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Cognitive impairment in hoarding disorder: a systematic review

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Review

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Abstract

Objective. In the present study, we aimed to perform a systematic review evaluating the cognitive performance of patients with hoarding disorder (HD) compared with controls. We hypothesized that HD patients would present greater cognitive impairment than controls.
Methods. A systematic search of the literature using the electronic databases MEDLINE, SCOPUS, and LILACS was conducted on May 2020, with no date limit. The search terms were "hoarding disorder," "cognition," "neuropsychology," "cognitive impairment," and "cognitive deficit." We included original studies assessing cognitive functioning in patients with HD.
Results. We retrieved 197 studies initially. Of those, 22 studies were included in the present study. We evaluated 1757 patients who were 41 to 72 years old. All selected studies comprised case–control studies and presented fair quality. Contrary to our hypothesis, HD patients showed impairment only in categorization skills in comparison with controls, particularly at confidence to complete categorization tasks. Regarding attention, episodic memory, working memory, information-processing speed, planning, decision-making, inhibitory control, mental flexibility, language, and visuospatial ability, HD patients did not show impairment when compared with controls. There is a paucity of studies on social cognition in HD patients, although they may show deficits. The impact of emotion in cognition is also understudied in HD patients.
Conclusion. Except for categorization skills, the cognitive performance in HD patients does not seem to be impaired when compared with that in controls. Further work is needed to explore social cognition and the impact of emotion in cognitive performance in HD patients.

Clinical Implications

- All included studies evaluating cognition in HD patients presented fair quality.
- Patients with HD showed impairment only in categorization skills.
- Patients with HD may show deficits in social cognition, and further work on this theme is warranted.
- Different tests were used to assess cognitive domains and subdomains, and data regarding information on comorbidities, medication use, and global cognitive efficiency were mostly unavailable.

Introduction

Saving and collecting possessions might be conceptualized along a continuum of common and adaptive habits to pathological and maladaptive behavior.[1,2] Hoarding disorder (HD) is defined as a persistent difficulty in discarding items regardless of value, urges to save items and distress associated with discarding, and the accumulation of possessions which compromise use of the home.[2,3] Epidemiological studies suggest HD to affect around 2.5% of population, with prevalence increases of 20% every 5 years, particularly after age 35.[3-5] HD is a progressive disease with an early onset, usually in adolescence, and few individuals reporting a waxing and waning course.[3,5,6] Older adults with HD commonly suffer from self-neglect and are at risk for food contamination, malnutrition, medication mismanagement, falls, and eviction from their homes.[3] HD is associated with poor quality of life not only in patients but also in family members.[2,7]

Before the recognition in the Diagnostic and Statistical Manual 5th edition (DSM-5) that HD is distinct from obsessive-compulsive disorder (OCD), neuroimaging studies compared OCD patients with and without clinical hoarding symptoms. These studies found preliminary

evidence for increased hoarding-related brain function in lateral prefrontal and ventro-medial/orbitofrontal brain regions associated with cognitive control and self-referential processing during tasks designed to provoke hoarding symptoms, and decreased activity in posterior cingulate and cuneus during a task-free resting state.[8] Several candidate neural systems have been implicated in HD, but the strongest evidence is for abnormality in the cingulo-opercular network (comprising primarily the dorsal anterior cingulate cortex and anterior insula). Neuroscience theories of decision-making also show involvement of lateral prefrontal–parietal systems to cognitive/executive aspects of value-based learning that might be compromised in HD. Also, semantic cognition guides decision-making choices via both executive control processes that engage lateral prefrontal cortex regions and the representation of semantic knowledge in various lateral temporal lobe regions. Collectively, the evidence suggests that these might be the impaired neural systems most directly associated with the central behavioral symptoms found in most HD patients.[8]

