06	0.02	0.02	0.10
2.3.2 physical abuse → impulsivity → recent suicide ideation	0.05	0.03	0.00	0.11

2.3.3 sexual abuse → impulsivity → recent suicide ideation	0.03	0.02	0.00	0.07
2.3.4 emotional neglect → impulsivity → recent suicide ideation	0.06	0.02	0.02	0.11
2.3.5 physical neglect → impulsivity → recent suicide ideation	0.06	0.03	0.01	0.13
2.4				
2.4.1 emotional abuse → executive function → recent suicide ideation	0.08	0.03	0.04	0.14
2.4.2 physical abuse → executive function → recent suicide ideation	0.05	0.03	0.01	0.11
2.4.3 sexual abuse → executive function → recent suicide ideation	0.03	0.02	-0.00	0.05
2.4.4 emotional neglect → executive function → recent suicide ideation	0.06	0.02	0.02	0.12
2.4.5 physical neglect → executive function → recent suicide ideation	0.10	0.03	0.02	0.07
Direct effects after inclusion of mediator	***b***	***t***	***p***	**95% CI**
2.1				
childhood trauma → recent suicide ideation	0.12	5.83	< .001	0.08, 0.17
2.2				
childhood trauma → recent suicide ideation	0.13	6.06	< .001	0.09, 0.17
2.3				
2.3.1 emotional abuse → recent suicide ideation	0.34	4.85	< .001	0.20, 0.48
2.3.2 physical abuse → recent suicide ideation	0.46	4.94	< .001	0.28, 0.64
2.3.3 Sexual abuse → recent suicide ideation	0.21	3.21	.001	0.08, 0.34
2.3.4 Emotional neglect → recent suicide ideation	0.44	5.80	< .001	0.29, 0.59
2.3.5 Physical neglect → recent suicide ideation	0.34	3.22	.001	0.13, 0.54
2.4				

2.4.1 Emotional abuse → recent suicide ideation	0.31	4.41	< .001	0.17, 0.45
2.4.2 Physical abuse → recent suicide ideation	0.46	4.95	< .001	0.28, 0.64
2.4.3 Sexual abuse → recent suicide ideation	0.22	3.26	.001	0.09, 0.35
2.4.4 Emotional neglect → recent suicide ideation	0.43	5.70	< .001	0.28, 0.58
2.4.5 Physical neglect → recent suicide ideation	0.30	2.84	.005	0.09, 0.51
Total effect of X on Y	***b***	***t***	***p***	**95% CI**
2.1				
Childhood trauma → executive function → recent suicide ideation	0.15	6.81	< .001	0.10, 0.19
2.2				
Childhood trauma → Impulsivity → recent suicide ideation	0.15	6.81	< .001	0.10, 0.19
2.3				
2.3.1 Emotional abuse → impulsivity → recent suicide ideation	0.40	5.64	< .001	0.26, 0.54
2.3.2 Physical abuse → impulsivity → recent suicide ideation	0.51	5.35	< .001	0.32 0.70
2.3.3 Sexual abuse → impulsivity → recent suicide ideation	0.25	3.62	< .001	0.11, 0.38
2.3.4 Emotional neglect → impulsivity → recent suicide ideation	0.50	6.45	<.001	0.35, 0.65
Physical neglect → impulsivity → recent suicide ideation	0.40	3.70	<.001	0.19, 0.61
2.4				
2.4.1 Emotional abuse → executive function → recent suicide ideation	0.40	5.64	< .001	0.26, 0.54
2.4.2 Physical abuse → executive function → recent suicide ideation	0.51	5.35	< .001	0.32, 0.70
2.4.3 Sexual abuse → executive function → recent suicide ideation	0.25	3.62	< .001	0.11, 0.38
2.4.4 Emotional neglect → executive function → recent suicide ideation	0.50	6.45	< .001	0.35, 0.65

2.4.5 Physical neglect → executive function → recent suicide ideation	0.40	3.70	< .001	0.19, 0.61

Table 7: *mediation analysis with wellbeing as the outcome variable*

Outcome: wellbeing				
Models of individual predictions	***b***	***t***	***p***	**95% CI**
Associations of models tested				
3.1				
Childhood trauma → executive function	0.14	4.49	< .001	0.08, 0.20
Executive function → Wellbeing	-0.07	-6.84	< .001	-0.08, -0.05
3.2 Childhood trauma → impulsivity	0.10	3.65	< .001	0.05, 0.16
Impulsivity → wellbeing	-0.05	-4.75	< .001	-0.07, -0.03
3.3				
3.3.1 Emotional abuse → impulsivity	0.34	3.67	< .001	0.16, 0.52
Impulsivity → wellbeing	-0.05	-4.92	< .001	-0.07, -0.03
3.3.2 Physical abuse → impulsivity	0.27	2.19	.029	0.03, 0.52
Impulsivity → wellbeing	-0.05	-5.02	< .001	-0.07, -0.03
3.3.3 Sexual abuse → impulsivity	0.17	1.98	.048	0.00, 0.35
Impulsivity → wellbeing	-0.05	-5.15	< .001	-0.08, -0.03
3.3.4 emotional neglect → wellbeing	0.33	3.22	.001	0.13, 0.53
Impulsivity → wellbeing	-0.05	-4.76	<.001	-0.07, -0.03
3.3.5 physical neglect → wellbeing	0.32	2.28	.023	0.04, 0.59
Impulsivity → wellbeing	-0.05	-5.12	<.001	-0.08, -0.03
3.4				

3.4.1 Emotional abuse → executive function	0.54	5.44	<.001	0.35, 0.74
Executive function → wellbeing	-0.07	-7.01	<.001	-0.09, -0.05
3.4.2 Physical abuse → executive function	0.29	2.12	.034	0.02, 0.56
Executive function → wellbeing	-0.07	-7.23	< .001	-0.08, -0.05
3.4.3 Sexual abuse → executive function	0.17	1.75	.081	-0.02, 0.36
Executive function → wellbeing	-0.07	-7.36	< .001	-0.09, -0.05
3.4.4 emotional neglect → wellbeing	0.40	3.55	< .001	0.18, 0.62
Executive function → wellbeing	-0.06	-6.91	<.001	-0.08, -0.04
3.4.5 physical neglect → wellbeing	0.56	3.69	< .001	0.26, 0.86
Executive function → wellbeing	-0.07	-7.24	< .001	-0.09, -0.05
Indirect effects	***b***	**SE**	**Bootstrapped 95% CI (N)**	
3.1				
Childhood trauma → executive function → wellbeing	-0.01	0.02	-0.10	-0.03
3.2				
Childhood trauma → impulsivity → wellbeing	-0.01	0.00	-0.01	-0.00
3.3				
3.3.1 Emotional abuse → impulsivity → wellbeing	-0.02	0.01	-0.03	-0.01
3.3.2 Physical abuse → impulsivity → wellbeing	-0.01	0.01	-0.03	-0.00
3.3.3 Sexual abuse → impulsivity → wellbeing	-0.01	0.01	-0.02	-0.00
3.3.4 Emotional neglect → impulsivity → wellbeing	-0.02	0.01	-0.03	-0.00
3.3.5 Physical neglect → impulsivity → wellbeing	-0.02	0.01	-0.04	-0.00

