Iran J Psychiatry 2024; 19: 4: 424-430

Original Article ***https://doi.org/10.18502/ijps.v19i4.16555***

Estimating the Heritability of Hoarding Symptoms: Insights from a Classical Twin Study "New Insights on the Nature of Clutter"

Sepehr Pourkhalili[1], Reza Soltani Shal[1], Abbas Abolghasemi[1], Minoo Dianatkhah[2], Mojgan Gharipour[2,3*]

Abstract

Objective: Hoarding disorder is a complex condition that significantly impacts individuals' lives, characterized by excessive acquiring, difficulty discarding, clutter, distress, and impairment. This study aimed to examine the extent to which genetics and environment influence difficulty discarding, excessive acquisition, and clutter through the implementation of a classical twin study.
Method: This classical twin study, conducted between April and September 2021, enrolled 194 twins (97 pairs) from Isfahan, recruited through the Isfahan Twins Registry (ITR). A total of 194 twins, consisting of 100 monozygotic (MZ) and 94 dizygotic (DZ) twins, participated in this study. Participants aged 16–50 were invited electronically and completed an online consent form and questionnaire. Hoarding symptoms were assessed using the saving inventory-revised. Zygosity was determined using a self-report method based on Song *et al*.'s questionnaire. To estimate the heritability of hoarding symptoms, the classical univariate twin model was employed.
Results: Based on the univariate analysis, the heritability estimates for difficulty discarding and excessive acquisition were found to be 0.43 and 0.52, respectively. However, the results did not provide support for the role of genetics in clutter. Instead, it was indicated that the common environment accounted for 0.54 of the variance in clutter, while the specific environment contributed 0.46 to this symptom.
Conclusion: The difficulty discarding and excessive acquisition were found to be moderately heritable. On the other hand, considering the contribution of genetics and environment to clutter, the results raise doubts about the association of clutter with hoarding. The relatively low genetic influence suggests that this trait may overlap with other behaviors rather than hoarding.

Key words: *Clutter; Difficulty Discarding; Etiology; Excessive Acquisition; Genetic; Heritability; Hoarding*

1. Department of Psychology, Humanities Faculty, University of Guilan, Rasht, Iran.
2. Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran.
3. Honorary Fellow, School of Medicine, Faculty of Health, Deakin University, Melbourne, Australia.

***Corresponding Author:**
Address: School of Medicine, Faculty of Health, Deakin University, Geelong Waurn Ponds Campus, Locked Bag 2000, Geelong, VIC 3220 (Wadawurrung Country).
Tel: 614-26101544, Email: m.gharipour@deakin.edu.au

Article Information:
Received Date: 2023/09/01, Revised Date: 2024/09/08, Accepted Date: 2024/09/09

Hoarding disorder is a severe and persistent mental illness characterized by extreme difficulty discarding possessions and significant clutter, which can lead to hazardous living conditions (1). Individuals with hoarding tendencies often retain items due to emotional attachment, aesthetic appeal, speculative beliefs about future usefulness, or the perception that these items contain valuable information (2). The consequences of hoarding are serious, leading to risks such as fire hazards, falling objects, and unsanitary living environments. Epidemiological studies estimate the prevalence of hoarding disorder to be 0.98% in children and 2.5% in adults, with a confidence interval of 1.7%-3.6% (3). Typically, hoarding disorder begins at the age of 16.7 (4), with an average age of diagnosis in the 20s to 30s (5). The disorder frequently co-occurs with other conditions, including major depressive disorder (62%), generalized anxiety disorder (32%), social phobia (14%), and neurological disorders such as epilepsy and movement disorders (6). A deeper understanding of the complex nature of hoarding disorder is essential for developing effective interventions that can improve the quality of life for those affected (7).

