

# Age-Specific Prevalence of Hoarding and Obsessive Compulsive Disorder: A Population-Based Study

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**Objective:** Little is known about the age-specific prevalence of hoarding and obsessive compulsive symptoms (OCS), particularly in older age groups. The objectives of this study were to estimate the age-specific prevalence, severity, and relationships between hoarding and OCS in males and females using a large population-based sample. **Methods:** We assessed the age-specific prevalence rates of hoarding disorder (HD) and OC disorder (OCD) in males and females (at various age ranges between 15 and 97 years) from the Netherlands Twins Register ( $N = 15,194$ ). Provisional HD and OCD diagnoses were made according to Diagnostic and Statistical Manual of Mental Health Disorders, 5th Edition, criteria using self-report measures. We also assessed hoarding and OCS severity in the various age groups and explored specific hoarding and OCS patterns (e.g., difficulty discarding, excessive acquisition, clutter, checking, washing, perfectionism, and obsessions) with age. **Results:** Prevalence of provisional HD diagnoses (2.12%) increased linearly by 20% with every 5 years of age ( $z = 13.8, p < 0.0001$ ) and did not differ between males and females. Provisional OCD diagnoses were most common in younger individuals and in individuals over age 65. Co-occurring OCD increased hoarding symptom severity (coefficient: 4.5; SE: 0.2; 95% CI: 4.1–4.9;  $t = 22.0, p < 0.0001$ ). Difficulty discarding for HD and checking behaviors for OCD appeared to drive most increases in these diagnoses in older ages. **Conclusion:** Increased prevalence and severity of HD with age appears to be primarily driven by difficulties with discarding. Increases in OCD prevalence with older age were unexpected and of potential clinical relevance. (Am J Geriatr Psychiatry 2017; 25:245–255)

**Key Words:** Hoarding disorder, obsessive compulsive disorder, discarding, prevalence, age

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## INTRODUCTION

Pathologic hoarding is defined as the acquisition of and persistent difficulty in parting with possessions, leading to excessive clutter, distress, and functional impairment. Pathologic hoarding occurs both independently and in conjunction with many neuropsychiatric disorders, including dementia, schizophrenia, obsessive compulsive disorder (OCD), and autism. Until recently, hoarding was typically classified as a symptom of either OCD or OC personality disorder.<sup>1-3</sup> In 2013 the *Diagnostic and Statistical Manual of Mental Health Disorders, 5th Edition* (DSM-5), named hoarding disorder (HD) as a distinct clinical syndrome within the OCD and related disorders category.<sup>4</sup> This change was informed by over a decade of accelerated research efforts examining pathologic hoarding behaviors, indicating that hoarding behavior is only present in about 20% of individuals with clinically significant OC symptoms (OCS) and that, conversely, around 83% of individuals with clinically significant hoarding symptoms do not present with clinically significant OCS.<sup>3,5-8</sup> These data suggest that individuals with OCD and hoarding may represent only a fraction of the total population suffering from HD.<sup>1</sup>

Although HD appears to be a chronic progressive disorder, little is known about its course and prevalence across the lifespan.<sup>9</sup> Expert consensus reports a population prevalence of HD between 2% and 6%.<sup>4,10-12</sup> The wide range of published prevalence estimates (1.5%–14%)<sup>5,13-21</sup> and the typically lower reported prevalence in studies of children and adolescents<sup>17,22</sup> underscore the need for additional work on the course of HD with aging. Previous retrospective studies suggest that hoarding symptoms begin during childhood and adolescence<sup>9,23</sup> and increase in severity throughout life. Up to 70% of adults who hoard report that their symptoms began before age 20, with a mean onset at age 12.<sup>11,24</sup> In populations over age 55, the prevalence of clinically impairing hoarding is over 6%, significantly higher than the general population prevalence (estimated at 2%–4%).<sup>25</sup> In clinical samples, hoarding severity increases with age, supporting the hypothesis that increased HD prevalence in older populations may be due to a progression of symptoms across the lifespan.<sup>9,26-29</sup> In fact, in older adults, HD is often conceptualized as a form of self-neglect or even elder

self-abuse, speaking to the clear impairment that hoarding behaviors cause among older adults.<sup>30,31</sup> Prolonged delay (at least a decade) often occurs between the onset of symptoms and the recognition of hoarding as a problem, complicating efforts to characterize the course of HD over the lifespan.<sup>9</sup>

Although pathologic hoarding affects both sexes, epidemiologic studies vary in findings on the prevalence of sex differences.<sup>10-12,17</sup> Some studies have found increased rates of hoarding among males,<sup>5,11,12,30</sup> whereas others report higher rates among females<sup>17</sup> or no sex differences.<sup>7,10</sup> This variability may be partly the result of whether the study sample was clinical or epidemiologic in nature, because females are more likely to present for clinical care. Moreover, until recently, most studies encompassed individuals with OCD as the primary diagnoses and hoarding as a secondary symptom, and only recently have prevalence rates of HD across sexes have been studied.