3.4				
3.4.1 Emotional abuse → executive function → wellbeing	-0.04	0.01	-0.06	-0.02
3.4.2 Physical abuse → executive function → wellbeing	-0.02	0.01	-0.04	-0.00
3.4.3 Sexual abuse → executive function → wellbeing	-0.01	0.01	-0.03	0.00
3.4.4 Emotional neglect → executive function → wellbeing	-0.03	0.01	-0.04	-0.01
3.4.5 Physical neglect → executive function → wellbeing	-0.04	0.01	-0.06	-0.02
Direct effects after inclusion of mediator	***b***	***t***	***p***	**95% CI**
3.1				
Childhood trauma → wellbeing	-0.02	-2.68	.008	-0.03, -0.00
3.2				
Childhood trauma → wellbeing	-0.02	03.21	.001	-0.03, -0.01
3.3				
3.3.1 Emotional abuse → wellbeing	-0.04	-1.92	.056	-0.08, 0.00
3.3.2 Physical abuse → wellbeing	-0.09	-3.08	.002	-0.14, -0.03
3.3.3 Sexual abuse → wellbeing	-0.03	-1.56	.119	-0.07, 0.01
3.3.4 Emotional neglect → wellbeing	-0.09	-3.85	< .001	-0.14, -0.04
3.3.5 Physical neglect → wellbeing	-0.05	-1.55	.121	-0.11, 0.01
3.4				
3.4.1 Emotional abuse → wellbeing	-0.02	-1.04	.298	-0.06, 0.02
3.4.2 Physical abuse → wellbeing	-0.08	-2.98	.003	-0.03, -0.13
3.4.3 Sexual abuse → wellbeing	-0.03	-1.50	.135	-0.07, 0.01

3.4.4 Emotional neglect → wellbeing	-0.08	-3.53	< .001	-0.12, -0.04
3.4.5 Physical neglect → wellbeing	-0.03	-0.90	.368	-0.09, 0.03
Total effect of X on Y	***b***	***t***	***p***	**95% CI**
3.1				
Childhood trauma → executive function → wellbeing	**-0.03**	**-3.98**	**< .001**	**-0.04, -0.01**
3.2				
Childhood trauma → impulsivity → Wellbeing	-0.03	-3.98	< .001	-0.04, -0.01
3.3				
3.3.1 Emotional abuse → impulsivity → wellbeing	-0.06	-2.72	.007	-0.10, -0.02
3.3.2 Physical abuse → impulsivity → wellbeing	-0.10	-3.52	< .001	-0.16, -0.04
3.3.3 Sexual abuse → impulsivity → wellbeing	-0.04	-1.99	.047	-0.08, -0.00
3.3.4 Emotional neglect → impulsivity → wellbeing	-0.11	-4.50	< .001	-0.15, -0.06
3.3.5 Physical neglect → impulsivity → wellbeing	-0.07	-2.05	.041	-0.13, -0.00
3.4				
3.4.1 Emotional abuse → executive function → wellbeing	-0.06	-2.72	.007	-0.10, -0.02
3.4.2 Physical abuse → executive function → wellbeing	-0.10	-3.52	< .001	-0.16, -0.04
3.4.3 Sexual abuse → executive function → wellbeing	-0.04	-1.99	.047	-0.08, -0.00
3.4.4 Emotional neglect → executive function → wellbeing	-0.11	-4.50	< .001	-0.15, -0.06
3.4.5 Physical neglect → executive function → wellbeing	-0.07	-2.05	.041	-0.13, -0.00

Table 8: *Moderation analysis for the outcomes impulsivity and executive functioning*

	b	*t*	*p*	95% CI	
Outcome: impulsivity					
4.1 Childhood trauma → impulsivity	0.09	3.25	.001	0.04	0.15
4.2 Stress * Childhood trauma → impulsivity	0.00	0.01	.989	-0.02	0.02
4.3 Emotional abuse → impulsivity	0.30	3.32	.001	0.12	0.48
4.4 Stress * emotional abuse → impulsivity	0.03	1.00	.319	-0.03	0.10
4.5 Physical abuse → impulsivity	0.22	1.78	.077	-0.02	0.47
4.6 stress* Physical abuse → impulsivity	0.00	0.04	.970	-0.09	0.10
4.7 Sexual abuse → impulsivity	0.15	1.78	.076	-0.02	0.32
4.8 stress* Sexual abuse → impulsivity	0.03	0.86	.391	-0.04	0.09
4.9 Emotional neglect → impulsivity	0.29	2.93	.004	0.10	0.49
5.1 stress*emotional neglect → impulsivity	-0.02	-0.59	.554	-0.09	0.05
5.2 physical neglect → impulsivity	0.30	2.23	.026	0.04	0.57
5.3 stress * physical neglect → impulsivity	-0.05	-0.83	.405	-0.15	0.06
Outcome: executive function					
6.3 Childhood trauma → executive function	0.09	3.25	.001	0.04	0.15
6.4 Stress * Childhood trauma → executive function	0.00	0.01	.989	-0.02	0.02
6.5 Emotional abuse → executive function	0.48	5.07	< .001	0.29	0.66
6.6 Stress * emotional abuse → executive function	0.01	0.18	.859	-0.06	0.07

6.7 Physical abuse → executive function	0.20	1.49	.137	-0.06	0.46
6.8 stress* Physical abuse → executive function	0.02	0.40	.687	-0.08	0.12
6.9 Sexual abuse → executive function	0.14	1.54	.125	-0.04	0.32
7.1 stress* Sexual abuse → executive function	0.00	0.03	.977	-0.07	0.07
7.2 Emotional neglect → executive function	0.33	3.11	.002	0.12	0.54
7.3 stress*emotional neglect → executive function	0.00	0.07	.945	-0.07	0.08
7.4 physical neglect → executive function	0.52	3.65	<.001	0.24	0.80
7.5 stress * physical neglect → executive function	-0.01	-0.20	.839	-0.12	0.10

Table 9: *Moderation analysis for the outcomes recent suicide ideation and wellbeing*

	b	*t*	*p*	95% CI	
Outcome: recent suicide ideation					
4.1 Childhood trauma → recent suicide ideation	0.13	6.51	< .001	0.09	0.17
4.2 Stress * Childhood trauma → recent suicide ideation	-0.00	-0.27	.789	-0.02	0.01
4.3 Emotional abuse → recent suicide ideation	0.35	5.29	< .001	0.22	0.47
4.4 Stress * emotional abuse → recent suicide ideation	-0.00	-0.16	.869	-0.05	0.04
4.5 Physical abuse → recent suicide ideation	0.45	4.95	< .001	0.27	0.62
4.6 stress* Physical abuse → recent suicide ideation	-0.00	-0.07	.941	-0.07	0.07
4.7 Sexual abuse → recent suicide ideation	0.22	3.51	<.001	0.10	0.34
4.8 stress* Sexual abuse → recent suicide ideation	0.02	0.82	.413	-0.03	0.07
4.9 Emotional neglect → recent suicide ideation	0.45	6.25	< .001	0.31	0.59
5.1 stress*emotional neglect → recent suicide ideation	-0.01	-0.46	.647	-0.06	0.04
5.2 physical neglect → recent suicide ideation	0.36	3.62	< .001	0.16	0.56
5.3 stress * physical neglect → recent suicide ideation	0.02	0.53	.600	-0.06	0.10
Outcome: wellbeing					
6.3 Childhood trauma → wellbeing	-0.02	-3.60	< .001	-0.03	-0.01
6.4 Stress * Childhood trauma → wellbeing	0.00	0.04	.965	-0.00	0.00
6.5 Emotional abuse → wellbeing	-0.03	-1.95	0.052	-0.06	0.00
6.6 Stress * emotional abuse → wellbeing	-0.01	-1.32	.189	-0.02	0.00
6.7 Physical abuse → wellbeing	-0.07	-3.27	.001	-0.11	-0.03
6.8 stress* Physical abuse → wellbeing	0.01	1.20	.231	-0.01	0.03

6.9 Sexual abuse → wellbeing	-0.03	-1.91	.057	-0.06	0.00
7.1 stress* Sexual abuse → wellbeing	-0.00	-0.12	.905	-0.01	0.01
7.2 Emotional neglect → wellbeing	-0.08	-4.43	< .001	-0.11	-0.04
7.3 stress*emotional neglect → wellbeing	-0.00	-0.74	.458	-0.02	0.01
7.4 physical neglect → wellbeing	-0.05	-2.22	0.027	-0.10	-0.01
7.5 stress * physical neglect → wellbeing	0.01	1.25	.211	-0.01	0.03

Power analysis and sample size estimation

The general approach taken to power analysis is to start with reasonable values of the parameters (e.g., effect size, correlations between predictors, base rates of outcomes) and estimate power as a function of *n*. As the parameters aren't known with any degree of certainty we also vary the values slightly around those reasonable starting points to gauge sensitivity to the key parameters and present these graphically. For complex analyses the values for power are simulated and all analyses were undertaken in R 4.03 (R Core Team, 2020). All analyses assume *alpha* = .05 unless otherwise stated.