Hoarding disorder is influenced by a variety of factors, including lower sociodemographic status (8), cold and controlling family environments, adverse and traumatic life events (9), and insecure attachment styles (1). In addition to these environmental factors, genetic influences have been identified as significant contributors to the development of hoarding disorder. Several twin studies have explored the gene-environment interaction in hoarding and estimated the heritability of this trait to be between 28% and 41% (10). Most research has focused on hoarding as a symptom of obsessive-compulsive disorder, with heritability estimates ranging from 25% to 61% (11–18). However, only a few studies have specifically examined the genetic contributions to hoarding symptoms, such as difficulty discarding, excessive acquisition, and clutter (19,20). Nordsletten *et al*. reported that the heritability of excessive acquisition and difficulty discarding were 49% and 45%, respectively (20), while Mathews *et al*. found heritability estimates of 22% for excessive acquisition and 37% for difficulty discarding (19). They provided the first evidence of the heritability of clutter at 20%, suggesting that genetic factors may influence this aspect of hoarding, which warrants further investigation.

Cultural factors significantly influence hoarding behaviors. For example, research indicates racial differences in how hoarding disorder is understood, managed, and experienced (21). There are also cultural differences in features of hoarding disorder. Nordsletten *et al*. revealed that while the severity and core features of hoarding disorder are consistent across cultures, clutter is the only core feature that varies between different cultural contexts. They also highlighted that the primary cultural differences in hoarding disorder are related to sociodemographic factors, such as the age of onset (22). Although studies on the gene-environment interaction in hoarding have been conducted in various countries and cultures, most have focused on European and Western populations, leaving significant gaps in understanding hoarding in other cultural contexts (23). In the only Iranian study investigating the heritability of obsessive hoarding using a classical twin study design, heritability was estimated at 0.54 (24). While this study provides initial evidence of hoarding heritability in an Iranian population, it assessed obsessive hoarding using a 5-item scale that measures the type and severity of the disorder across five dimensions. However, the study did not estimate the heritability of specific components such as clutter, excessive acquisition, and difficulty discarding. Expanding research to include diverse cultural backgrounds and addressing the gaps in the literature concerning the heritability of specific hoarding components is essential for a more comprehensive understanding of the disorder.

Recent research has highlighted that, among the core symptoms of hoarding disorder, clutter is the only symptom that shows significant variation across different cultural contexts. However, only two studies have explored the heritability of hoarding symptoms, including clutter, and just one study has investigated the heritability of hoarding disorder in an Iranian twin sample. Moreover, the heritability of clutter has been questioned in similar studies, raising uncertainty about its genetic basis. Given these gaps, this study aims to estimate the heritability of hoarding disorder symptoms, particularly clutter, within the Iranian cultural context. By addressing these issues, the research seeks to provide a more nuanced understanding of the gene-environment interaction in hoarding disorder.

Materials and Methods

This classical twin study, conducted between April 2021 and September 2021, enrolled 194 twins from Isfahan, recruited through the Isfahan Twins Registry (ITR). This study is a subset of the larger ITR study (25), which received prior approval from the Ethical Committee of Isfahan University of Medical Sciences (IR.mui.med.rec.1399.169). Participants were invited via electronic invitation, and if they consented, they completed an online questionnaire, which included a consent form.

Participants

Eligible participants were between 16 and 50 years old, consisted of accessible twin pairs, and had not been raised apart. The study followed a three-phase recruitment process:

Phase 1: The Isfahan Twins Registry provided the records of 88 twin pairs who met the inclusion criteria. After contacting them by phone, 44 twins (22 pairs) completed the questionnaires.

Phase 2: A contract was established between the researcher and the Parsian Twins Association. In exchange for a free communication skills workshop, twins from this association agreed to complete the study's questionnaires. In this phase, 16 twins (8 twin pairs) participated.

Phase 3: A public call was announced via social media platforms linked to the Parsian Twins Association and the Isfahan Twin Health Registry. A total of 171 twins responded, but only 134 twins (67 pairs) met the study's criteria. In total, 194 questionnaires (97 twin pairs) were collected from the three phases.