In OCD, most longitudinal studies have reported on clinical cohorts,<sup>32-35</sup> although one population-based longitudinal cohort study has been performed in adults,<sup>36</sup> with follow-up periods ranging between 3 and 40 years. Some of these studies suggest that OCD has a relatively stable and chronic course, whereas others report more favorable outcomes with age.<sup>32-35</sup> However, it should be noted that age at follow-up did not exceed 60 years (with the exception of the naturalistic follow-up study by Skoog and Skoog).<sup>32</sup> Only one large-scale epidemiologic study examining OCD prevalence in individuals over age 60 has been conducted to date, to the best of our knowledge.<sup>37</sup> This study showed lower rates of OCD and OCS among individuals age 65 and older compared with younger individuals but has not yet been replicated. Previous studies in the Netherland Twin Register have found equally distributed clinically significant OCS among males and females,<sup>5,6</sup> and the DSM-5 also notes no sex differences in OCD prevalence rates, although age at onset can differ by sex.<sup>4</sup> However, as with HD, few studies examine the prevalence of OCD in older ages and potential differences in prevalence in the older age groups in males and females. Thus, one aim of the current study is to replicate and extend previous cohort studies with data on OCS in old age groups.

There is evidence, despite the separation of HD into a distinct disorder from OCD, of an etiologic overlap between HD and OCD, with genetic correlations

between hoarding and OCS in twin-family studies varying between 0.1 and 0.4.<sup>2,3,5,6,38</sup> Although the severity of self-reported hoarding symptoms is similar for those with and without OCD, the presence of hoarding appears to increase the clinician-rated severity of OCS in subjects with OCD.<sup>38</sup> Moreover, individuals with OCD and hoarding symptoms also have higher rates of comorbid anxiety, although not necessarily greater hoarding symptom severity.<sup>3,39–41</sup> Further, small clinical studies suggest that the course and outcome of HD + OCD may be more unfavorable than for HD alone.<sup>3,42</sup> Better understanding of the age-specific relationship between hoarding and OCS is a first step in developing appropriate screening and intervention approaches for at-risk individuals.

Thus, the aims of this study were to extend the previous work to describe the prevalence and severity, by age and sex, of hoarding and OCS in a large epidemiologic population-based sample, the Netherlands Twin Register (NTR). We hypothesized that (1) HD prevalence and hoarding symptom severity would increase with age in both males and females, whereas OCS prevalence and severity would remain stable or even be lower in older age groups of both males and females; (2) comorbid OCD + HD would be associated with greater OCS severity; and (3) based on the younger age at onset of OCS compared with hoarding symptoms, the stabilization of OCS in older age groups, and the data from the previous population-based study,<sup>37</sup> rates of co-occurring hoarding and OCS would be highest in younger age groups.

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## METHODS

### Participants

Participants were adults in the NTR, an epidemiologic (population-based) sample of adults that includes twin pairs and extended family (spouses, parents, children, and siblings) who had data available for hoarding and OCS.<sup>5</sup> This sample, which is representative of the larger population of the Netherlands, has been thoroughly described previously; for example, see Willemsen et al.<sup>43</sup> Participants were recruited through city councils and the media, and participants in the NTR have been shown to be representative of the Dutch population as a whole.<sup>43</sup>

Data were drawn from the eighth wave of surveys (collected between 2009 and 2012), which were mailed to all twins over age 18 and their family members.<sup>43,44</sup> Individuals in the NTR were similar across age groups with regard to response rates, educational attainment, urbanization, work, and financial stress.<sup>44</sup> Of the 47,122 individuals invited to participate in Wave 8, we estimate that approximately 19.5% did not receive the invitation because of incorrect address information, based on follow-up of participants over the past years. Of the 37,934 who received the invitation, 45% returned the survey. Previous research suggests little to no bias in the sample, as differences between responders and nonresponders are small with respect to lifestyle, personality, and mental health questionnaires in the NTR.<sup>45</sup> In all, 15,194 participants who completed one or both of the OCS and hoarding scales were included in the present analyses. Ethical approval for the study was obtained from the Medical Ethical Committee of the VU University Medical Center.