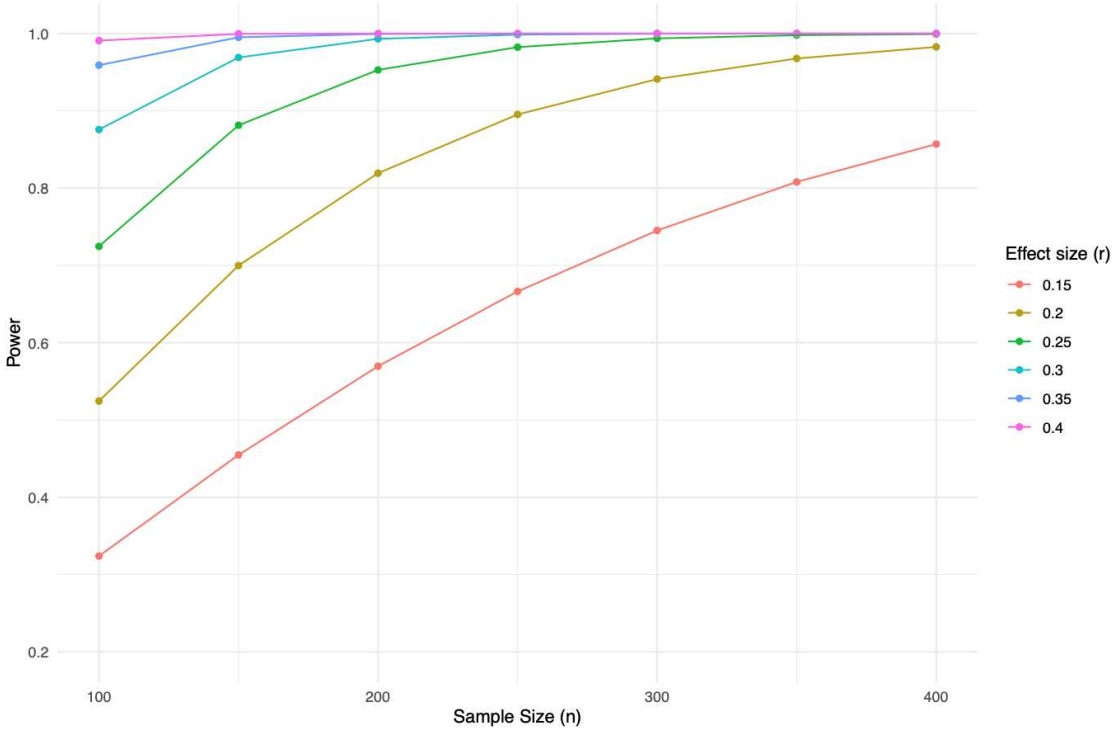
In summary the aim is not to arrive at a single number for each test but arrive at an overall sample size that will have good power (e.g., approximately 80% or more) for a wide range of effect sizes.

Hypothesis 1a:

Predictor: Childhood trauma (CTQ)

Outcome: Recent suicide ideation (outcome 1)

Recent research suggests correlations ranging from .2 to .4 for different subscales and the overall CTQ measure (Bahk et al., 2017).



Interpretation: With sample sizes of 350 and above power is relatively high (80% or more) for correlations > .15 and for correlations as low as .20 *n* = 200 would be sufficient.

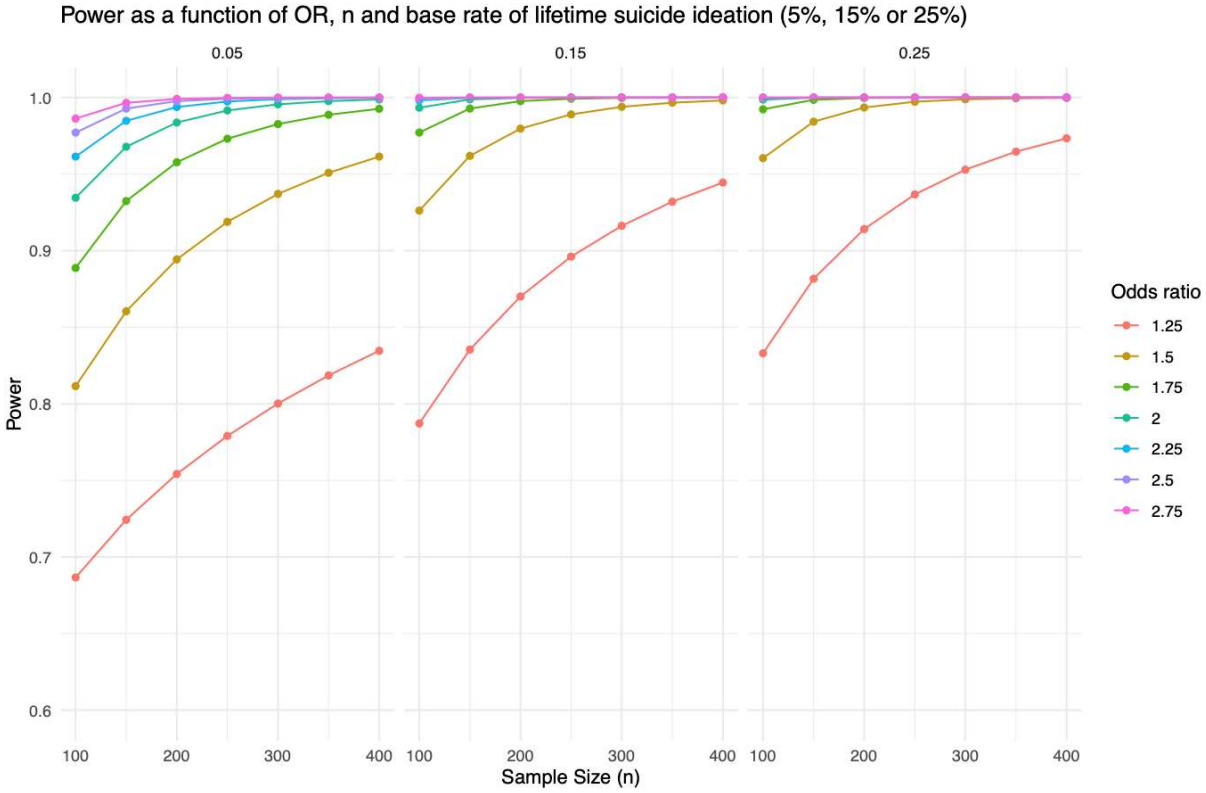
Hypothesis 1b and c:

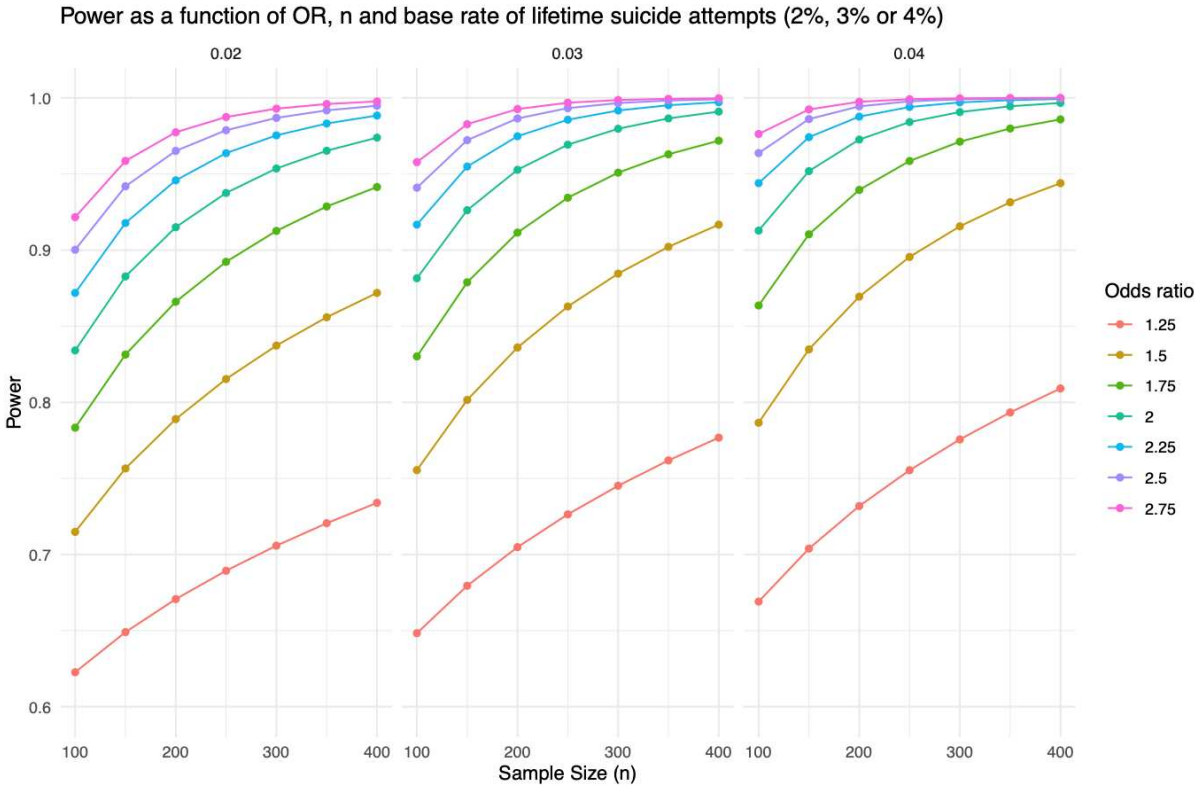
Predictor: Childhood trauma (CTQ)

Outcome: Lifetime suicide ideation or attempt (outcomes 2 and 3)

Previous research suggests an odds ratio (*OR*) of 2.66 (1.63?) for this ideation and 2.09 (1.45) for attempt (Angelakis et al., 2019). Here we used the power estimation approach for logistic regression of Vittinghoff et al. (2009). Importantly the key parameters are the *OR* (for a standardized predictor, i.e., the OR for a 1 *SD* increase in the predictor) and the base rate of the outcome coded 1 (here lifetime suicide ideation). As the original *OR* seems to be from a dummy coded dichotomous predictor it needs to be rescaled to have an *SD* of 1. This produces more conservative estimates of the *OR*s as 1.63 and 1.45 (as halving the effect on the log odds scale is equivalent to taking the square root of the *OR*).

Approaches that ignore the base rate could be wildly wrong (as when the outcome is rare or common this dramatically reduces power relative to outcomes with prevalence around .50). Base rate of lifetime suicide ideation was estimated as around .135 (Kessler et al., 1999). Other estimates are lower so a wider range is used here. For attempts prevalence is estimated around 3% (Nock et al., 2008).





Interpretation: For lifetime suicide ideation reasonable power is maintained even with the lower prevalence estimate of 5% provided the *OR* is at least 1.5 for a wide range of *n*. With *n* = 300 power is over 80% to detect an *OR* of 1.25. For suicide attempts prevalence is much lower and with prevalence at the lower end of what the literature suggests (2%) power is only satisfactory if the *OR* is 1.5 or greater and *n* at least 250.

Hypothesis 2ai

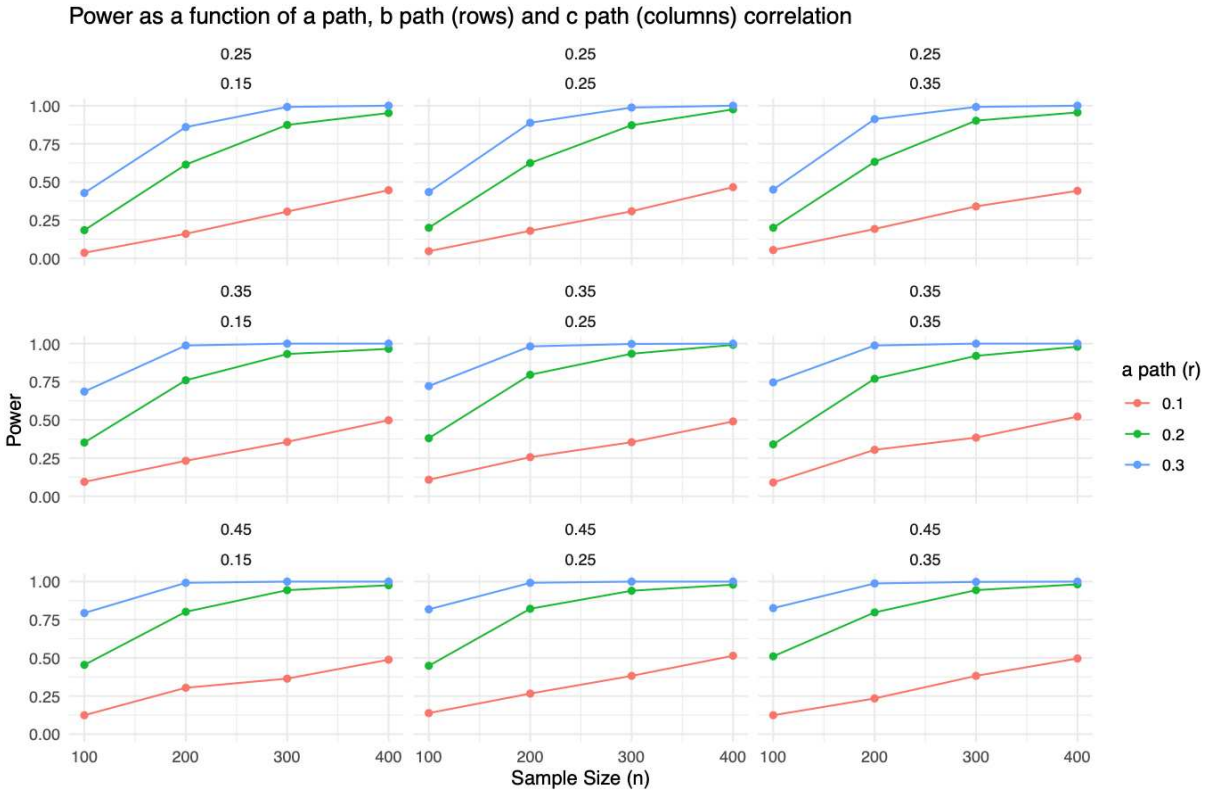
Predictor: Childhood trauma (CTQ)

Mediator: Executive function

Outcome: Recent suicide ideation

Power analysis for simple mediation (the *a* times *b* path in the model) depends on the correlations between the three variables. Power could be further impacted by additional covariates/predictors either reducing the error in the model or introducing collinearity (respectively increasing or decreasing power), but simulating simple mediation for a range of plausible correlation values should give a good idea of the sensitivity to assumed parameter values at different sample sizes. From previous research correlation between predictor and mediator (*a* path) is around .21 (Op den Kelder et al., 2018), between mediator and outcome (*b* path) .35 (Saffer & Klonsky, 2017) and (*c* path) predictor and outcome .26 (Angelakis et al., 2019).