Zygosity Determination

To determine the zygosity of the twins, a self-report method using the questionnaire by Song *et al*. was employed (29). This questionnaire is highly reliable, with an accuracy of 97.2% for identifying monozygotic twins and 95% for dizygotic twins. The questionnaire determines the zygosity of each twin individually by asking three questions and using a flowchart. The zygosity of the first twin is determined first, followed by the second twin, and finally, the overall zygosity of the pair is identified based on their responses.

The decision-making process follows a flowchart, where if a participant believes they are often mistaken by their parents or teachers, they are classified as monozygotic (MZ). If not, additional questions about being mistaken by teachers and strangers are considered. If the responses are inconsistent or the result is indeterminate, a decision guide is used.

In cases where the zygosity of the two twins does not match, the decision guide helps choose one of six possible outcomes: MZ/MZ, DZ/DZ, MZ/DZ, MZ/XZ, DZ/XZ, or XZ/XZ. The first two outcomes are determined based on the consistency between the twins, while the remaining four are decided using genetic testing results. The second decision guide provides the final outcome when zygosity is unclear or inconsistent.

Intruments

The research questionnaires consisted of the Zygosity and Saving Inventory-Revised (SI-R) questionnaires (26). The Saving Inventory-Revised (SI-R) questionnaire, developed by Frost *et al*. (2004), is a widely used tool for assessing the severity of hoarding symptoms. The SI-R consists of 23 questions divided into three subscales: difficulty discarding, excessive acquisition, and clutter. Participants rate each item on a 5-point Likert scale. The internal consistency of the SI-R has been evaluated in several studies, with high reliability reported (Cronbach's alpha = 0.94 for the overall scale). The subscales also demonstrate good internal consistency, ranging from 0.80 to 0.93 (26–28). In this study, the estimated Cronbach's alpha values were 0.81 for difficulty discarding, 0.82 for clutter, 0.68 for excessive acquisition, and 0.88 for the overall score.

Statistical Analysis

Descriptive statistics were utilized to examine the data prior to conducting inferential statistical analysis. To assess the normality of the data, a Kolmogorov-Smirnov test was performed. The ACE structural equation model was employed to estimate the proportion of heritability attributed to additive and non-additive genetics, common environment, and specific environment. Various R software packages, including lme4, mets, psych, and nortest, were employed for the analysis. The intra-pair correlation coefficient was calculated to evaluate the correlation between pairs within each zygosity group. Additionally, an F-test was conducted to examine the homogeneity of variance among twins within each zygosity group. The ACE model was then applied to the data, and subsequent AE, CE, and E models were evaluated. Model fit was assessed using Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC), with smaller values indicating a better fit. The -2L models were compared to the reference (ACE) model using chi-square analysis (29).

Ethical Consideration

This study has been done as a sub-study of the ITR. The ITR was previously approved by the Institutional Research Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran. The ethical code of this research is IR.mui.med.rec.1399.169. Also, the participation of employees was voluntary, based on written informed consent before data collection. Additionally, the aim and method of the study and the anonymity and confidentiality of their data were informed to them by researchers. Furthermore, all methods were performed in accordance with the relevant guidelines and regulations (Declarations of Helsinki).

Results

Table 1 demonstrates demographic characteristics of the study population. The majority of the participants were identified as women. The age range of the monozygotic (MZ) group spanned from 16 to 49 years, while the dizygotic (DZ) group exhibited an age range of 16 to 43 years. The mean age of the MZ and DZ groups were 27 and 25 years, respectively.

Table 2 demonstrates the results of the intra-pair correlation analysis for the MZ group, revealing significantly higher correlations across all variables compared to the DZ group. However, based on this analysis, it is not possible to definitively conclude that genetics have a dominant influence on the variables. The findings suggest a potential association between genetics and the variables under investigation. Additionally, the F-test results indicate that the variance observed between MZ and DZ pairs is not significantly different, suggesting that twin pairs do not differ significantly.