Frost and Hartl[9] described the cognitive-behavioral model associated with HD, which highlights information-processing deficits, problems in forming emotional attachments, behavioral avoidance, and erroneous beliefs about the nature of possessions. The cognitive-behavioral model of compulsive hoarding suggests that executive dysfunction may contribute to the development and maintenance of hoarding behaviors.[10] Cognitive impairment may interact with a person's genetic vulnerabilities and learned core beliefs to result in increased hoarding tendencies.[10] Cognitive impairment in patients with HD seems to be associated with the severity of saving and acquiring behavior.[11] Once the current treatment is based on a cognitive behavioral model,[5] it is important to re-evaluate the evidence supporting the presence of cognitive impairment in HD patients. A previous systematic review evaluated hoarding symptoms in OCD main diagnostic and demonstrated that subjects with hoarding symptoms present impairments at planning/problem-solving decisions, visuospatial learning and episodic memory, sustained attention, working memory, and organization.[12] The most recent systematic review focused specifically on information processing, which is one aspect of executive functioning.[13] The authors showed that attention, motor inhibition, and organization domains were impaired in HD patients,[13] although visuospatial learning and working memory seem to be not compromised.[13]

In the present study, we aimed to perform a systematic review by evaluating cognitive performance including attention, episodic memory, executive functioning (including working memory, information-processing speed, planning, decision making, inhibitor mental control flexibility, categorization skills, and memory), visuospatial ability, and social cognition in patients with HD compared with those in controls. We hypothesized that HD patients would present greater cognitive impairment than controls.

Methods

Search strategy and study selection criteria

A systematic search of the literature using the electronic databases MEDLINE, SCOPUS, and LILACS was conducted in May 2020, with no date limit. The search terms were "hoarding disorder," "cognition," "neuropsychology," "cognitive impairment, and "cognitive deficit." There was no restriction regarding the date of publication. Studies written in English, Portuguese, or Spanish were selected for review. Two reviewers (B.P.S. and M.S.F.M.) independently evaluated the titles and abstracts and then the full text for inclusion eligibility A third reviewer (I.G.B.) evaluated disagreements. Only original studies assessing cognitive functioning in patients with HD were eligible for inclusion. Reviews and case studies were searched for the manual extraction of additional possible references. Studies with animals, children, or adolescents and without control group were excluded from the review. Participants without HD symptoms were considered as controls.

Data extraction process and literature quality assessment

We developed a data extraction table based on the Cochrane template.[14] Two investigators (B.P.S. and M.S.F.M.) extracted data and a third reviewer (I.G.B.) verified the data. In addition, two reviewers (B.P.S. and M.S.F.M.) independently assessed the quality of studies included using the Study Quality Assessment Tools of the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH) for quality assessment of case–control studies.[15]

In the current study, we considered a study that scored ≥7 points to be of good quality.[15] Studies that scored 5 or 6 points were considered to be of fair quality, and studies that received ≤4 points were considered to be of poor quality and were excluded from this review. Any disagreement between authors was resolved by consensus and, if necessary, a third author (I.G.B.) was consulted. As referred by the NIH classification: "good" studies refer to studies with a low risk of bias and results were considered valid, "a fair" study is susceptible to some bias deemed, although not sufficient to invalidate the results, and "poor" studies indicate significant risk of bias.[15]

The data extracted included the first author's last name and the year of publication; sample size (number of patients and controls); whether subjects fulfilled diagnostic criteria for HD; both inclusion and exclusion criteria; the selection setting; the diagnostic assessment, scales, and neuropsychological tests that were used; the characteristics of the study population (mean age, sex, and mean level of education); and the main outcomes. This systematic review was registered on Prospero under the protocol CRD42020167964.

Results

Description of the studies

A total of 197 studies were initially identified through database search (PUBMED: 42, SCOPUS: 74, and LILACS: 81). Duplicate studies (N: 72) and studies unrelated to the topic of the review according to title and abstract screening (N: 86) were excluded. Twenty additional studies were identified through reference lists.

Of the 59 studies selected for full text review, 37 were excluded, that is, 14 did not include control subjects,[16-29] 11 did not evaluate cognition,[30-40] 3 included patients with subclinical hoarding,[41-43] 1 was a PhD thesis,[44] 3 evaluated cognition only in patients with OCD,[45-47] 2 were literature reviews,[12,48] 1 did not evaluate participants with HD,[49] and 2 scored <5 according to The Study Quality Assessment Tools of the NHLBI of the NIH for quality assessment of case–control studies.[50,51] A total of 22 studies composed the final selection for this review (Figure 1).