## Measures

### Hoarding Symptoms

Hoarding symptoms were assessed using a modified Hoarding Rating Scale–Self-Report (HRS-SR), which contains five questions assessing difficulty discarding, excessive acquisition, clutter, emotional distress, and impairment related to hoarding.<sup>46</sup> The HRS-SR has been thoroughly tested in hoarding and nonhoarding populations, has good internal consistency, shows high correlations with standardized hoarding interviews ( $r = 0.74–0.92$ ), has 73% agreement between interview and self-report, has excellent sensitivity and specificity, and has good convergent and discriminant validity.<sup>14,17,24</sup> It was designed to reflect the DSM-5 criteria of difficulty discarding, resulting clutter, excessive acquisition (a DSM-5 specifier rather than a core feature of HD),<sup>4</sup> impairment, and emotional distress.<sup>17,24</sup> Because of restrictions in the number of items approved for inclusion in the larger 20-page NTR participant questionnaire, the emotional distress item was excluded. Otherwise, the measure items and 0–8 rating scale were included in full.<sup>24</sup> Our previous work in this population suggests that this abbreviated version of the HRS-SR has excellent performance in this epidemiologic sample.<sup>5</sup>

*Obsessive Compulsive Symptoms*

OCS were assessed using the Padua Inventory-Revised Abbreviated (PI-R ABBR),<sup>47</sup> a 12-item questionnaire derived from the 41-item Padua Inventory, containing two to three items from each of five OCS dimensions (checking, impulses, precision, rumination, and washing),<sup>47</sup> with item responses given on a 0–4 scale. For specific details of the PI-R ABBR and HRS-SR, as well as item categorizations, see Mathews et al.<sup>5</sup> Briefly, The PI-R ABBR has been investigated and tested in both epidemiologic (NTR) and clinical samples<sup>47,48</sup> and shows good internal consistency (Cronbach  $\alpha = 0.73$ ). Receiver operating characteristic analyses showed that the area under the curve for the PI-R ABBR was 0.78 (95% confidence interval [CI]: 0.73–0.83) in OCD patients when compared with clinical control subjects and 0.93 for OCD patients compared with population control subjects (95% CI: 0.90–0.95). At the best cut-off point of 16, the sensitivity of the PI-ABBR was 0.74, with a specificity of 0.72, when compared with clinical control subjects.<sup>47,48</sup>

*Derivation of HD and OCD Diagnoses*

The HRS-SR and PI-R ABBR were used to derive HD and OCD diagnoses. HD was defined based on DSM-5 criteria<sup>4</sup> as a score of 4 or more (moderate or greater symptomatology) on each of three hoarding-specific questions: difficulty discarding, excessive clutter, and impairment related to hoarding. These cut-offs have been previously shown to represent clinically significant symptomatology<sup>49,50</sup> and are commonly used as proxies for DSM-5 criteria<sup>4</sup> in hoarding research.<sup>5,17,45,46</sup> We excluded the excessive acquisition item from the final definition of HD, because excessive acquisition is included as a specifier rather than a core component of

the DSM-5 definition of HD.<sup>4</sup> Secondary analyses indicated that inclusion of the acquisition specifier did not change the outcome of analyses (data not shown).

Because the PI-R ABBR does not directly allow for derivation of DSM-5–based criteria,<sup>4</sup> OCD was defined as a total PI-R ABBR score  $\geq 16$ , as previously reported based on receiver operating characteristic curve analyses in a clinical sample.<sup>5,47</sup> Note that diagnoses of HD and OCD are provisional because they are based on self-report rather than on clinical interview and are designated as such throughout this article. Based on previous work by Cath et al.,<sup>47</sup> we also generated five OCD symptom categories: checking, impulses, precision, rumination, and washing (Table 1). Although included in the total severity score used to generate the cut-off score for provisional OCD, two items that appear to assess general anxiety (item 6: “When I start thinking of certain things, I become obsessed with them”) or attention problems (item 9: “My thoughts constantly go astray, therefore I find it difficult to attend to what is happening around me”) rather than being specific to the diagnosis of OCD were excluded from the creation of symptom categories. These symptom categories roughly correspond to the categories generated by an item-level factor analysis conducted by our group in 1,400 individuals with OCD that includes contamination/cleaning (PI-R ABBR Washing), “taboo” (aggressive/sexual/religious) obsessions (PI-R ABBR Impulses), doubts (PI-R ABBR Ruminations), ordering/symmetry (PI-R ABBR Precision), and superstitions/rituals (PI-R ABBR Checking).<sup>51</sup>