Table 1. Demographic Characteristics of Monozygotic (MZ) and Dizygotic (DZ) Studied Twins

Zygosity	Variable	No.	x̄	Std.	Min.	Max.
MZ	Sex	Male: 20 Female: 80 Total: 100	-	-	-	-
	Age	-	26.78	7.67	16	49
DZ	Sex	Male: 18 Female: 76 Total: 94	-	-	-	-
	Age	-	24.61	5.74	16	43

Table 2. Descriptive Statistics, Intra-Pair Correlation, F-Test Outcomes, and Normality Assessment for Hoarding Behavior in (MZ) and Dizygotic (DZ) Studied Twins

Variable	Zygosity	No.	x̄	Std.	Range	r	CI (95%)	F	KS
Difficulty discarding	MZ	100	14.12	5.16	7-31	0.54	(0.22 – 0.61)	0.00*	MZ: 0.86* DZ: 0.63*
	DZ	94	22.06	5.90	7-28	0.41	(0.11 – 0.31)	1.03*	
Excessive Acquisition	MZ	100	16.15	5.01	7-33	0.51	(0.32 - 0.66)	0.35*	
	DZ	94	16.24	3.79	8-29	0.32	(-0.02 - 0.60)	1.90*	
Clutter	MZ	100	22.56	7.19	10-43	0.56	(0.40 - 0.69)	0.55*	
	DZ	94	22.06	5.90	11-37	0.28	(0.21 - 0.35)	0.19*	

*: P > 0.05

Table 3. Univariate Additive Genetic, Common Environment, and Specific Environment (ACE) Model of Hoarding Behavior Subscales in (MZ) and Dizygotic (DZ) Studied Twins

Model	A	C	E	-2LL	$\chi\Delta^2$	P	df	AIC	BIC
Difficulty Discarding									
ACE	0.43 (0.23 – 0.63)	0.00 (0.00 – 0.00)	0.57 (0.37 – 0.76)	- 579.21	-	-	6	1170.43	1185.88
AE	**0.43 (0.23 – 0.63)**	**-**	**0.57 (0.37 – 0.76)**	**- 579.21**	**1.21**	**1.00**	**5**	**1168.43**	**1181.31**
CE	-	0.34 (0.16 – 0.51)	0.66 (0.48 – 0.84)	- 580.03	1.61	0.20	5	1170.05	1182.92
E	-	-	1	- 572.82	13.40	0.00	4	1179.84	1190.14
Excessive Acquisition									
ACE	0.38 (- 0.31 – 1.00)	0.12 (- 0.52 – 0.78)	0.48 (0.31 – 0.65)	- 549.28	-	-	6	1110.56	1126.01
AE	**0.52 (0.35 – 0.68)**	**-**	**0.48 (0.31 – 0.64)**	**- 549.35**	**0.14**	**0.70**	**5**	**1108.70**	**1121.58**
CE	-	0.46 (0.25 – 0.60)	0.54 (0.40 – 0.75)	- 549.95	1.34	0.24	5	1109.91	1122.78
E	-	-	1	- 561.19	23.83	6.68	4	1130.39	1140.70
Clutter									
ACE	0.00 (0.00 – 0.00)	0.54 (0.40 – 0.68)	0.46 (0.32 – 0.60)	- 618.61	-	-	6	1249.22	1264.67
AE	0.56 (0.41 – 0.71)	-	0.44 (0.28 – 0.58)	- 620.85	4.48	0.03	5	1251.71	1264.58
CE	**-**	**0.54 (0.40 – 0.68)**	**0.46 (0.32 – 0.60)**	**- 618.61**	**2.27**	**1.00**	**5**	**1247.22**	**1260.10**
E	-	-	1	- 635.55	33.87	4.41	4	1279.10	1289.39