Characteristics of included studies

All selected studies comprised case–control studies.[11,52-72]

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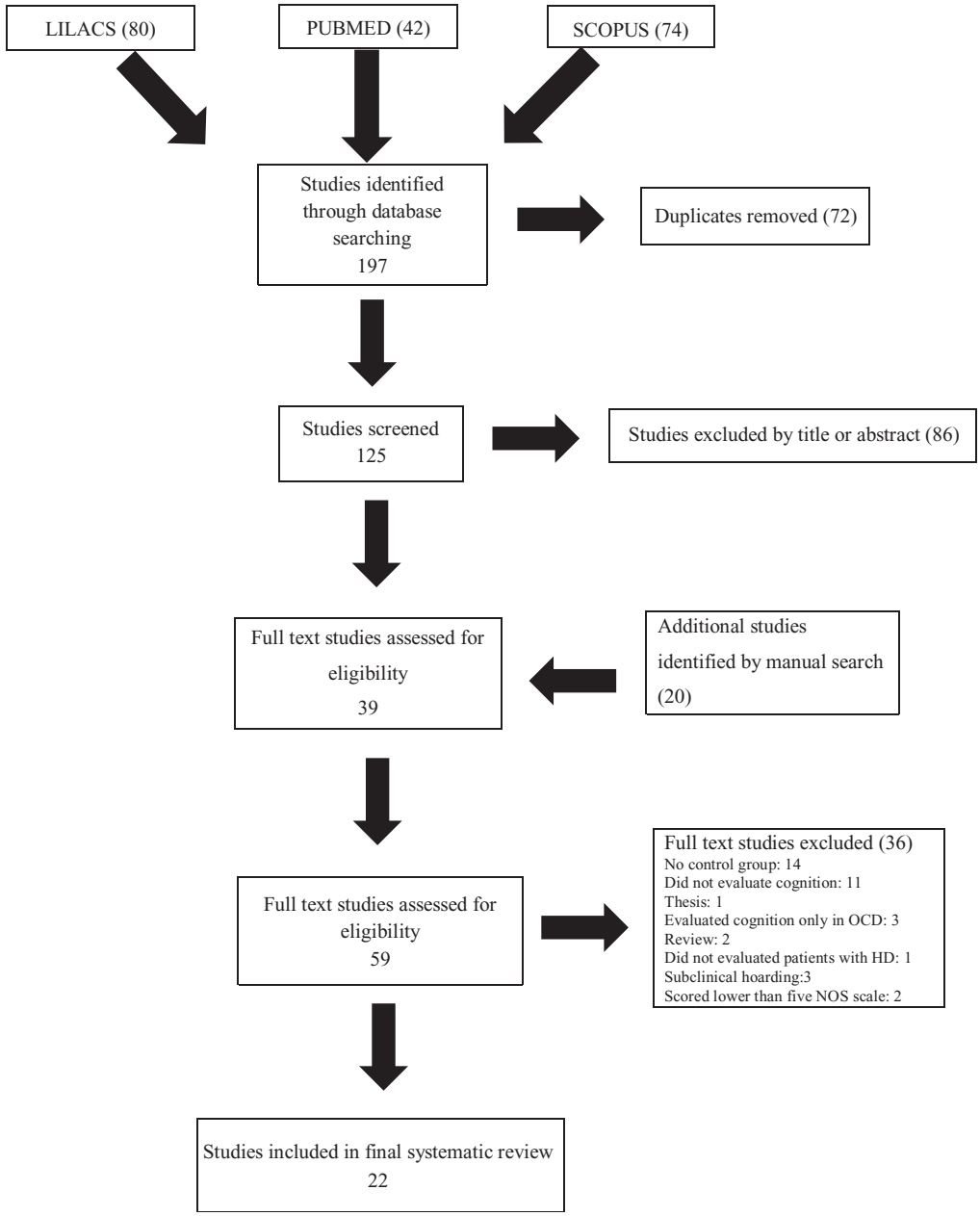

Figure 1. Flow chart of the studies included in the systematic review.

Seven studies diagnosed patients with HD according to the DSM-5 criteria.[61,62,64,66,67,69,72] In these studies, 1757 patients were evaluated. The mean age ranged from 41.7[70] to 71.5 years.[58] The frequency of female gender varied from 44.2%[61] to 85.5%.[69] The mean level of education ranged from 12.8[72] to 17.1 years,[54,57] although approximately one third of the studies included did not provide this information. All included studies scored between five to seven, according to the Study Quality Assessment Tools of the NHLBI[15] (Table 1).

