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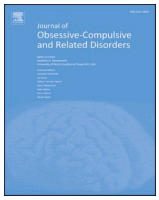

The role of emotional regulation, executive functioning, and aggression in hoarding behaviours

Emily Bates *, Nick Neave, Alyson Dodd, Colin Hamilton

Hoarding Research Group, Northumbria University, Newcastle Upon Tyne, NE1 8ST, UK

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ABSTRACT

Emotion regulation (ER), executive function (EF) and aggression have all been separately linked with hoarding behaviours. This study aimed to investigate whether difficulties with ER, deficits in EF, and an increase in aggression are linked with hoarding behaviours in a community sample, whilst controlling for anxiety, depression, age, and sex. Using a correlational design, we recruited 225 adults who completed questionnaires of anxiety and depression, hoarding severity, difficulties with ER, EF, and aggression. Two hierarchical multiple regressions were conducted to uncover which factors predicted an increase in hoarding behaviours, as well as the unique variance of these contributing factors. They revealed that difficulties with ER and physical aggression both contributed unique variance to hoarding severity scores. Further research is needed to fully uncover the relationship between aggression and HD, and the interconnection between EF and ER. The current study, although not without its limitations, has implications for further research in clinical samples.

1. Introduction

Hoarding Disorder (HD) is characterised by the excessive accumulation of possessions, and a subsequent failure to discard them, leading to severely cluttered living spaces, distress, and a significant impact upon daily life (American Psychiatric Association, 2013). Additionally, HD can lead to safety issues through unsanitary living spaces, as well as significantly contributing to the number of fire related deaths (e.g. Iyer & Ball, 2010). Social impairments, occupational problems and financial difficulties have all been linked with HD (e.g. Tolin et al., 2008). According to Nutley et al. (2023), hoarding is associated with a clear disability burden, higher than that of major medical/psychiatric disorders such as diabetes, major depression, and chronic pain. The prevalence of HD is around 2.5%, making it more common than disorders such as schizophrenia and OCD (Postlethwaite et al., 2019; Adam et al., 2012). Yet there is a relative scarcity of research on the possible underlying psychological characteristics associated with HD, and better understanding of such factors is crucial for the development of appropriate intervention strategies (Goldberg, 2009).

Research assessing possible neuropsychological/cognitive deficits associated with hoarding behaviours have been strongly influenced by the Cognitive-Behavioural Model (CBM) originally proposed by Frost and Hartl (1996). The model hypothesises three types of information processing deficits experienced by individuals who hoard, namely decision-making deficits, problems in categorisation and organisation, and difficulties with memory. The common underlying factor here is likely to be frontal lobe deficits, leading to generalised impairments in executive functioning (EF). In support of this, there is neuroimaging evidence that abnormal activity in the frontal lobes underlies hoarding behaviours (e.g. Hombali et al., 2019). There is support for EF deficits in HD, with evidence for significant associations between impaired executive functioning and hoarding severity, and of greater impairments in EF tasks in individuals with HD compared to controls groups (e.g. Dozier, Wetherell, et al., 2016; Grisham et al., 2010; Heffernan et al., 2024; Morein-Zamir et al., 2014; Warren & Ostrom, 1988). In a review by Gledhill et al. (2021) they reported that individuals with HD could experience problems with attention, inhibition, and organisation, which are all components of EF. However, the same review found varying evidence for the dysfunction of these facets within HD, with some studies finding no difference in EF between control and clinical groups. One facet that has a clear relation to HD is inhibitory control, of which there are many papers that have found a relationship between HD and a lack of inhibitory control (Norberg et al., 2023; Van der Meulen, 2013; Kort, 2012). Due to the mixed findings of previous literature more research is needed to clarify the role of EF within the manifestation of hoarding behaviours, and further research should investigate factors

* Corresponding author.
E-mail address: e.j.bates@northumbria.ac.uk (E. Bates).

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which may also affect an individual's EF.

An additional variable to consider when discussing potential links between EF and HD is emotion regulation (ER). ER has been defined as the attempts that individuals make to inhibit, maintain, and enhance emotional experiences and expressions (Bridges et al., 2004). ER can occur both before and after an emotionally arousing event, can be used to respond to both positive and negative emotional experiences, and can be automatic or deliberate (Gross & John, 2003; Mauss et al., 2007; Parrot, 1993). Firstly, EF deficits have been linked to difficulties in ER (Dickson & Ciesla, 2018). These findings are supported by other studies that all reported difficulties in EF to be linked with an increase in maladaptive ER techniques such as rumination (Altamirano et al., 2010), thought suppression (Brewin & Smart, 2005), and worry (Crowe et al., 2007).