Table 3, based on the AIC values, the AE model appears to be the most appropriate for assessing the influence of genetic factors and specific environment on difficulty discarding and excessive acquisition. Specifically, additive genes contribute to approximately 0.43 and 0.52 of these variables, respectively. Additionally, the CE model provides a more parsimonious explanation for the contribution of genetics and environment in clutter, with the common environment component accounting for approximately 0.54 of this symptom. These findings suggest a potential association between genetics and difficulty discarding and excessive acquisition. The higher correlations observed in the monozygotic group compared to the dizygotic group indicate a possible

genetic influence on these variables. However, it is important to note that the intra-pair correlation analysis by itself cannot definitively establish a dominant genetic influence. Furthermore, the AIC and BIC values are noteworthy in determining the most appropriate models for assessing the impact of genetic factors and specific environments on these variables.

Discussion

To the best of our knowledge this study is the first one that estimates the heritability of hoarding symptoms among Iranian twins. Our results revealed a noteworthy genetic influence on difficulty discarding (heritability of 0.43) and excessive acquisition (heritability of 0.52), while common and specific environmental factors predominantly contributed to clutter. These findings offer valuable insights into these behaviors' potential genetic and environmental contributions.

Previous research indicated heritability estimates of 0.37 for difficulty discarding and 0.22 for excessive acquisition (19). Similarly, Nordsletten *et al*. reported heritability estimates of 0.45 and 0.49 for these traits (20). The present study's outcomes align with these results, revealing heritability estimates of 0.43 for difficulty discarding and 0.52 for excessive acquisition. These consistencies substantiate the current findings about analogous traits. The conformity between our study and previous research could be elucidated by considering the three fundamental principles of behavioral genetics, which assert the heritability of human behaviors, the prominence of genetic impact over common environment, and the multifaceted role of a specific environment. Worth noting is that the congruity across studies suggests limited cultural distinctions regarding difficulty discarding and excessive acquisition between the Iranian sample and other twin samples.

Our analysis favored the AE models as the most suitable explanation for difficulty discarding and excessive acquisition, attributing around 0.43 and 0.52, respectively, to additive genetic factors. Conversely, the CE model emerged as the most parsimonious for clarifying the genetic and environmental contributions to clutter, with the common environment accounting for approximately 0.54 of this symptom's variability. Regarding the distinction between the present study and previous results on the heritability of clutter (19), it is vital to acknowledge the study's limitations, including its predominantly female participant base, which might restrict generalizability to males. Moreover, slight age discrepancies in the MZ and DZ groups could impact the results. To enhance the robustness of these findings, further investigations encompassing more diverse samples are warranted.

While our study confirms prior research regarding difficulty discarding and excessive acquisition, it introduces innovative insights related to clutter. Significantly, our findings unveil, for the first time, that the CE (common and specific environment) model provides the optimal framework for elucidating gene-environment interactions in clutter. The outcomes emphasize the considerable influence of environmental factors on clutter, estimated at 0.54. This contrasts with earlier studies that emphasized genetic influences in clutter. The only investigation of clutter in a study by Mathews *et al*. suggested contributions of 0.20, 0.11, and 0.69 for additive genetic, specific environment, and common environment factors, respectively (19). In contrast, our study refrains from estimating genetic effects, highlighting instead that common and specific environmental factors contribute to 0.53 and 0.47 of clutter's variability, respectively.

Given the inconsistencies in our findings, several plausible explanations arise. First, clutter may not be an exclusive symptom of hoarding, as it is also associated with various psychological conditions such as psychosomatic symptoms, depression, anxiety, and stress (30,31). Our inability to control for these comorbidities within our sample may have amplified the influence of environmental factors on clutter. Additionally, prior research (19) suggests that the common environment plays a substantial role in the development of clutter, unlike other hoarding symptoms. This raises the possibility that clutter may not be an inherent feature of hoarding, as supported by previous studies (32).