Studies differed in terms of controls used for comparison with HD patients: 9 included controls,[11,53,61,62,65-67,69,71] 6 included controls and OCD patients,[52,55,59,60,64,72] 3 employed controls and patients with major depression or anxiety disorders,[54,56,57] 2 used OCD patients and comorbid OCD and HD,[68,70] 1 included patients with anxiety disorders,[63] and 1 included late life depression patients[58] (Table 2).

Attention

Nine out of 22 studies evaluated attention in patients with HD in comparison with controls.[54,57-59,64,66-69] Six out of nine studies did not demonstrate differences in attention between HD patients and controls.[57-59,66,68,69]

Sustained attention

Four out of 22 studies evaluated sustained attention in patients with HD[54,57,64,67] according to the Conners' continuous performance test (CPT)—omissions and signal detectability[54,67] and intra-extra dimensional set shift (IED).[57,64] Patients with HD did not differ from controls in three studies.[54,57,64] One study demonstrated that HD patients showed poor performance than controls.[67] One study demonstrated a poorer performance in patients with HD than in

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Table 1. Quality Assessment of Case–Control Studies

	Criteria												
First author, year	Objective	Study population	Sample size	Controls' origin	Inclusion and exclusion criteria	Cases definition	Cases and/or controls selection	Concurrent controls	Exposure confirmation	Reliable exposure/ risk	Blinding	Statistical adjustment	Total
Steketee, 2003[52]	Yes	Yes	No	Yes	Yes	No	NA	NA	NA	Yes	NA	Yes	6
Hartl, 2004[53]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Grisham, 2007[54]	Yes	Yes	No	Yes	Yes	Yes	CD	NA	NA	Yes	NA	Yes	7
Wincze, 2007[55]	Yes	Yes	No	Yes	Yes	No	NA	NA	NA	Yes	NA	Yes	6
Grisham, 2008[56]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Grisham, 2010[57]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	No	6
Mackin, 2011[58]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Tolin, 2011a[59]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Tolin, 2011b[60]	Yes	Yes	No	Yes	Yes	Yes	CD	NA	NA	Yes	NA	No	6
Ayers, 2013[61]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Diefenbach, 2013[62]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	No	6
Rasmussen, 2013[63]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Morein-Zamir, 2014[64]	Yes	No	No	Yes	Yes	Yes	CD	NA	NA	Yes	NA	No	5
Hallion, 2015[65]	Yes	Yes	No	Yes	Yes	Yes	CD	NA	NA	Yes	NA	No	6
Hough, 2016[66]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Mackin, 2016[67]	Yes	Yes	No	Yes	Yes	Yes	CD	NA	NA	Yes	NA	Yes	7
Moshier, 2016[68]	Yes	Yes	No	Yes	Yes	Yes	CD	NA	NA	Yes	NA	Yes	7
Sumner, 2016[69]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7
Pushkarskaya, 2017[70]	Yes	Yes	No	Yes	No	No	CD	NA	NA	Yes	NA	Yes	5
Pushkarskaya, 2018[71]	Yes	Yes	No	Yes	No	No	CD	NA	NA	Yes	NA	Yes	5
Tolin, 2018[11]	Yes	Yes	No	Yes	No	Yes	CD	NA	NA	Yes	NA	No	5
Suñol, 2020[72]	Yes	Yes	No	Yes	Yes	Yes	NA	NA	NA	Yes	NA	Yes	7

Table 2. Studies Evaluating Cognitive Tasks in Patients with HD in Comparison with Controls