**Analyses**

Analyses were conducted in Stata IC version 11.2 (StataCorp, College Station, TX, USA). Primary outcome

**TABLE 1. PI-R ABBR and Corresponding Symptom Categories**

Symptom Category	Item
Washing	I sometimes have to wash or clean myself simply because I think I may be dirty or “contaminated.”
Washing	I touch something which I think is “contaminated,” I immediately have to wash or clean myself.
Precision	I feel I have to repeat certain numbers for no reason.
Checking	I check and recheck gas and water taps and light switches after turning them off.
Precision	I feel obliged to follow a particular order in dressing, undressing, and washing myself.
Checking	I return home to check doors, windows, drawers, etc. to make sure they are properly shut.
Impulses	When I see a train approaching I sometimes think I could throw myself under its wheels.
Impulses	I get upset and worried at the sight of knives, daggers, and other pointed objects.
Rumination	In certain situations, I am afraid of losing my self-control and doing embarrassing things.
Rumination	Unpleasant thoughts come into my mind against my will and I cannot get rid of them.

variables included provisional HD and OCD diagnoses, hoarding symptom severity (total HRS-SR score), and OCS severity (total PI-R ABBR score). Patterns of hoarding and OCS across age groups were examined graphically in the entire sample as well as by sex. Although age was analyzed as a continuous variable, for clarity, figures show age in 5-year increments from 15 to 70. Few participants were located at the extremes of age distribution, so individuals younger than 15 years were excluded from the analyses, and individuals older than 70 years were included as one group.

We conducted logistic regression to examine the relationship of disorder prevalence (provisional HD and provisional OCD) by age. We adjusted for family relationships using the robust cluster option. We examined the relationship of hoarding and OCS severity to age using linear regressions, again adjusting for family relationships using the robust cluster option. Males and females were analyzed separately in all analyses. To assess potential bias introduced by family relatedness, particularly the presence of twin pairs, we repeated these analyses using one randomly selected individual per family (sensitivity analyses). Because the results of the sensitivity analyses were highly similar to the primary findings, although the CIs were wider because of the reduction in sample size, data for the sensitivity analyses are not presented in the text.

Finally, to further investigate observed associations between age and HD/OCS, we conducted secondary exploratory analyses to determine which of the HD and OCD individual symptom groups (e.g., discarding, acquiring, clutter, washing, checking, precision, impulses) showed the most significant change with age. For phenotypes where the relationship between prevalence and age was not linear, age-squared and, as needed, age-cubed variables were constructed and included in the analysis. For categorical outcomes, relationships were expressed as odds ratios (ORs). For linear outcomes,  $\beta$  coefficients are presented.

## RESULTS

### Demographic Characteristics

The sample ( $N = 15,194$ ) consisted of 5,480 males (36%) and 9,714 females (64%), aged 15–97. Fifty

TABLE 2. Age and Sex Distribution of Participants

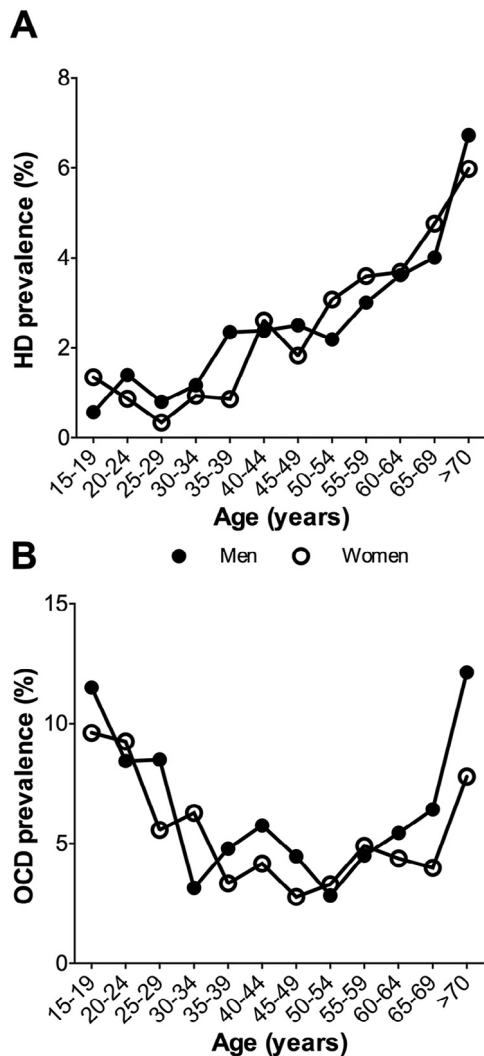
Age Group	Number of Males (% of age group)	Number of Females (% of age group)	Total Number in Age Group (% of total sample)
15–19	524 (32)	1,113 (68)	1,637 (16)
20–24	572 (33)	1,150 (67)	1,722 (11)
25–29	250 (30)	588 (70)	838 (5.5)
30–34	516 (32)	1,076 (68)	1,592 (10)
35–39	605 (37)	1,051 (63)	1,656 (11)
40–44	290 (29)	698 (71)	988 (6.5)
45–49	450 (30)	1,047 (70)	1,497 (10)
50–54	644 (38)	1,054 (62)	1,698 (11)
55–59	574 (43)	763 (57)	1,337 (9)
60–64	566 (47)	631 (53)	1,197 (8)
65–69	279 (35)	301 (65)	580 (4)
>70	210 (46)	242 (54)	452 (3)
Total	5,480 (36)	9,714 (64)	15,194 (100)