Moreover, clutter may simply be a byproduct of difficulty discarding, a core symptom of hoarding, rather than an independent behavior with its own heritable traits (32). There is also evidence that parents often intervene in their children’s cluttering behaviors, further suggesting that the shared environment significantly influences this symptom (33,34). Lastly, research indicates that clutter is the only core symptom of hoarding that varies across different cultures (22), suggesting that it may not be a universal trait of the disorder.

Despite these findings, the limited number of studies exploring the genetic and environmental underpinnings of clutter warrants further research, particularly studies that control for other disorders within clinical hoarding samples. Interpretations of our findings should remain cautious, taking into account the characteristics of our sample.

Despite the three laws of behavioral genetics (35), we did not provide an estimate of the heritability of clutter in our study. One possible explanation for this omission is that the exclusion of additive genes from the model was motivated by the parsimony principle, rather than an indication that the phenotype is not heritable (36). It is important to note that this does not imply that clutter is not influenced by genetic factors but rather suggests that their impact may be limited. Nevertheless, given the scarcity of studies examining hoarding symptoms, further research is necessary to comprehensively understand the contribution of environmental and cultural factors to hoarding behavior and its symptoms.

Limitation

This study had a few limitations that should be considered. Firstly, the small sample size may limit the generalization of the findings to a larger population. Conducting similar studies with larger sample sizes would increase the statistical power and improve the external validity of the results. Moreover, the study focused on a twin sample, which may not accurately represent the broader population. Further research using non-twin samples is necessary to explore the relationship between hoarding symptoms and environmental factors in a more diverse sample. Additionally, the study did not account for the Equal Environment Assumption (EEA), which assumes that both monozygotic (MZ) and dizygotic (DZ) twin pairs are equally exposed to shared environmental factors. In reality, MZ pairs may experience more similar environments compared to DZ pairs. Future studies should consider the EEA hypothesis for a more comprehensive understanding of the factors contributing to hoarding. Lastly, the study used the E factor to measure environmental influences on hoarding behavior. However, it is essential to note that the E factor includes specific environmental factors and potential measurement errors, which may introduce some bias to the study's findings.

Conclusion

This study aimed to estimate the proportion of genetic and environmental factors contributing to hoarding symptoms. The findings suggest that genetic factors influence difficulty discarding and excessive acquisition, while the shared environment influences clutter. This study adds to the existing literature on the complex interplay between genetic and environmental factors about clutter, a symptom of hoarding disorder. By highlighting the significant role of the shared environment in the development of clutter, this study challenges the idea of clutter as a core symptom of hoarding. These findings have important implications for clinical practice and future research. However, it is essential to acknowledge that this study has limitations and cannot establish causality or determine the relative contributions of different factors to the development of hoarding symptoms. Future studies should explore alternative methodologies and investigate hoarding symptoms across diverse social backgrounds and cultural contexts to advance our understanding.

Acknowledgment

We would like to show our gratitude to the Parsi Twins Association for collaborating with us. We are also immensely grateful to all people who helped us conduct this study.

Conflict of Interest

None.