Cognitive function	Study	P/C (N)	P/C Mean age (y)	HD criteria	Instruments	Results
Attention						
Sustained attention	Grisham et al., 2007[54]	30/30/30 (MD/AD)	55/52.1/51.5 (MD/AD)	CD	CPT -omissions	HD = C = MD/AD
					CPT - signal detectability	HD = C
						HD < MD/AD
	Grisham et al., 2010[57]	23/20/17 (MD/AD)	48/48/48 (MD/AD)	CD	IED	HD = C = MD/AD
	Morein-Zamir et al., 2014[64]	22/28/24 (HD + OCD)	53.95/51.5/48.75 (HD + OCD)	DSM-5	IED	HD = C > HD + OCD
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	CPT - signal detectability	HD < C
Selective attention	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	SCWT	HD = C
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	SCWT	HD = C = OCD
	Hough et al., 2016[66]	15/25/17 (OCD)	54.1/44.8/36.1 (OCD)	DSM-5	SCWT	HD = C = OCD
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	SCWT	HD = C
	Moshier et al., 2016[68]	20/19 (OCD + HD)/14 (OCD)	60.05/35.71 (OCD + HD)/35.05 (OCD)	HRS-I	SCWT	HD = HD + OCD = OCD
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	SCWT	HD = C
Episodic memory						
	Hartl et al., 2004[53]	22/24	52.7/50.3	CD	RCFT	HD < C
	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	BVMT-R	HD = C
					HVLT	HD = C
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	CVLT RCFT	HD = C = OCD
						Delayed recall: HD = C = OCD
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	BVMT-R	Learning: HD = C
						Delayed recall:
						HD < C
					HVLT	HD = C
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	CVLT RCFT	HD = C
						HD = C
Executive functions						
Working memory	Grisham et al., 2007[54]	30/30/30 (MD/AD)	55/52.1/51.5 (MD/AD)	CD	WAIS - DS	HD = C = MD/AD
					WAIS - VMS	Backward: HD = C = MD/AD
						Forward: HD < C = MD/AD
	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	WAIS - DS	HD = C
					WAIS - LNS	HD = C
	Ayers et al., 2013[61]	42/25	66.9/66.76	DSM-5	WAIS - DS	HD < C
					WAIS - LNS	HD < C

Table 2. *Continued*

Cognitive function	Study	P/C (N)	P/C Mean age (y)	HD criteria	Instruments	Results
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	WAIS - DS	HD = C
					WAIS - LNS	HD = C
	Moshier et al., 2016[68]	20/19 (OCD + HD)/14 (OCD)	60.05/35.71 (OCD + HD)/35.05 (OCD)	HRS-I	Nonverbal NT	HD = HD + OCD = OCD
					Verbal NT	
						Immediate: HD = HD + OCD = OCD
						Delayed: HD = OCD > HD + OCD
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	OAT	HD = C
Information processing speed	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	SCWT	HD = C
					SDMT	
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	SCWT	HD = C = OCD
	Hough et al., 2016[66]	15/25/17 (OCD)	54.1/44.8/36.1 (OCD)	DSM-5	SCWT	HD = C = OCD
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	SDMT	HD = C
	Moshier et al., 2016[68]	20/19 (OCD + HD)/14 (OCD)	60.05/35.71 (OCD + HD)/35.05 (OCD)	HRS-I	SCWT	HD = HD + OCD = OCD
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	SCWT	HD = C
Planning	Grisham et al., 2010[57]	23/20/17 (MD/AD)	48/48/48 (MD/AD)	CD	SOC	Thinking time: HD = C = MD/AD
						Problem solved: HD < C = MD/AD
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	TOL	HD = C = OCD
	Morein-Zamir et al., 2014[64]	22/28/24 (HD + OCD)	53.95/51.5/48.75 (HD + OCD)	DSM-5	TOL	HD = HD + OCD < C
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	D-KEFS - Tower test	HD = C
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	TOL	HD = C
Decision-making	Grisham et al., 2007[54]	30/30/30 (MD/AD)	55/52.1/51.5 (MD/AD)	CD	IGT	HD = C = MD/AD
	Grisham et al., 2010[57]	23/20/17 (MD/AD)	48/48/48 (MD/AD)	CD	CGT	HD = C = MD/AD
	Tolin and Villavicencio, 2011b[60]	42/36/29 (OCD)	51.14/47.0/31.2 (OCD)	HRS-I	IGT	HD = C = OCD
	Morein-Zamir et al., 2014[64]	22/28/24 (HD + OCD)	53.95/51.5/48.75 (HD + OCD)	DSM-5	CGT	HD = C = HD + OCD
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	IGT	HD = C
	Pushkarskaya et al., 2017[70]	19/57/19 (HD + OCD)/19 OCD	51.3/37.2/40.6 (HD + OCD)/33.3 (OCD)	ND	R&AT	HD = C < HD + OCD = OCD
	Pushkarskaya et al., 2018[71]	19/19	53.7/47.2	ND	IGT	HD = C
Inhibitory control	Grisham et al., 2007[54]	30/30/30 (MD/AD)	55/52.1/51.5 (MD/AD)	CD	CPT - CO	HD < C = MD/AD
	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	SCWT	HD = C