Secondly, difficulties with ER have been noted as maintenance factors for a range of mental health conditions, and poor ER skills are thought to prompt the use of maladaptive cognitive and behavioural responses to avoid distress (Barton et al., 2021). Hoarding behaviours are also associated with difficulties in ER. For example, in a non-clinical sample, higher levels of hoarding were related to poorer ER, and greater reliance on possessions for help with regulating emotions (Phung et al., 2015). In addition, Tolin et al. (2018) found that individuals with HD reported greater deficits in ER compared to healthy controls, and the reported deficits in ER were not solely attributed to anxiety and depression, implying that the difficulties with ER themselves had a role to play in the HD. In a review by Barton et al. (2021) the authors concluded that hoarding was associated with a restricted capacity to understand emotions, the avoidance of emotions, a narrow range of emotional coping strategies, and difficulties in controlling behaviours when emotional. Recently, Bates et al. (2023) found that after controlling for anxiety, depression and current mood, hoarding severity was associated with increased difficulties in ER, but not linked to specific ER strategies.

How we regulate our emotions influences our emotional arousal, and the General Aggression Model (GAM; Bushman & Anderson, 2002) links aggressive responses to affect and arousal, indicating a role for ER. Research has supported this by showing that difficulties with ER are related to aggressive behaviour in both offenders and non-clinical groups (Roberton et al., 2014; Holley et al., 2017). As well as ER, the GAM takes into consideration the role of EF in displays of aggression. The GAM suggests that an individual's cognitive skills greatly influence their likelihood to be aggressive. Indeed, a range of studies now support the finding that deficits in EF are linked with an increase in aggression (Cruz et al., 2020; Morgan & Lilienfeld, 2000; Ogilvie et al., 2011; Paschall & Fishbein, 2002; Yang & Raine, 2009).

Aggression may also have a role to play in HD although the extent of this is not well researched. Aggression is a multi-facetted concept and certain facets of aggression have been linked with HD in previous research, one of those facets being hostility. One study by Mathes et al. (2019) reported that greater levels of hostility were associated with increased hoarding severity. Furthermore, anecdotal evidence from clinicians and family members has shown that attempts to discard the possessions of an individual with HD are sometimes met with threats of violence and angry displays (Steketee & Frost, 2006). New research from Chen et al. (2024) has found that there is an association between HD and angry feelings, hostility, and displaced aggression, further adding support to the theory that certain expressions of aggression play a role in the manifestation of HD. The current study aimed to further investigate aspects of aggression and learn more about their association with hoarding.

There are important practical implications of understanding the associations between these constructs and hoarding. Difficulties in emotion regulation are the focus of a number of transdiagnostic CBT models, and these difficulties are linked to outcomes (Hallion et al., 2018). Incorporating anger management methods in CBT has been shown to be a successful feature of therapy for psychopathologies that are associated with aggression (Howells & Day, 2003), so if a link between aggression and hoarding is uncovered, this paves the way to include these anger management techniques within CBT for hoarding. Thus far, only hostility has been linked with HD, and such research aims to uncover the relationship between different aspects of aggression and hoarding (Mathes et al., 2019. Understanding EF deficits within psychopathologies is important as they have important implications for evidence-based assessments and advanced interventions, as well as leading to enhanced screening, better prevention strategies and better understanding of treatment mechanisms (Snyder et al., 2015).

Taken together, understanding more about the psychological processes related to hoarding can improve interventions, increasing the low success rates and high dropout of psychological interventions for hoarding (Williams & Viscusi, 2016).