Note that for all mediation tests power is likely to depend on the weakest of the *a* and *b* paths. This is because the mediation effect is *a* times *b* then is either *a* or *b* is close to zero then *ab* will necessarily be close to zero. This is a feature not a bug – power ought to be low when the mediator effect is near zero.



Interpretation: With executive function as a mediator power depends critically on the *a* path but is over 80% when $n = 300$ or more as long as the a path is around $r = 0.2$ or greater.

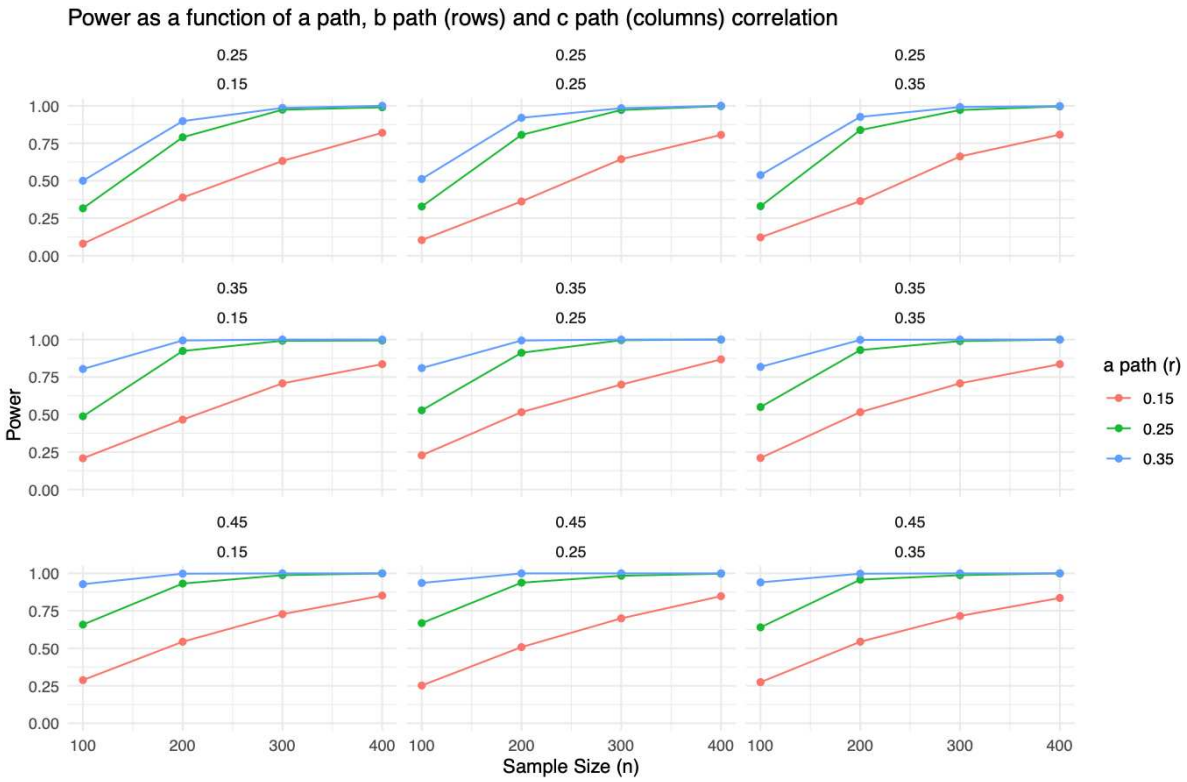
Hypothesis 2aii

Predictor: Childhood trauma (CTQ)

Mediator: Impulsivity

Outcome: Recent suicide ideation

From previous research correlation between predictor and mediator is around .253 (Dal Santo et al., 2020) between mediator and outcome .33 (Kleiman et al., 2012) and predictor and outcome .26 (as above).



Interpretation: Power tends to be poor when *a* or *b* is small (as one would expect) but is reasonable at $n = 400$ even when both paths are as weak as $r = .15$. For larger effects $n = .200$ may well be sufficient.

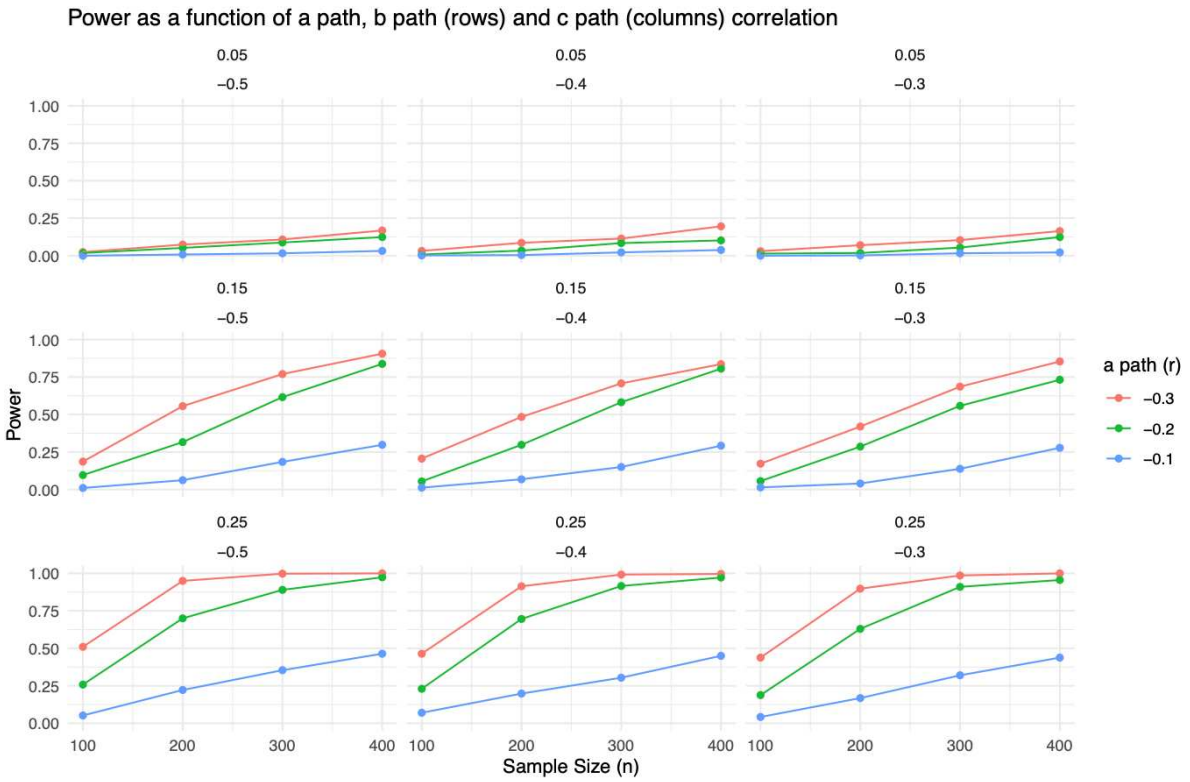
Hypothesis 2bi

Predictor: Childhood trauma (CTQ)

Mediator: Executive function

Outcome: Wellbeing

From previous research correlation between predictor and mediator is around -.21 (Op den Kelder et al., 2018), between mediator and outcome .10 (Gray-Burrows et al., 2019) and predictor and outcome -.39 (McElroy & Hevey, 2014).