percent of the sample was composed of siblings, 11% of the sample were only-children (singletons), 33% of the sample were parents of these individuals, 5% were spouses of these individuals, and 1% were offspring of the siblings or singletons. There was a relatively even distribution of individuals across age groups, with each 5-year group representing approximately 5%–10% of the sample, although each of the two oldest age groups comprised fewer than 5% of the participants (Table 2). The roughly 2:3 sex ratio of males to females was relatively stable across the younger age groups; in the older age groups, the sex ratio more closely approximated 1:1 (Table 2).

### Rates of Provisional HD and OCD by Age and Sex

The overall prevalence of provisional HD in this sample was 2.12%, and rose by 3.7% with every year of age, or about 20% for every 5 years of age (OR: 1.037; robust standard error [SE]: 0.003;  $z = 9.69$ ,  $p < 0.0001$ ). The results were similar for males and females. In males, the overall prevalence of provisional HD was 2.34% and in females 2.00% ( $\chi^2 = 1.89$ ,  $p = 0.17$ ). Males showed a 3.4% increase in prevalence rate with each year of age (OR: 1.034; robust SE: 0.006;  $z = 5.60$ ,  $p < 0.0001$ ), whereas females showed a 3.9% increase (OR: 1.039; robust SE: 0.005;  $z = 7.80$ ,  $p < 0.0001$ ). Although there were small differences in provisional HD prevalence rates between males and females in some age groups, these differences were not significant, and there were no significant interactions between sex and age with provisional HD prevalence (data not shown).

**FIGURE 1.** [A] Percent of individuals with provisional HD in each age group. [B] Percent of individuals with provisional OCD in each age group. As noted in the text, there are no statistically significant differences in rates of provisional HD between males and females by age group. The same is true for provisional OCD for each individual age group, although the overall differences in prevalence by sex across all age groups are statistically significant.



The overall trend was for a linear relationship between age and provisional HD prevalence, beginning in the third decade (see Figure 2A).

The overall prevalence of provisional OCD was 5.7%. The relationship of provisional OCD and age was not linear; as demonstrated in Figure 1, both younger in-

dividuals and much older individuals had higher prevalence rates than did individuals in middle age. There were no significant differences between males, who had an overall prevalence of 6.02%, and females, who had an overall prevalence of 5.52% ( $\chi^2 = 1.61$ ,  $p = 0.21$ ). There was significant interaction between sex and age with provisional OCD prevalence, with females having lower prevalence rates with increasing age compared with males (OR: 0.99; robust SE: 0.005;  $z = -2.14$ ,  $p = 0.032$ ). As can be seen in Figure 1B, most of this difference is accounted for by sex-specific differences in prevalence at the older age ranges (e.g., ages 65 and older).

The same trends were seen with global symptom severity across ages. Hoarding severity increased with increasing age, particularly after age 35 (B coefficient: 0.07; robust SE: 0.005;  $t = 14.5$ ,  $p < 0.0001$ ) (Figure 2A). There were significant relationships between sex and hoarding severity (B coefficient: 1.18; robust SE: 0.27;  $t = 4.42$ ,  $p < 0.0001$ ) and between sex, hoarding severity, and age (B coefficient:  $-0.04$ ; robust SE: 0.006;  $t = -7.02$ ,  $p < 0.0001$ ). Although males and females in the younger age ranges had similar hoarding severity scores, males in the older ages had progressively higher severity scores than did females (Figure 2A). As with prevalence of provisional OCD, OCS severity and age showed a U-shaped relationship, with no statistically significant differences between sexes (Figure 2B).