Given this, the aim of this current study is to investigate whether ER, EF and aggression are linked with an increase in hoarding behaviours, and to investigate whether ER, EF and different facets of aggression predict unique variance in hoarding behaviours. The current study recruited a non-clinical sample, as symptoms of HD are seen to be dimensional, and continuum theories of HD state that all individuals fall somewhere on the continuum between clinical hoarders and non-hoarders (Timpano et al., 2013). Using a community sample will allow for a range of participants at different points on the continuum to be investigated and non-clinical samples have been successfully implemented in past hoarding research (e.g. Coles et al., 2003; Timpano et al., 2009). We also control for age, sex, and anxiety/depression as these factors have all been associated with hoarding severity (e.g. Cath et al., 2017; Dozier & Ayers, 2017; Iervolino et al., 2009; Timpano et al., 2011; Tolin et al., 2011), and this means we can investigate the unique contribution of aggression, ER, and EF difficulties over and above demographic and clinical factors.

We hypothesise that.

H1. Difficulties with ER will be positively associated with hoarding behaviours.

H2. Higher levels of aggression with be positively associated with hoarding behaviours.

H3. Difficulties with EF will be positively associated with hoarding behaviours.

2. Method

2.1. Participants

An *a'priori* power calculation using G*Power 3.1.9.7 (Faul et al., 2007) with its alpha level at 0.05, a power of 0.80 and Cohen's d of 0.5, produced a minimum sample size of 102. An opportunity sample was recruited through social media posts. Participants had to be over the age of 18 but no specific groups were targeted. A total of 259 responses were gathered, however 23 responses had to be removed due to their data being incomplete, and 11 responses were deleted for not specifying whether they were male or female. This left 225 data sets to be used in analysis comprising 68 males and 157 females, aged 18–77 (Mean = 30.68 years, SD = 12.10). No remuneration was offered to participants for completing the study. A poster and link to the survey platform was posted on social media platforms, describing the study as an investigation into the relationship between hoarding behaviours, emotional regulation, aggression, and executive functioning.

3. Materials

3.1. The Savings Inventory-Revised (SI-R)

The SI-R (Frost et al., 2004) is a 23-item questionnaire that is used to assess self-reported hoarding behaviours, including clutter, excessive

acquisition, and difficulty discarding, and is often used as a screening tool for diagnosing HD. Higher scores on the SI-R are indicative of greater hoarding severity, with the clinical cut off point being 41. It has been shown to be an appropriate instrument for assessing hoarding behaviours in both clinical and non-clinical samples (Frost et al., 2004), furthermore it has been praised for its high internal reliability when used with control and clinical samples, with alpha = 0.84 and 0.94 respectively (Fontenelle et al., 2010).

3.2. The difficulties in emotion regulation scale (DERS)

The DERS (Gratz & Roemer, 2004) is a 36-item scale used to assess an individual's problems with their own emotional regulation and asks respondents questions based on how they relate to their own emotions. The DERS assesses problems and difficulties with the following: emotional clarity, emotional awareness, impulse control, engaging in goal-directed behaviour, access to emotional regulation strategies and, acceptance of emotional responses. Higher scores are representative of individuals having more difficulties with their ER. It has been found to have good internal validity, with an alpha level of 0.80 (Kökönyei et al., 2014), and has high validity and good reliability in adult samples (e.g. Orgeta, 2009).

3.3. The Buss-Perry Aggression Questionnaire (BPAQ)

The BPAQ (Buss & Perry, 1992) is a 29-item self-report questionnaire used to assess individuals' levels of aggression. It can be used to determine an overall score of aggression, as well as individual scores for hostility, physical aggression, verbal aggression, and anger. Each of these dimensions captures a different aspect of aggressive behaviour and tendencies, and it allows for aggression to be examined as a complex behaviour, not limited to just acts of physical violence. Because of the scope of this measure, it was well suited for this exploratory piece of research. Some example questions of the BPAQ include; "I can't help getting into arguments when people disagree with me" and "I am suspicious of overly friendly strangers". The BPAQ was chosen for this study as not only does it measure hostility, but it also measures other aspects of aggression that have not thus far been investigated in relation to HD. Additionally, the BPAQ has high internal reliability (alpha of 0.85; Madran, 2013) and has been hailed as the 'gold standard' for the measurement of aggression (Gerevich et al., 2007).

3.4. The Adult Executive Function Inventory (ADEXI)

The ADEXI (Holst & Thorell, 2018) is a 14-item self-report questionnaire used to assess two factors of adult EF; working memory, and inhibitory control, with a higher score indicating greater problems with EF. It has a Cronbach's alpha of 0.83, indicating good internal reliability (Strait et al., 2020). The fact that the ADEXI can measure inhibitory control, which has been strongly linked with HD, as well as other aspects of EF, make it well suited for this study (Morein-Zamir et al., 2014).