References

1. Mathes BM, Timpano KR, Raines AM, Schmidt NB. Attachment theory and hoarding disorder: A review and theoretical integration. Behaviour research and therapy. 2020;125:103549.
2. Timpano KR, Bainter SA, Goodman ZT, Tolin DF, Steketee G, Frost RO. A network analysis of hoarding symptoms, saving and acquiring motives, and comorbidity. Journal of obsessive-compulsive and related disorders. 2020;25:100520.
3. Vieira LS, Guastello A, Nguyen B, Nutley SK, Ordway A, Simpson H, et al. Identifying psychiatric and neurological comorbidities associated with hoarding disorder through network analysis. Journal of psychiatric research. 2022;156:16-24.
4. Zaboski II BA, Merritt OA, Schrack AP, Gayle C, Gonzalez M, Guerrero LA, et al. Hoarding: A meta-analysis of age of Zaboski BA, Merritt OA, Schrack AP, Gayle C, Gonzalez M, Guerrero LA, et al. Hoarding: A meta-analysis of age of onset. Depression and anxiety. 2019;36(6):552-64.
5. Dozier ME, Porter B, Ayers CR. Age of onset and progression of hoarding symptoms in older adults with hoarding disorder. Aging & mental health. 2016;20(7):736-42.
6. Vieira LS, Nguyen B, Nutley S, Mackin RS, Mathews CA. Comorbidity Patterns of Hoarding Disorder. Biological Psychiatry. 2021;89(9):S133-S4.
7. Williams MT, Brown TL, Sawyer B. Psychiatric comorbidity and hoarding symptoms in African Americans with obsessive-compulsive disorder. J Black Psychol. 2017;43(3):259-79.
8. Da Cunha GR, Martins CM, Pellizzaro M, Pettan-Brewer C, Biondo AW. Sociodemographic, income, and environmental characteristics of individuals displaying animal and object hoarding behavior in a major city in South Brazil: A cross-sectional study. Vet World. 2021;14(12):3111-8.
9. Chia K, Pasalich DS, Fassnacht DB, Ali K, Kyrios M, Maclean B, et al. Interpersonal attachment, early family environment, and trauma in hoarding: A systematic review. Clin Psychol Rev. 2021;90:102096.
10. Strom NI, Smit DJ, Silzer T, Iyegbe C, Burton CL, Pool R, et al. Meta-analysis of genome-wide association studies of hoarding symptoms in 27,651 individuals. Transl Psychiatry. 2022;12(1):479.
11. Burton CL, Park LS, Corfield EC, Forget-Dubois N, Dupuis A, Sinopoli VM, et al. Heritability of obsessive-compulsive trait dimensions in youth from the general population. Transl Psychiatry. 2018;8(1):191.
12. Iervolino AC, Perroud N, Fullana MA, Guipponi M, Cherkas L, Collier DA, et al. Prevalence and heritability of compulsive hoarding: a twin study. Am J Psychiatry. 2009;166(10):1156-61.
13. Ivanov VZ, Mataix-Cols D, Serlachius E, Lichtenstein P, Anckarsäter H, Chang Z, et al.