### Relationship between Individual Hoarding and OCS Types and Age

Because we found age-specific patterns for provisional HD and OCD prevalence rates, we next explored the relationship between age and specific symptom types of HD (i.e., excessive acquisition, clutter, and difficulty discarding) and OCD (i.e., precision, rumination, impulses, washing, and checking). As can be seen in Figure 3, the mean severity of all hoarding symptoms increased somewhat across the age groups; however, the overall increase in HRS-SR scores was driven primarily by difficulty discarding, which increased most sharply with age compared with the other symptom dimensions (Figure 3A). The severity of individual OCS types remained constant across age, with the exception of checking severity, which increased primarily among individuals over age 60 (Figure 3B).

FIGURE 2. [A] Total hoarding symptom severity by age. [B] Total OCS severity by age.

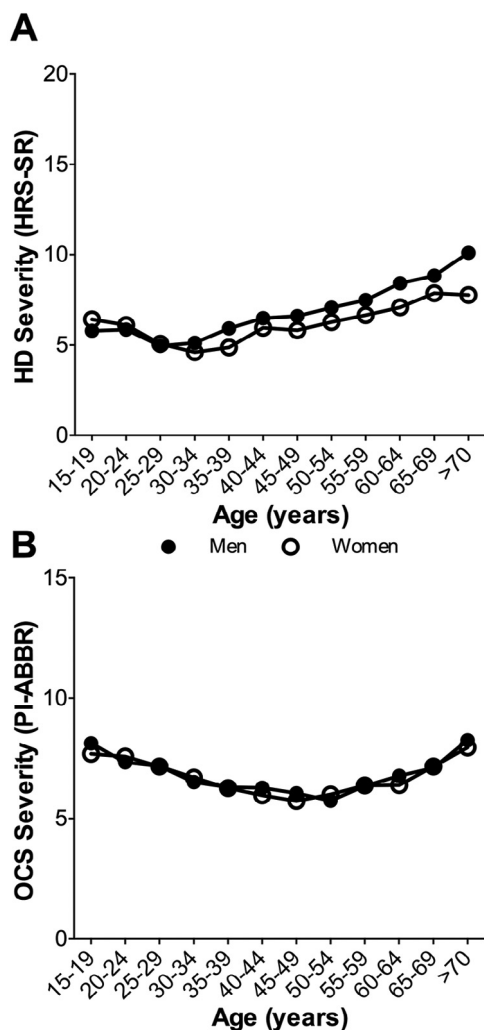
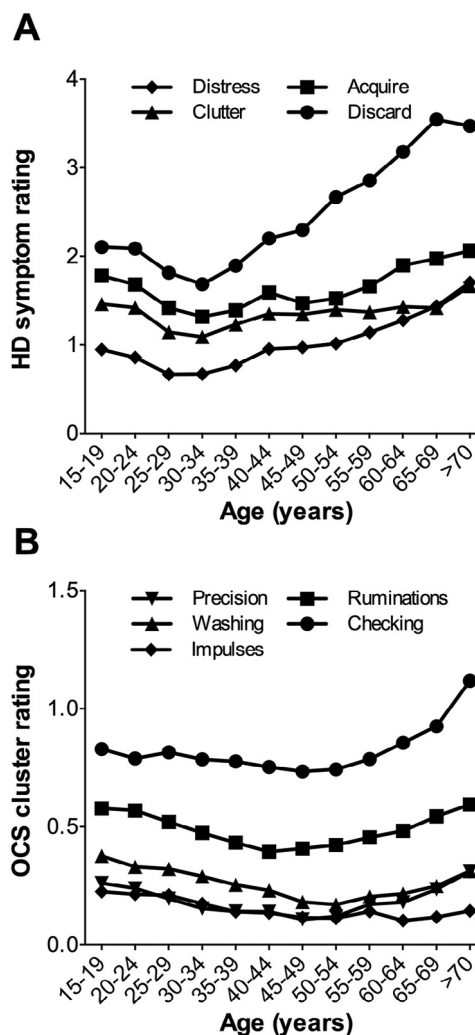


FIGURE 3. Distribution of individual symptom severity scores by age group. [A] Hoarding symptoms. [B] OCS.