3.5. The Generalised Anxiety Disorder Questionnaire (GAD-7)

The GAD-7 (Spitzer et al., 2006) is a 7-item questionnaire to measure generalised anxiety, with a higher score indicating higher levels of anxiety. It has strong internal reliability with a Cronbach's alpha of 0.89 (Zhong et al., 2015) and strong validity and reliability as a measure of anxiety in a general population (Löwe et al., 2008). A measure of general anxiety has been included as research has shown strong links between anxiety and hoarding behaviours (e.g. Tolin et al., 2011).

3.6. The Patient Health Questionnaire (PHQ-9)

The PHQ-9 (Kroenke et al., 2001) is a 9-item questionnaire assessing depression, with a higher score indicating increased depressive symptoms. It is a quick and reliable measure of depression in a non-clinical sample and has high internal reliability (alpha = 0.85; Hansson et al., 2009). A measure of depression has been included as research has shown that depression and hoarding behaviours are linked (e.g. Frost et al., 2015).

3.6.1. Procedure

A link shared via social media took participants to a Qualtrics page where the survey had been created. After reading an information sheet and providing their consent participants were asked to provide a personal codeword, ensuring anonymity throughout the study and analysis, and to allow for the withdrawal of their data if necessary. They were then asked to indicate their age and sex. They then completed the SI-R, DERS, BPAQ, ADEXI, GAD-7 and PHQ-9. Finally, they were debriefed. The study took approximately 10–15 min to complete. This study received ethical approval from the Department of Psychology Ethics Committee, in accordance with the Faculty of Health and Life Sciences Ethics Committee at Northumbria University.

3.6.2. Procedure for analysis

Analysis was carried out in SPSS 27.0.1. Before analysis began 34 incomplete datasets were removed. Bivariate correlations were carried out to compare the questionnaire scores. Following this, assumption tests were carried out to make sure no regression assumptions were violated before carrying out four regressions. The first hierarchical regression was carried out with SI-R scores as the dependent variable, and with the GAD-7, PHQ-9, age, and sex being included in the first level, and the DERS, ADEXI and BPAQ being added in the second level. This would allow to control for anxiety, depression, age, and sex.

The second hierarchical regression carried out was similar to the first, but instead of including the combined BPAQ scores in the second step, it included the broken-down scores for verbal aggression (BPAQ-VA), physical aggression (BPAQ-PA), anger (BPAQ-Anger) and hostility (BPAQ-Hostility). This would identify which aspects of aggression were linked with SI-R scores.

4. Results

4.1. Data screening

The 225 complete responses were exported to IBM's SPSS for analysis. Some answers were reverse scored as per the scoring guidelines and then total scores were created for each questionnaire complete. Additionally, to this, the BPAQ scores were split to provide not only an overall score, but total scores for physical aggression, verbal aggression, anger, and hostility.

4.2. Preliminary analysis

Before the regressions were carried out, the data had to be reviewed, to ensure that the key regression assumptions were met. These assumptions are as follows, no multicollinearity, no autocorrelation, a linear relationship, multivariate normality, and homoscedasticity. All independent variables were checked to ensure there was no multicollinearity. All variables had a tolerance score of more than 0.1 (the minimum tolerance score was 0.39), which shows there was no collinearity present between variables. As well as this, all variance inflation factor values were lower than 10, proving that the multicollinearity assumption was met. The scatter plots produced highlighted that the data was homoscedastic and had a linear relationship with one another. The highest Durbin-Watson test score for all regression models was 2.12, exceeding 1, showing that there was no autocorrelation exhibited.

4.3. Analysis

Basic descriptive statistics of variable scores and age can be found in

Table 1
Means and SDs and T-test result of demographic data and factor scores split by sex, and total.