Table 2. *Continued*

Cognitive function	Study	P/C (N)	P/C Mean age (y)	HD criteria	Instruments	Results
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	CPT - CO	HD = C = OCD
					SCWT	HD = C = OCD
	Rasmussen et al., 2013[63]	32/32 (AD)	61.0/33.1 (AD)	HRS-I	SART - CO	HD = C
					RNT	HD = C
					BART	HD = C
	Morein-Zamir et al., 2014[64]	22/28/24 (HD + OCD)	53.95/51.5/48.75 (HD + OCD)	DSM-5	SST - RT	HD = HD + OCD < C
	Hough et al., 2016[66]	15/25/17 (OCD)	54.1/44.8/36.1 (OCD)	DSM-5	GNG - CO	HD = C = OCD
					SCWT	HD = C = OCD
	Moshier et al., 2016[68]	20/19 (OCD + HD)/14 (OCD)	60.05/35.71 (OCD + HD)/35.05 (OCD)	HRS-I	GNG - CO	HD = HD + OCD = OCD
						HD = HD + OCD = OCD
					SCWT	
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	SCWT	HD = C
	Suñol et al., 2020[72]	17/19/18 (OCD)	49.3/46/46.7 (OCD)	DSM-5	SST - CO	HD < OCD = C
					Switch-signal task - CO	HD < OCD = C
Mental flexibility	Grisham et al., 2010[57]	23/20/17 (MD/AD)	48/48/48 (MD/AD)	CD	IED	HD = C = MD/AD
	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	SCWT	HD = C
					D-KEFS - CST	HD < C
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	WCST	HD = C = OCD
					SCWT	HD = C = OCD
	Ayers et al., 2013[61]	42/25	66.9/66.76	DSM-5	WCST	HD < C
	Morein-Zamir et al., 2014[64]	22/28/24 (HD + OCD)	53.95/51.5/48.75 (HD + OCD)	DSM-5	IED	HD = C > HD + OCD
					PLR	Stage 1: HD = C = HD + OCD Stage 2: HD = HD + OCD < C
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	SCWT	HD = C
					D-KEFS - CST	Total correct: HD < C
						Incorrect: HD < C
						Time: HD = C
	Moshier et al., 2016[68]	20/19 (OCD + HD)/14 (OCD)	60.05/35.71 (OCD + HD)/35.05 (OCD)	HRS-I	SCWT	HD = HD + OCD = OCD
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	SCWT	HD = C
Categorization skills	Wincze et al., 2007[55]	21/21/21 (OCD)	54.8/48.5/45.6 (OCD)	CD	OST	Piles: HD = C = OCD
						Times: HD = C = OCD
						SUDS: HD = OCD < C

Table 2. *Continued*

Cognitive function	Study	P/C (N)	P/C Mean age (y)	HD criteria	Instruments	Results
					MST	Piles: HD = C = OCD
						Times: HD = C = OCD
						SUDS: HD = OCD < C
					PST	Piles: HD = OCD < C
						Time: HD < OCD = C
						SUDS: HD = OCD < C
	Grisham et al., 2010[57]	23/20/17 (MD/AD)	48/48/48 (MD/AD)	CD	POCT	Piles: HD = C < MD/AD
						Times: HD < C = MD/AD
						pre-SUDS: HD < C = MD/AD
						post-SUDS: HD < C = MD/AD
						Piles: HD = C = MD/AD
						Times: HD = C = MD/AD
					Non-POCT	pre-SUDS: HD < C = MD/AD
						post-SUDS: HD < C = MD/AD
						Piles: HD = C < MD/AD
						Times: HD = C = MD/AD
						pre-SUDS: HD < C = MD/AD
						post-SUDS: HD < C = MD/AD
					PICT	
						Piles: HD = C = MD/AD
						Times: HD < C = MD/AD
						pre-SUDS: HD = C < MD/AD
						post-SUDS: HD < C = MD/AD
					Non-PICT	
	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	D-KEFS - CST	Total correct: HD < C
						Sort time: HD < C
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	D-KEFS - CST	Total correct: HD < C
						Incorrect: HD < C
						Time: HD = C
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	PCT	HD = C
Language	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	BNT	HD = C
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	ANT COWAT	HD = C = OCD