Interpretation: With wellbeing as the outcome and executive function as mediator power depends largely on the *b* path which previous research suggests is a relatively small effect. As long as the *b* path effect is around .15 power is acceptable (over 75%) with $n = 400$ or more. It would be important to maximize reliability of the executive function and wellbeing measures.

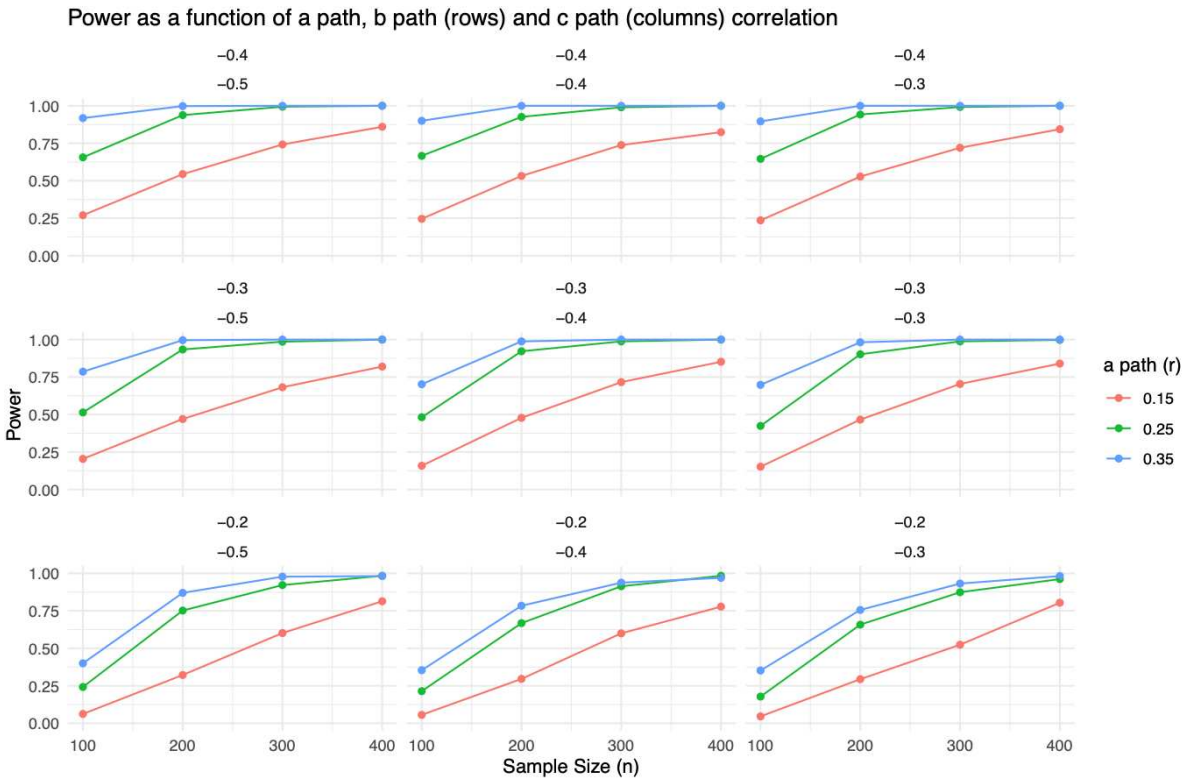
Hypothesis 2bii

Predictor: Childhood trauma (CTQ)

Mediator: Impulsivity

Outcome: Wellbeing

From previous research correlation between predictor and mediator is .253 (as above), between mediator and outcome -.302 (Goodwin et al., 2017) and predictor and outcome -.39 (as above).



Interpretation: Overall, power is reasonable for $n > 250$ except when the *a* path correlation is .15 or lower, but even then is acceptable for $n = 400$.

Hypothesis 3a

Predictor: Childhood trauma (CTQ)

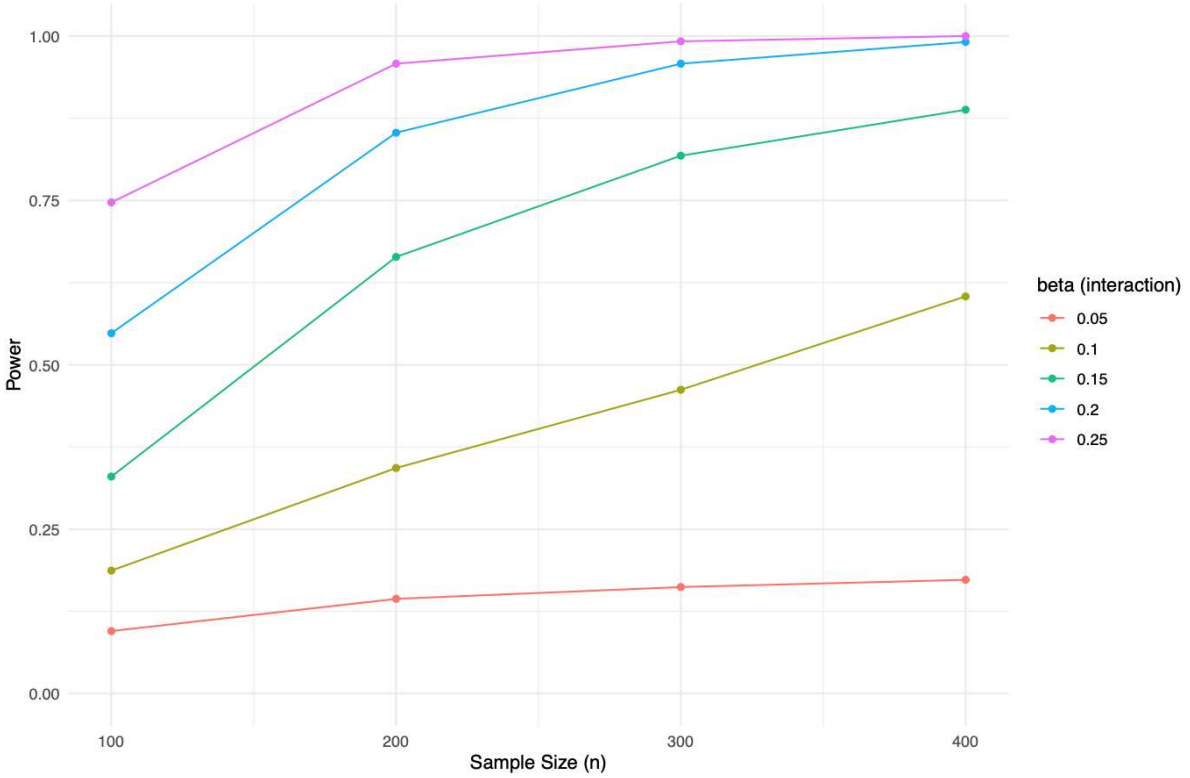
Moderator: Recent stress

Outcome: Impulsivity

Moderator effects (interactions between two continuous predictors) are notoriously low in power. While the correlations between three variables impact the power (as do collinearity with other predictors), what matters most in simulations likely to be the change in standardized coefficient of the predictor when there is a one *SD* increase in the moderator (*beta*). This tends to be small in practice because of range restriction in the product term (predictor times mediator) that is, in effect, the predictor of interest. This tends to lead to small *beta* for the interaction unless extreme values of both predictor and moderator are common (which they tend not to be).