Variable	Male (n = 68)	Female (n = 157)	t(df)	Total (n = 225)
Age	30.76 (11.61)	30.64 (12.35)	0.123 (222)	30.68 (12.10)
GAD-7 Total	6.35 (4.77)	7.81 (5.57)	1.92 (222)	7.37 (5.37)
PHQ-9 Total	7.56 (5.63)	8.50 (6.36)	1.09 (222)	8.21 (6.15)
DERS Total	90.50 (23.53)	90.99 (21.98)	0.24 (222)	90.84 (22.41)
BPAQ Total	75.07 (17.26)	66.99 (16.34)	−3.22 (222)[a]	69.44 (17.00)
ADEXI Total	37.24 (10.78)	36.15 (9.93)	−0.723 (222)	36.48 (10.18)
BPAQ-PA	20.71 (6.44)	16.55 (5.25)	−4.58 (104.86) [a]	17.08 (5.94)
BPAQ-VA	14.63 (3.72)	12.82 (4.16)	−3.02 (222)[a]	13.36 (4.11)
BPAQ-Hostility	21.24 (7.12)	20.65 (6.65)	−2.16 (222)	20.83 (6.79)
BPAQ-Anger	18.50 (4.54)	16.98 (4.63)	−2.16 (222)[a]	17.44 (4.64)
SI-R Total	25.66 (16.12)	25.21 (15.60)	−1.9(222)	25.35 (15.72)

Note: GAD-7 – Generalised Anxiety Disorder Questionnaire; PHQ-9 – Patient Health Questionnaire; DERS – Difficulties with Emotional Regulation Scale; BPAQ – Buss-Perry Aggression Questionnaire; ADEXI – Adult Executive Function Inventory; SI-R – Savings Inventory – Revised.
[a] $p < .05$.

Table 1. Table 2 shows the number of participants that scored above the clinical cut-off point of the SI-R, indicating that these individuals had extremely high levels of hoarding behaviours. 18.22% of participants scored above the cut-off point, which is much higher that the predicted prevalence of HD in the population, which Postlethwaite et al. (2019), estimated to be around 2.5%. These findings will be explored further in the discussion. To test how all the factors would correlate with the SI-R results, Pearson's bivariate correlations were run between the variables to assess the effect size, as shown in Table 3. A Bonferroni correction was performed, and the significance level of the correlation table was adjusted accordingly.

A hierarchical linear regression was used to assess the extent to which SI-R scores could be predicted by BPAQ, DERS, and ADEXI scores (block 2), when controlling for anxiety, depression, age and sex (block 1). Table 4 shows that block one is able to account for 23% of the variance in SI-R score ($\Delta R^2 = 0.23$, $F(4,219) = 18.06$, $p < 0.001$) with the PHQ-9 score ($\beta = 0.45$, $t(219) = 5.15$, $p < 0.001$) being a significant predictor. The second model accounted for 35% of the variance in SI-R score ($\Delta R^2 = 0.35$, $F(7,216) = 17.95$, $p < 0.001$), a 12% increase from model 1, with DERS score ($\beta = 0.33$, $t(216) = 3.92$, $p < 0.001$), BPAQ score ($\beta = 0.17$, $t(216) = 2.51$, $p = 0.013$) and PHQ-9 scores ($\beta = 0.24$, $t(216) = 2.74$, $p = 0.007$) being significant contributors to the regression. This suggests that DERS scores and total PBAQ scores predict unique variance in SI-R scores when controlling for anxiety and depression.

Table 4 showed that the BPAQ scores were a significant predictor of SI-R scores, and therefore another hierarchical linear regression was conducted to assess the extent to which SI-R scores could be predicted by verbal aggression scores (BPAQ-VA), physical aggression scores (BPAQ-PA) hostility scores (BPAQ-Hostility) and anger scores (BPAQ-Anger), as well as DERS scores and ADEXI scores (block 2), when controlling for anxiety, depression, age and sex (block 1). Table 5 shows that block one is able to account for 23% of the variance in SI-R score ($\Delta R^2 = 0.23$, $F(4,219) = 18.06$, $p < 0.001$) with the PHQ-9 score ($\beta = 0.45$, $t(219) = 5.15$, $p < 0.001$) being a significant predictor. The second model accounted for 38% of the variance in SI-R score ($\Delta R^2 = 0.38$, $F(10,213) = 14.64$, $p < 0.001$), a 15% increase from model 1, with physical aggression scores ($\beta = 0.28$, $t(213) = 3.73$, $p < 0.001$) being a significant predictor, as well as DERS score ($\beta = 0.35$, $t(213) = 4.11$, $p < 0.001$) and PHQ-9 scores ($\beta = 0.26$, $t(213) = 2.97$, $p = 0.003$) being significant contributors to the regression. This suggests that physical aggression scores, additionally to DERS scores and PHQ-9 scores predict unique variance in SI-R scores when controlling for anxiety and depression.