Table 2. *Continued*

Cognitive function	Study	P/C (N)	P/C Mean age (y)	HD criteria	Instruments	Results
						HD = C = OCD
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	COWAT	HD = C
					NAART	HD = C
Visuospatial ability						
	Hartl et al., 2004[53]	22/24	52.7/50.3	CD	RCFT	Delayed recall: HD = C
						Organizational score: HD < C
	Mackin et al., 2011[58]	7/45 (LLD)	72.9/70.2 (LLD)	CD	JLO	HD = C
					MVPT	HD = C
	Tolin et al., 2011a[59]	27/26/12 (OCD)	53.7/44.8/31.0 (OCD)	HRS-I	HVOT	HD = C < OCD
					RCFT	Delayed recall: HD = C = OCD
						Organizational score: HD = OCD < C
	Mackin et al., 2016[67]	78/70	58.17/58	DSM-5	WAIS - BD	HD = C
	Sumner et al., 2016[69]	26/23	49.85/52.43	DSM-5	RCFT	Delayed recall: HD = C
						Organizational score: HD = C
Social cognition						
Emotional intelligence	Grisham et al., 2008[56]	30/30/30 (MD/AD)	55,0/52.1/51.5 (MD/AD)	CD	EIS	HD = C = MD/AD
Interpersonal problems	Grisham et al., 2008[56]	30/30/30 (MD/AD)	55,0/52.1/51.5 (MD/AD)	CD	IIPCV	HD = MD/AD < C

Abbreviations: AD, anxiety disorder; AGN, affective go/no-go; ANT, animal naming test; BART, balloon risk analog task; BD, block design; BNT, Boston naming test; BVMT-R, brief visuospatial memory test revised; C, control; CGT, Cambridge gambling task; CD, clinical diagnosis; CO, commission errors; CST, card sorting task; COWAT, controlled oral word association test; CPT, Conners' continuous performance test; CVLT, California verbal learning test; D-KEFS, Delis–Kaplan executive function system; DS, digit span; DSM-5, Diagnostic and Statistical Manual 5th Edition; EIS, Emotional Intelligence Scale; GNG, go/no-go; HD, hoarding disorder; HRT, hit reaction time; HSR-I, Hoarding Rating Scale Interview; HVLT, Hopkins verbal learning test, HVOT, Hooper visual organization test; IED, intra-extra dimensional set shifting; IIPCV, inventory of interpersonal problems-circumplex version; IGT, Iowa gambling task; JLO, judgment of line orientation; LLD, late life depression; LNS, letter number sequencing; MD, mood disorder; MST, modified sorting task; MVPT, motor free visual perception test; N, number; NAART, North American adult reading test; ND, not described; NT, NeuroTrax; OAT, object alternation task; OST, object sorting task; P, patients; PCPT, PEBL continuous performance test; PCT, perceptual categorization task; PICT, personal index cards categorization task; PLR, probabilistic learning and reversal; POCT, personal objects categorization task; PST, personal sorting task; RCFT, Rey–Osterrieth complex figure test; R&AT, risk and ambiguity task; RNT, recent negatives task; RT, reaction time; S, similarities; SART, sustained attention to response task; SCWT, Stroop color and word test; SDMT, symbol digit modalities test; SIHD, structured interview hoarding disorder; Sim, similarities; SOC, Stockings of Cambridge; SST, stop-signal task; SUDS, Subjective Units of Distress Scale; TOL, Tower of London; VMS, visual memory span; Voc, vocabulary; WAIS, Wechsler Adult Intelligence Scale; WCST, Wisconsin card sorting test.

patients with mood or anxiety disorders at signal detectability on CPT.[54]

Selective attention

Six out of 22 studies evaluated selective attention in patients with HD,[58,59,66-69] always with the Stroop color and word test (SCWT).[58,59,66-69] According to these studies, there was no difference when HD patients were compared with controls[58,59,66,67,69] and with OCD patients.[59,66,68]

Episodic memory

Five out of 22 studies evaluated episodic memory in patients with HD.[53,58,59,67,69] The neuropsychological instruments employed in these studies were the Rey–Osterrieth complex figure test (RCFT),[53,59,69] the brief visuospatial memory test—revised (BVMT-R),[58,67] the Hopkins verbal learning test (HVLT),[58,67] and the California verbal learning test (CVLT).[59,69]