We simulated *beta* from 0.05 to 0.25 for a range of plausible correlations between the variables. (The simulated variables are standardized and therefore centred, but this doesn't impact the estimate of the interaction effect; however centering is advised in the actual analysis to aid interpretation – particularly if there are other covariates). The first plot shows

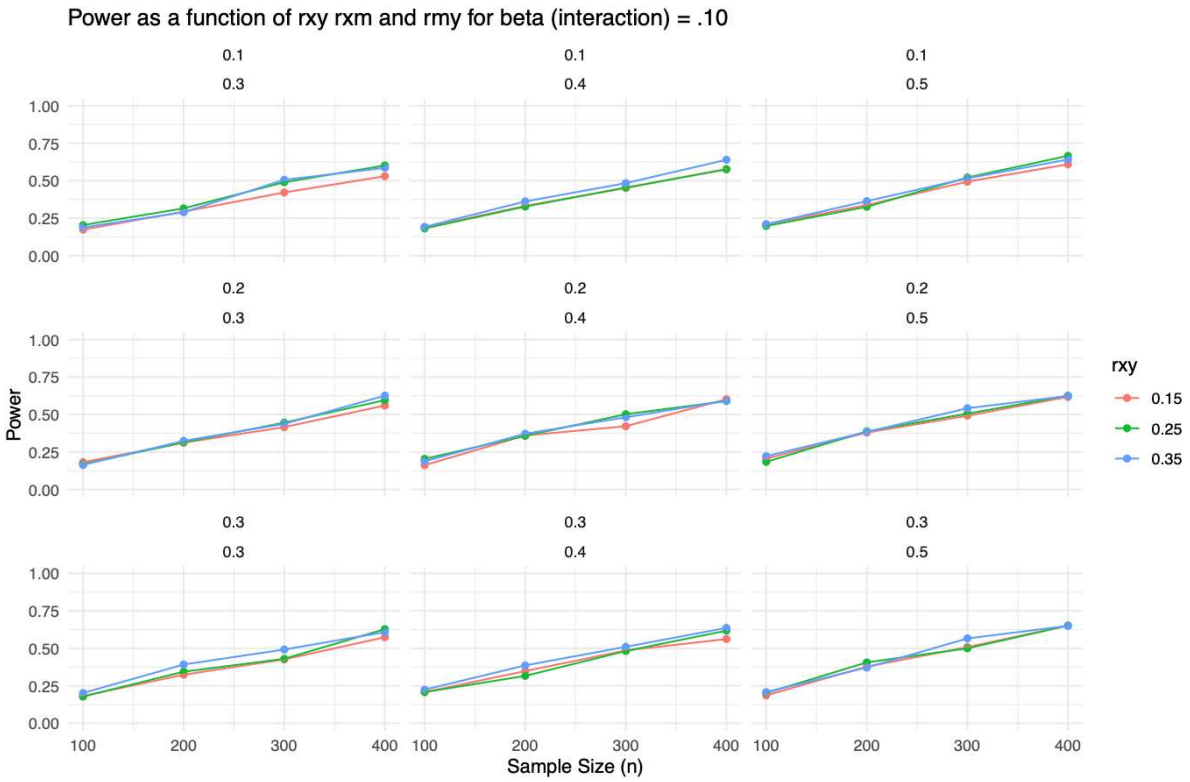
the power with the predictor-moderation correlation fixed at .412 (McElroy & Hevey, 2014), the predictor-outcome at .253 (as above) and moderator-outcome *r* = .192 (Ansell et al., 2012).



Interpretation: Power to detect the moderator effect is reasonable for *n* = 250 or greater if the *beta* for the interaction is around 0.15 or greater. For small standardized effects (which might include meaningful effects given the presence of range restriction for the moderator) of 0.05 to 0.10 power tends to be poor. However, at least one of the predictors is skewed and that may limit the impact of range restriction (power to detect moderators can be increased by skew and kurtosis as there are more extreme observations). A cautious approach would be to work with samples of 400 plus, but moderator effects are notoriously hard to detect (McClelland & Judd, 1993).

Sensitivity check:

For each moderator analysis we also varied the correlations around the original values (in this case with *beta* = 0.10). This doesn't have a huge impact on the power estimates. The sensitivity plot for Hypothesis 3a is shown below (but not for subsequent analyses as it isn't that informative).



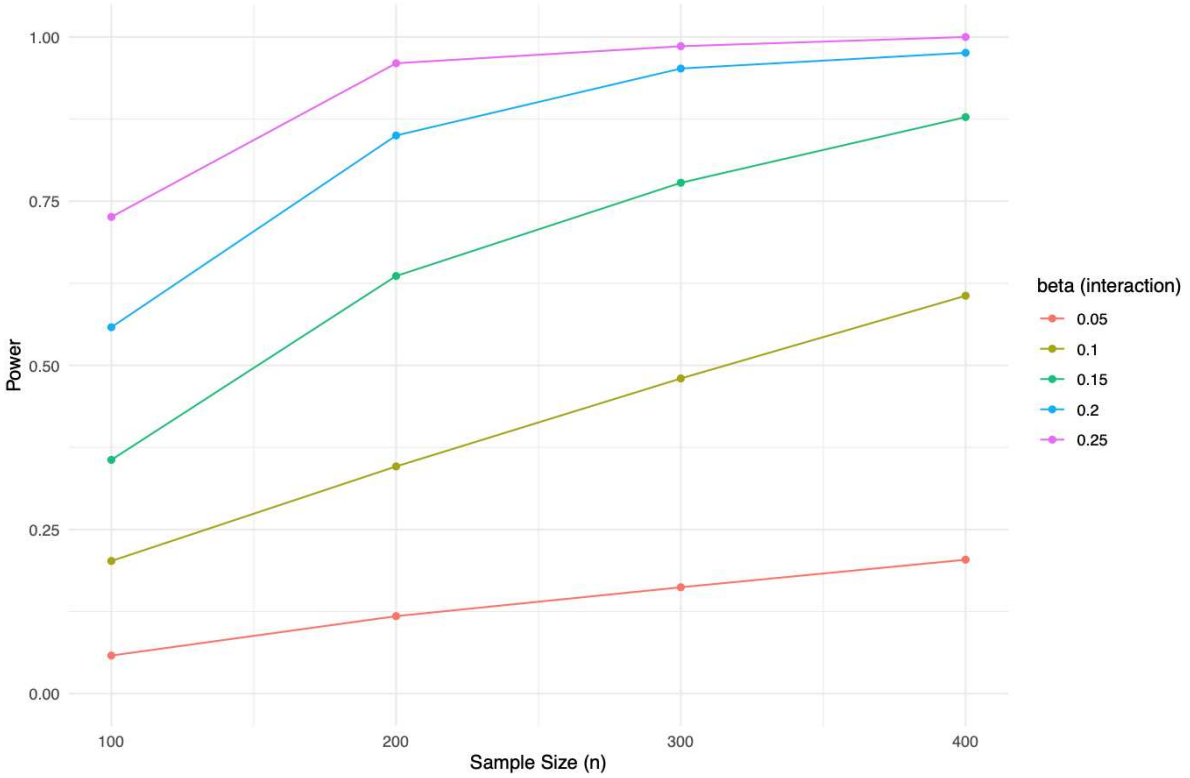
Hypothesis 3b

Predictor: Childhood trauma (CTQ)

Moderator: Recent stress

Outcome: Executive function

The plot below shows the power with the predictor-moderation correlation fixed at .412 (as above), the predictor-outcome at -.21 (Op den Kelder et al., 2018) and moderator-outcome *r* of -.10 to -.30 (Shields et al., 2016) representing different measures of executive function.



Interpretation: Power to detect the moderator effect is reasonable for n = 300 or greater if the *beta* for the interaction is 0.15 or greater. Power is approaching 60% for n = 400 when beta is 0.1. Again it would desirable to have samples of 400 or greater.