Table 2
Table showing the number of participants who scores above and below the clinical cut-off point on the SI-R.

	Total (n = 225)	Male (n = 68)	Female (n = 157)
Below clinical cut-off	*184*	*52*	*132*
Above clinical cut-off	*41*	*16*	*25*

5. Discussion

We found that having more self-reported difficulties with ER, and higher levels of self-reported physical aggression are significantly linked with an increase in self-reported hoarding behaviours. These findings were significant, even when controlling for anxiety, depression, age, and sex. Deficits in self-reported executive functioning were however not significantly linked with increases in hoarding behaviours. These findings fully support the first hypothesis, partially support the second hypothesis, but do not support the third hypothesis.

The finding that self-reported difficulties in ER are linked with an increase in self-reported hoarding behaviours when controlling for anxiety, depression, age, and sex is supported by past research (e.g. Bates et al., 2023). In addition to the studies cited in the introduction, Raines et al. (2015) also found that difficulties with ER are positively correlated with an increase in hoarding behaviours. The results from that study mirror the findings of this current study; as SI-R scores increased so did scores on the DERS. Moreover, previous research and our finding that difficulties in ER are linked with HD, adds support to the notion that different psychopathologies all show ER difficulties (Sheppes et al., 2015). ER problems appear to be a key characteristic of HD, and difficulties in ER are found in those who display higher levels of hoarding behaviours.

H2 was partially met, as it was found that an increase in self-reported physical aggression scores are significantly linked with an increase in SI-R scores, however no other aspects of self-reported aggression were significantly linked. Physical aggression has been associated with a range of different psychopathologies, such as depression, psychosis, bipolar, and anxiety disorders (Ballester et al., 2012; Chung et al., 2019; Darrell-Berry et al., 2016; Dutton & Karakanta, 2013), however until now it the research linking it with HD is limited. Anecdotal evidence from family members and clinicians has stated that attempts to discard the possessions of an individual with HD are sometimes met with threats of physical violence (Steketee & Frost, 2006). One explanation for this increase in levels of physical aggression could be due to frequent incidents of conflict. Research shows that conflict is common between individuals who hoard and family members, sometimes leading to the relationship breaking down all together (Mathes et al., 2019; Wilbram et al., 2008).

Furthermore, past research shows that attachment issues are closely linked with more aggressive behaviours. Research by Michiels et al. (2008) proposed that children that had insecure attachments with their parents were more likely to engage in physically aggressive behaviour with their peers. The development of HD has been shown to be linked with having insecure attachments in childhood (Chia et al., 2021), and disturbed interpersonal attachments is a key element of HD (Mathes et al., 2020; Neave et al., 2016). These attachment issues present in HD could be a contributing factor as to why physical aggression was found to be linked with hoarding behaviours. Future research should look at the relationship between physical aggression and HD, with relation to attachment styles, as this would allow for a deeper understanding of the role that physical aggression plays within HD.

Despite finding that self-reported physical aggression is linked to

Table 3
- Pearson's bivariate correlations.

Variable	SI-R Total	DERS Total	BPAQ Total	ADEXI Total	GAD-7 Total	PHQ-9 Total	PA-BPAQ	VA-BPAQ	Anger-BPAQ	Hostility-BPAQ
SI-R total	-	0.56**	0.41**	0.41**	0.37**	0.48**	0.38**	0.11	0.35**	0.39**
DERS Total	–	–	0.5**	0.61**	0.56**	0.65**	0.29**	0.16	0.44**	0.6**
BPAQ Total	–	–	–	0.45**	0.42**	0.4**	0.82**	0.66**	0.86**	8**
ADEXI Total	–	–	–	-	0.39**	0.44**	0.28**	0.13	0.38**	0.53**
GAD-7 Total	–	–	–	-	-	0.74**	0.24**	0.11	0.33**	0.54**
PHQ-9 Total	–	–	–	-	-	-	0.23**	0.15*	0.26**	0.51**
PA-BPAQ	–	–	–	-	-	-	-	0.45*	0.66*	0.46**
VA-BPAQ	–	–	–	-	-	-	-	-	0.50**	0.31**
Anger-BPAQ	–	–	–	-	-	-	-	-	-	0.59**

Note: ** = $p < 0.001$; * = $p < 0.005$.