**Co-Occurring Provisional OCD and HD**

Although quite low compared with rates of provisional HD alone and provisional OCD alone, there was a significant over-representation of provisional HD + OCD over expected rates based on the prevalence of each disorder within the sample (e.g., expected rate of provisional HD + OCD:  $2.12\% \times 5.70\% = 0.12\%$ ). Specifically, 0.4% of individuals in this sample met criteria for provisional HD + OCD, nearly four times higher than the predicted rate of 0.12% ( $\chi^2 = 117.2$ ,  $p < 0.0001$ ). Contrary to our hypothesis, the rates of provisional HD + OCD were not increased in younger age

cohorts. Instead, rates of provisional HD + OCD were significantly increased among older individuals (2.5% increase per year,  $z = 3.03$ ,  $p = 0.002$ ). Females were less likely to have provisional HD + OCD than males (0.28% versus 0.65%; OR: 0.47;  $z = -2.87$ ,  $p = 0.004$ ), but there was no interaction between age and sex. Finally, as hypothesized, co-occurring provisional OCD significantly increased the overall severity of reported hoarding symptoms (B coefficient: 4.5; SE: 0.2; 95% CI: 4.1–4.9;  $z = 22.0$ ,  $p < 0.0001$ ). Similarly, co-occurring provisional HD increased the overall severity of reported OCS

(B coefficient: 3.6; SE: 0.4; 95% CI: 2.9–4.3;  $z = 9.91$ ,  $p < 0.0001$ ).

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## DISCUSSION

To our knowledge, this is the first study to examine the age-specific prevalence and severity of problematic hoarding in conjunction with OCS within a large, population-based sample. These data are of particular interest as, to our knowledge, currently no studies are available that have addressed age-specific prevalence and severity of hoarding symptoms in individuals older than age 60 and only one examining OCS.<sup>37</sup> As previously observed in clinical samples, in this population-based sample, provisional HD rates increased linearly with age for both males and females (approximately 20% with every 5-year increment in age, beginning in the third decade), reaching a prevalence of more than 6% in individuals over age 70. Severity of hoarding symptoms also progressively increased with age. Although all hoarding symptoms contributed somewhat to this trend, difficulty discarding drove the increase most strongly in older age groups. This finding aligns with the DSM-5,<sup>4</sup> where difficulty discarding is defined as a core feature of HD, whereas clutter is defined as a consequence of difficulty discarding and excessive acquisition as a specifier that occurs in some, but not all, individuals with HD.

Although we cannot determine the relative contributions of excessive acquisition to the development of provisional HD in a longitudinal fashion, the results of our analysis did not change when excessive acquisition was added to our definition of provisional HD. Although previous work has indicated that this symptom is an important feature of HD for some individuals and highly related to the other HD symptoms, these results do support the idea that difficulty discarding is the core contributor to HD and is primarily responsible for increasing rates of problematic hoarding in older individuals. Whether increased difficulty discarding represents a function of age-related cognitive decline and, as a result, a worsening of premorbid executive function deficits, particularly visual memory and categorization, known to play a role in HD,<sup>52–54</sup> potentially combined with an abundance of loss experiences<sup>26</sup> or, alternatively, a hypersensitivity to loss experiences that HD subjects experience with age are issues that we cannot address in this study. Other pos-

sible explanations for the increased prevalence with age, such as living on a fixed income or living through financial hardships, seem to be less likely because there is no evidence from the literature of any relationship between employment status and hoarding behavior (although there is evidence of increased debt because of hoarding behaviors).<sup>15</sup> However, all these possible explanations require further testing.

Our findings have two clinically relevant implications. First, older adults are at particularly high risk for HD, and as has been seen in previous studies, prevalence rates approach 6% in individuals over age 60 and exceed 6% in individuals over age 70.<sup>25</sup> This is of particular relevance as interventions for HD tailored to older adults have been developed and shown to be effective.<sup>55</sup> Second, hoarding symptoms may be mitigated in older adults by identifying and treating at-risk individuals, perhaps identified on the basis of family history, given the heritable nature of HD.<sup>5,6,17,56</sup> Thus, in older individuals, one should particularly focus on identifying problems with discarding items and combine the treatment as usual with interventions that may be specific to the aging brain. For example, Ayers et al.<sup>57</sup> found that incorporating cognitive rehabilitation techniques focused on improving executive function significantly improved hoarding outcomes in older adults.<sup>55</sup> Such approaches, when implemented earlier in life, may help to decrease disorganization, restore deficits in inhibition, and improve outcomes later in life.