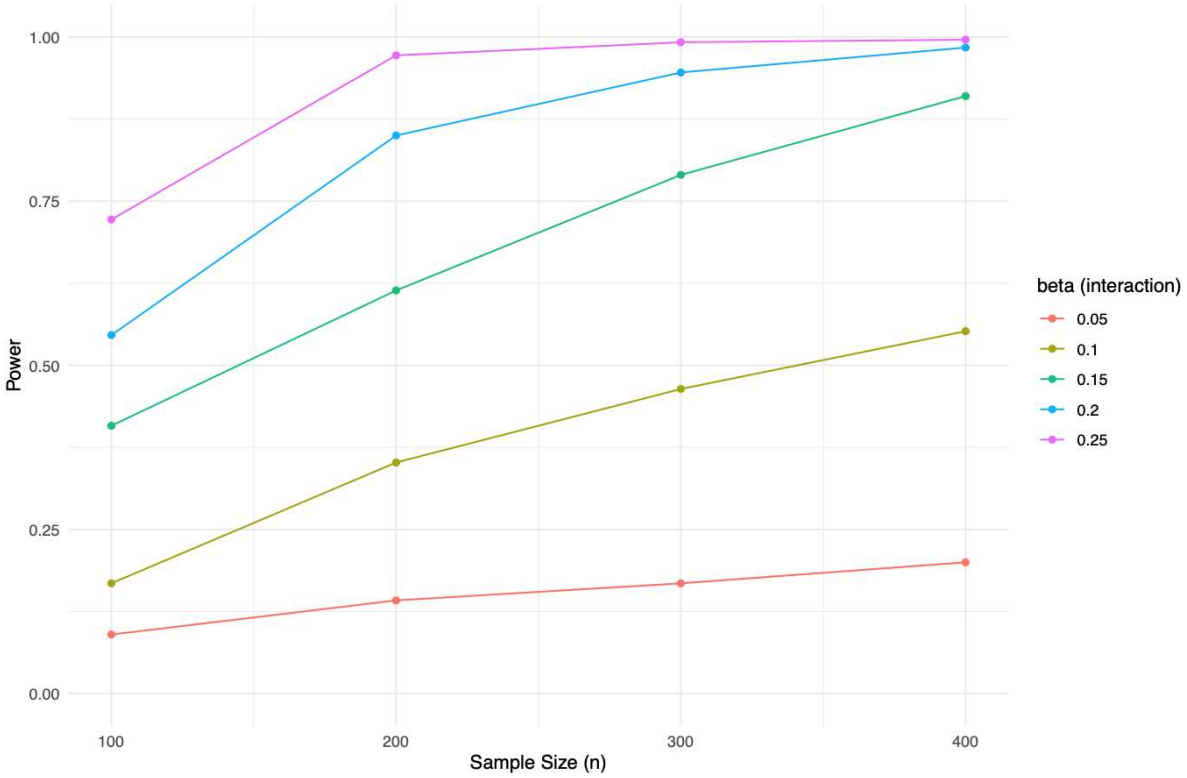
Hypothesis 4a

Predictor: Childhood trauma (CTQ)

Moderator: Recent stress

Outcome: Recent suicide ideation

As for hypothesis 3a and 3b we simulated *beta* from 0.05 to 0.25 for a range of plausible correlations between the variables. The plot shows power with the predictor-moderation correlation fixed at .412, the predictor-outcome at .092 (Angelakis et al., 2019) and moderator-outcome r = .24 (Polanco-Roman et al., 2016).



Interpretation: Here the pattern is very similar pattern to the hypothesis 3b. Power to detect the moderator effect is reasonable for n = 300 or greater if the *beta* for the interaction is 0.15 or greater. As before, it would be desirable to have samples of 400 or greater.

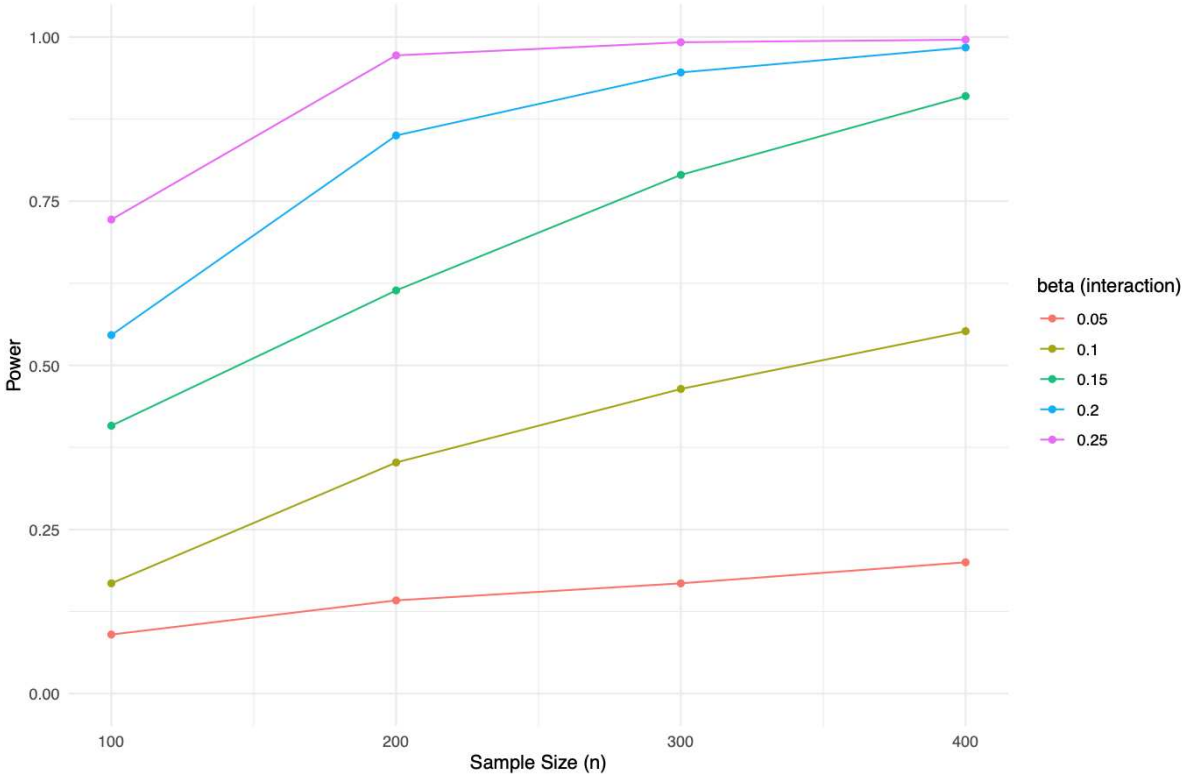
Hypothesis 4b

Predictor: Childhood trauma (CTQ)

Moderator: Recent stress

Outcome: Wellbeing

For hypothesis 4b we simulated *beta* from 0.05 to 0.25 for a range of plausible correlations between the variables. The plot shows power with the predictor-moderation correlation fixed at .412, the predictor-outcome at -.39, and moderator-outcome r = -.41 (McElroy & Hevey, 2014).



Interpretation: Here the pattern is very similar pattern to the hypothesis 4a. As before, it would be desirable to have samples of 400 or greater.

Missing data & data exclusion

Missing data will include items missed by participants and those who selected the option 'would rather not say' to the APMS suicide behaviour questions. If a participant had completed at least 75% of a psychological measure, their data will be retained for analyses. Otherwise their scores for that measure will be treated as missing. In cases where the data are missing multiple imputation (MI) or full information maximum likelihood (FIML) methods which assume data are Missing At Random (MAR) (Little, 1988) will be used. MI can be more flexible as it allows the inclusion of auxillary variables that predict missingness but aren't in the model used for analysis, but FIML is implemented in some SEM software (e.g., MPLUS, lavaan) which may be used for some analyses. For null effects additional Bayesian analyses may be conducted with R to obtain Bayes factors to assess the degree of support for the null hypothesis and for computationally demanding analyses (e.g., multiple imputation if the proportion of missing data is high).

1 2