Table 4
Coefficients for Model 1 and Model 2 following hierarchal multiple regression including all factors.

		B	SE B	β	Adjusted R^2
Block 1	(Constant)	27.97	9.90		0.23**
	Age	−0.15	0.08	−0.11	
	Sex	−1.61	2.03	−0.05	
	GAD-7 Total	0.001	0.26	0.00	
	PHQ-9 Total	1.16	0.22	0.45**	
Block 2	(Constant)	−12.62	11.44		0.35**
	Age	−0.08	0.08	−0.06	
	Sex	0.57	1.96	0.02	
	GAD-7 Total	−0.33	0.25	−0.11	
	PHQ-9 Total	0.62	0.23	0.24*	
	DERS Total	0.23	0.06	0.33**	
	BPAQ Total	0.16	0.06	0.17*	
	ADEXI Total	0.09	0.11	0.06	

Note: ** = $p < 0.001$; * = $p < 0.01$.

Table 5
Coefficients for Model 1 following hierarchical multiple regression using split up BPAQ scores and all other factors.

		B	SE B	β	Adjusted R^2
Block 1	(Constant)	27.97	9.9		0.23**
	Age	−0.15	0.08	−0.11	
	Sex	−1.61	2.03	−0.05	
	GAD-7 Total	0.001	0.26	0.00	
	PHQ-9 Total	1.16	0.22	0.45**	
Block 2	(Constant)	−18.1	11.71		0.38**
	Age	−0.06	0.08	−0.47	
	Sex	1.81	1.97	0.05	
	GAD-7 Total	−0.34	0.25	−0.12	
	PHQ-9 Total	0.67	0.23	0.26*	
	DERS Total	0.24	0.06	0.35**	
	BPAQ-VA	−0.40	0.24	−0.12	
	BPAQ-PA	0.75	0.20	0.28**	
	BPAQ-Anger	0.15	0.29	0.04	
	BPAQ-Hostility	−0.11	0.19	−0.05	
	ADEXI Total	0.1	0.11	0.06	

Note: ** = $p < 0.001$; * = $p < 0.01$.

self-reported hoarding behaviours, the results show that all other areas of aggression measured by the BPAQ were not significantly linked with hoarding behaviours. This contradicts previous research, with such as Mathes et al. (2019) reporting that hostility was positively correlated with an increase in hoarding behaviours. As well as hostility, verbal aggression has been linked to HD in the past. Kysow (2018) for example investigated how a group of people with HD reacted to interventions and found that 26% of the individuals with HD were verbally aggressive towards people who were trying to declutter their home, highlighting that verbal aggression is a component of HD, and that many individuals with HD may become verbally aggressive when they feel threatened. Despite there being evidence that other aspects of aggression are associated with HD, the current study only found physical aggression to be significantly related.

A reason for this could be due to the use of the BPAQ. Although the BPAQ has been praised for its internal reliability and been named the 'gold standard' aggression measure by Gerevich et al. (2007), when used to measure separate components of aggression, not just overall aggression, it may not be as powerful. The study by Mathes et al. (2019) used a questionnaire specifically developed to assess hostility, and the study by Kysow (2018) relied on reports given by those delivering the interventions to assess verbal aggression. Using standalone measures designed to assess different components of aggression may have yielded different results to using the BPAQ to assess all components. Future research could investigate these different areas of aggression separately using measures designed to assess single facets of aggression.

H3 was not supported, meaning that the current study did not find self-reported EF deficits to be linked with an increase in self-reported hoarding behaviours. Despite Table 3 showing that there was an initial strong correlation between ADEXI scores and SI-R scores, this correlation was lost in the regression analyses, with the DERS and BPAQ-PA scores taking precedence. These findings indicate that ER problems may be more strongly linked with hoarding behaviours than EF problems. One reason for EF deficits not being significantly linked with a decrease in hoarding behaviours could be because the current study controlled for age in the analysis. An increase in age has been shown to be related with a decline in EF in previous research (Ferguson et al., 2021) and with most help seeking populations of individuals with HD being older, this could explain why previous research has found EF deficits to be related with HD. Research shows that the age of onset for HD is in adolescence and early adulthood (Dozier, Wetherell, et al., 2016), although their hoarding can go unnoticed by friends, family and services until later in life when significant accumulation has happened over a prolonged period of time.