Prevalence, comorbidity and heritability of hoarding symptoms in adolescence: a population based twin study in 15-year olds. PloS one. 2013;8(7):e69140.
14. Ivanov VZ, Nordsletten A, Mataix-Cols D, Serlachius E, Lichtenstein P, Lundström S, et al. Heritability of hoarding symptoms across adolescence and young adulthood: A longitudinal twin study. PloS one. 2017;12(6):e0179541.
15. López-Solà C, Fontenelle LF, Alonso P, Cuadras D, Foley DL, Pantelis C, et al. Prevalence and heritability of obsessive-compulsive spectrum and anxiety disorder symptoms: A survey of the Australian Twin Registry. Am J Med Genet B Neuropsychiatr Genet. 2014;165b(4):314-25.
16. Mathews CA, Nievergelt CM, Azzam A, Garrido H, Chavira DA, Wessel J, et al. Heritability and clinical features of multigenerational families with obsessive-compulsive disorder and hoarding. Am J Med Genet B Neuropsychiatr Genet. 2007;144b(2):174-82.
17. Monzani B, Rijsdijk F, Harris J, Mataix-Cols D. The structure of genetic and environmental risk factors for dimensional representations of DSM-5 obsessive-compulsive spectrum disorders. JAMA psychiatry. 2014;71(2):182-9.
18. Zilhão NR, Smit DJ, Boomsma DI, Cath DC. Cross-Disorder Genetic Analysis of Tic Disorders, Obsessive-Compulsive, and Hoarding Symptoms. Front Psychiatry. 2016;7:120.
19. Mathews CA, Delucchi K, Cath D, Willemsen G, Boomsma D. Partitioning the etiology of hoarding and obsessive–compulsive symptoms. Psychol Med. 2014;44(13):2867-76.
20. Nordsletten AE, Monzani B, Fernández de la Cruz L, Iervolino AC, Fullana MA, Harris J, et al. Overlap and specificity of genetic and environmental influences on excessive acquisition and difficulties discarding possessions: Implications for hoarding disorder. Am J Med Genet B Neuropsychiatr Genet. 2013;162b(4):380-7.
21. Zia N. Exploration of Culture in Relation to Hoarding Disorder: What are the lived experiences of individuals that suffer from HD, and hoarding-related symptoms, between three of the largest racial demographics in the UK; Black, White and South Asian? : City, University of London; 2023.
22. Nordsletten AE, Fernandez de la Cruz L, Aluco E, Alonso P, López-Solà C, Menchón JM, et al. A transcultural study of hoarding disorder: Insights from the United Kingdom, Spain, Japan, and Brazil. Transcult Psychiatry. 2018;55(2):261-85.
23. Fernández de la Cruz L, E Nordsletten A, Mataix-Cols D. Ethnocultural aspects of hoarding disorder. Current Psychiatry Reviews. 2016;12(2):115-23.
24. Khorramdel K, Brahmand U, Abolghasemi A, Rashid S, Dashtianeh S, Zare S, et al. Etiology of Hoarding Disorder in Monozygotic and Dizygotic Twins: An Integrated Genetic, Environmental, and Behavioral Model. Internal Medicine Today. 2022;29(1):34-43.
25. Gharipour M, Haghjooy Javanmard S, Mansourian M, Sabri M, Khosravi E, Dianatkhah M, et al. Isfahan Twins Registry (ITR): An Invaluable Platform for Epidemiological and Epigenetic Studies: Design and Methodology of ITR. Twin Res Hum Genet. 2019;22(6):579-82.
26. Frost RO, Steketee G, Grisham J. Measurement of compulsive hoarding: saving inventory-revised. Behav Res Ther. 2004;42(10):1163-82.
27. Kellman-McFarlane K, Stewart B, Woody S, Ayers C, Dozier M, Frost RO, et al. Saving inventory–Revised: Psychometric performance across the lifespan. J Affect Disord. 2019;252:358-64.
28. Mohammadzadeh A. Validation of Saving Inventory-Revised (SI-R): compulsive hoarding measure. Iranian Journal of Psychiatry and Clinical Psychology. 2009;15(1):33-41.
29. Moser JS, Slane JD, Alexandra Burt S, Klump KL. Etiologic relationships between anxiety and dimensions of maladaptive perfectionism in young adult female twins. Depress Anxiety. 2012;29(1):47-53.
30. Icht M, Zukerman G, Zigdon A, Korn L. There is more to cluttering than meets the eye: The prevalence of cluttering and association with psychological well-being indices in an undergraduate sample. Int J Lang Commun Disord. 2023;58(6):2022-32.
31. Coles ME, Frost RO, Heimberg RG, Steketee G. Hoarding behaviors in a large college sample. Behav Res Ther. 2003;41(2):179-94.
32. Ivanov VZ, Mataix-Cols D, Serlachius E, Brander G, Elmquist A, Enander J, et al. The developmental origins of hoarding disorder in adolescence: a longitudinal clinical interview study following an epidemiological survey. Eur Child Adolesc Psychiatry. 2021;30:415-25.
33. Plimpton EH, Frost RO, Abbey BC, Dorer W. Compulsive hoarding in children: six case studies. Int J Cogn Ther. 2009;2(1):88-104.
34. Storch EA, Lack CW, Merlo LJ, Geffken GR, Jacob ML, Murphy TK, et al. Clinical features of children and adolescents with obsessive-compulsive disorder and hoarding symptoms. Compr Psychiatry. 2007;48(4):313-8.
35. Turkheimer E. Three laws of behavior genetics and what they mean. Curr Dir Psychol Sci. 2000;9(5):160-4.
36. Everitt BS, Howell DC. Encyclopedia of Statistics in Behavioral Science–Volume 2: John Wiley & Sons, Ltd; 2021.