Unlike previous studies, we did not find sex differences in rates of provisional HD in this sample and did not find excessive rates of acquisition in females compared with males.<sup>4</sup> However, we did find sex differences in hoarding severity across age, with males showing higher hoarding severity in the older age groups than females. This is in line with our previous work in this sample using a severity cut-off score (modified HRS-SR score  $\geq 17$ )<sup>5</sup> instead of DSM-based definitions of HD. In our previous work, men over age 45 showed higher rates of hoarding using the severity cut-off criteria than did women.<sup>5</sup> This suggests that although hoarding symptom severity may be slightly higher in older men than in older women, this difference is not enough to impact sex-specific prevalence rates in these age groups.

As expected, we found higher rates of provisional OCD among the youngest individuals; although contrary to expectation, we also found higher rates of



provisional OCD among the oldest individuals. For most OCS types, severity of symptoms was lower in individuals older than ages 20–29 than in the younger age groups, suggesting that OCS may improve with age. However, OCS severity increased again, although less dramatically, in individuals older than age 60. Although most symptom types remained fairly stable, checking symptoms showed a dramatic increase among older individuals. The previously published population-based study examining OCD rates in older adults suggested no increase in overall rates among older compared with younger adults.<sup>37</sup> However, this study also found an association between OCS and lower verbal IQ and lower verbal fluency, which was not accounted for by education or estimated IQ,<sup>37</sup> suggesting that in older individuals decline in cognitive functions might be associated with OCSs. When extrapolated to our findings of increased checking behaviors but not other types of OCSs among older adults, this suggests that the increase in checking behavior may represent a compensatory behavior that is potentially associated with age-related cognitive decline rather than representing a primary OCD diagnosis. However, because we have no longitudinal data to investigate this, this hypothesis requires further testing.

The rates of provisional HD + OCD were higher than expected in the entire sample, based on HD and OCD prevalence rates alone, although they were still lower than some previous reports in OCD clinical samples.<sup>8,58</sup> These findings support the previous work demonstrating etiologic and clinical overlap between OCD and HD.<sup>5,12,17,21,56</sup> However, contrary to our hypothesis, we did not see an increase in rates of provisional HD + OCD in younger individuals compared with older individuals and did not see sex differences in the rates of provisional HD + OCD. These findings are fully in line with previous studies suggesting that although this comorbidity is increased over what would be expected based on population rates, most individuals with problematic hoarding do not have co-occurring OCD.<sup>1</sup> Although we did see an increase in OCS severity, as expected, with comorbid HD, we also saw an increase in hoarding symptom severity with comorbid OCD, in contrast to the previous literature.<sup>3,38–41</sup> Although these findings may be simply attributable to overall increased symptom burden, they also have potential clinical relevance, because severity of illness is associated with poorer functional outcomes in both disorders.<sup>59–61</sup>

This study has some limitations. This cross-sectional study describes the age-specific prevalence of hoarding symptoms and OCS. Such a methodologic approach does not allow for direct, longitudinal assessment of symptoms over the lifespan but relies on inference of the relationship between aging and prevalence. Second, HD and OCD diagnoses were derived from self-report measures, rather than clinical assessments, and must thus be considered provisional. Although the rates of provisional HD are in line with previously reported prevalence rates,<sup>4,10–12</sup> the rates of provisional OCD were somewhat higher than previous reports,<sup>62–66</sup> suggesting that our definition of provisional OCD may also be capturing individuals with subclinical OCD in addition to those who meet full DSM-5 criteria.<sup>4</sup> Third, the study does not include information on cognitive status, life events, or other psychiatric diagnoses, limiting further exploration of age effects on specific symptomatology and on possible causes of these symptoms. However, these limitations are mitigated by several strengths. This is the largest study reported to date examining hoarding symptoms, with over 15,000 participants of both sexes and wide range of ages. The population-based sample minimizes the problem of ascertainment bias, thus providing a more accurate assessment of the co-occurrence of OC and hoarding symptoms than might be found in clinical case series.

In summary, these results provide further evidence that the prevalence and severity of problematic hoarding increase with age, beginning around ages 30–35, with the highest prevalence rates seen among individuals over age 65. Previously reported sex differences in hoarding were not seen in our sample and may be better explained by differences in ascertainment strategies across studies (e.g., clinical versus population-based samples). Although males may be more likely to report hoarding symptoms than females, they are no more likely to meet diagnostic criteria for HD. As previously reported,<sup>67</sup> co-occurring OCD increases the severity of hoarding symptoms and vice versa. These findings have implications for improving the utility of screening and treatment for older individuals who are at risk for HD or who are demonstrating symptoms. Similarly, older adults who are exhibiting increased checking symptoms should be carefully assessed for the presence of other OCSs, and cognitive testing should be considered (although it is noted that this area requires further research).

## Age-Specific Prevalence of Hoarding and OCD

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