A limitation of the current study is its heavy reliance on self-report to assess both EF and aggression. The current study used a self-report measure of EF aggression in order to keep the attrition rates low and because it is an easy method to implement. However, self-report methods can suffer from social desirability bias, especially when discussing socially sensitive topics about oneself, such as personal aggression. When answering these questions, participants may have not answered truthfully in order to align with what they perceive to be more socially desirable, and in the case of aggression it would mean participants may have answered in a way that makes them seem less aggressive. Although data was kept anonymous to limit the risk of social desirability bias, research has shown that even when data is anonymised, social desirability still affects results (Van de Mortel, 2008). To overcome this issue, future research could assess EF and aggression in a different way, for example using cognitive tasks and observer rated aggression, where a trained researcher would rate the individual's aggression levels using a scale, such as the Modified Overt Aggression Scale (Sorgi et al., 1991). Both methods have been successfully

implemented in both clinical and non-clinical samples, and cognitive tasks have been used frequently in previous literature regarding HD, demonstrating that they are appropriate to use in these samples. Furthermore, Observer rated aggression been shown to be a reliable measure of aggression, meaning it would be an appropriate tool to use in future research (Oliver et al., 2007; Endicott et al., 2002).

Another limitation of the current study is that it did not control for other comorbid psychopathologies. The current study controlled for both anxiety and depression which have both been shown to be strongly linked with HD in a paper by Vieira et al. (2022). However, OCD has also been shown to be strongly associated with HD in the same paper. Future research should control for OCD, as well as anxiety and depression. A final limitation of the current study is that it had a cross-sectional design and therefore no causal conclusions can be made from the findings. Further research using a longitudinal design is needed to be able to make causal conclusions on the role on ER, EF and aggression within HD.

A further important point to note is the high number of participants that scored above the clinical cut-off point on the SI-R. As previously mentioned, the prevalence of HD in the population is estimated to be around 2.5% (Postlethwaite et al., 2019), however this study found that just over 18% of the participants scored above the clinical cut-off point on the SI-R. This could have been due to the use of the words "hoarding disorder" in the title, which may have attracted an unrepresentatively large number of individuals with HD to take part in the study, which was shared across social media, leading to unintentional sampling bias. Previous studies have also found high levels of participants scoring high on the SI-R (Yap et al., 2020; Yap & Grisham, 2020) This implies that the results may not be as generalisable to the adult population as it does not accurately represent the expected number of individuals with HD to be assessed when using a non-clinical sample. However, an argument could be made that the findings could instead be more generalisable to a clinical population, due to its high percentage of those meeting the clinical cut-off point.

Despite its limitations, the current study still has important implications for future research around HD. Currently, HD interventions have been shown to suffer with very high dropout rates (Williams & Viscusi, 2016). These high dropout rates suggest that there is a need for a more appropriate therapy to be developed to help those with HD, and a better suited therapy could lower dropout rates would increase the number of individuals who fully recover. The current study's shows that problems with ER and higher levels of self-reported physical aggression are linked with an increase in hoarding behaviours and therefore future research should aim to develop and test the effectiveness of interventions targeting these areas.

To conclude, we found that self-reported difficulties in ER are significantly linked to an increase in self-reported hoarding behaviours in a non-clinical sample. As well as ER difficulties, higher levels of self-reported physical aggression was found to be significantly associated with self-reported hoarding behaviours, whilst other aspects of aggression and executive function were not. Future research could be conducted to investigate the role of aggression in more depth, as well as the relationship between ER and EF. The implications of this study's findings could help to lead to the development of successful treatments for HD. However, this study was not without its limitations as the use of self-report and the unusually large number of participants scoring high enough of the SI-R to be considered clinical hoarders may have limited the findings and generalisability of the study.

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CRediT authorship contribution statement

Emily Bates: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Nick Neave:** Writing – review & editing, Supervision, Methodology, Formal analysis. **Alyson Dodd:** Writing – review & editing, Methodology, Conceptualization. **Colin Hamilton:** Writing – review & editing, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that there were no conflicts of interest with respect to the authorship or the publication of this article.

Data availability

Data will be made available on request.

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