Three studies did not demonstrate differences between HD patients and controls in episodic memory.[58,59,69] In one study, patients with HD did not differ from patients with OCD.[59] HD patients presented poorer episodic memory than controls in the RCFT[53] and delayed recall subtest on BVMT-R.[67]

Executive functions

Sixteen out of 22 studies evaluated executive functions in patients with HD in comparison with controls.[54,55,57-61,63,64,66-72]

Working memory

Six out of 22 studies evaluated working memory in patients with HD.[54,58,61,67-69] The neuropsychological instruments employed in these studies were subtests of the Wechsler adult intelligence scale (WAIS): digit span (DS),[54,58,61,67] letter number sequencing (LNS),[58,61,67] and visual memory span (VMS)[54]; the NeuroTrax (NT) verbal and non-verbal memory tests[68]; and the object alternation task (OAT).[69]

Three studies did not demonstrate differences between HD patients and controls in terms of working memory.[58,67,69] In one study, patients with HD did not differ from patients with OCD.[68] HD patients presented poorer working memory than controls in WAIS DS and LNS subtests[61] and in forward WAIS VMS subtest.[54]

Information-processing speed

Six out of 22 studies evaluated information-processing speed and demonstrated no differences between patients with HD and controls.[58,59,66-69] The neuropsychological instruments employed were the symbol digit modalities test (SDMT)[58,67] and SCWT.[58,59,66-69] One study assessed category learning and demonstrated that patients with HD showed a trend toward less implicit learning and greater use of explicit learning strategies during perceptual categorization task (PCT) compared with controls.[69]

Planning

Five out of 22 studies evaluated planning in patients with HD in comparison with controls.[57,59,64,67,69] The neuropsychological instruments employed were the Stockings of Cambridge (SOC),[57] the Tower of London (TOL),[59,64,69] and the tower test on the D-KFES.[67] Three studies demonstrated that HD patients did not differ from controls,[59,67,69] and one study demonstrated that they did not differ from patients with OCD.[59] One study showed poor performance in patients with HD in comparison with controls on the TOL[64] and one study demonstrated that HD patients, compared with controls, performed poorly at problem solving on the SOC.[57]

Decision-making

All seven studies that evaluated decision-making in patients with HD demonstrated that they do not differ from controls[54,57,60,64,67,70,71] or from patients with mood or anxiety disorders.[54,57] The main neuropsychological instruments employed to assess decision-making were the Iowa gambling task (IGT)[54,60,67,71] and the Cambridge gambling task (CGT).[57,64]

Inhibitory control

Nine out of 22 studies evaluated inhibitory control in patients with HD.[54,58,59,63,64,66,68,69,72] The main neuropsychological instruments employed for the assessment of inhibitory control were the commission errors on the CPT,[54,59] the SCWT,[58,59,66,68,69] the Stop-Signal task (SST),[64,72] and the commission errors on go/no-go task (GNG).[66,68] Five studies demonstrated that patients with HD did not differ from controls[58,59,63,66,69] or from patients with OCD.[59,66,68] Three studies demonstrated that HD patients presented poorer performance than controls,[54,64,72] from patients with OCD[72] and mood or anxiety disorders.[54]

Mental flexibility

Eight out of 22 studies compared mental flexibility in patients with HD.[57-59,61,64,67-69] The main neuropsychological instruments that assessed mental flexibility were the IED,[57,64] the SCWT,[58,59,67,68] the card sorting task (CST) on the D-KEFS,[58,67] and the Wisconsin card sorting task (WCST).[59,61,69] Four studies demonstrated that patients with HD did not differ from controls[57,59,61,69] or from patients with mood or anxiety disorders[57] and OCD.[59,68] Two studies demonstrated that patients with HD showed poor performance at CST on the D-KEFS compared to controls,[58,67] and one study demonstrated that HD patients performed poorly than controls on stage 2 of the probabilistic learning and reversal (PLR).[64]

Categorization skills

Five out of 22 studies evaluated categorization skills in patients with HD.[55,57,58,67,69] The main neuropsychological instrument employed was the card sorting test (CST) on the D-KEFS.[58,67] One study demonstrated that patients with HD did not differ from controls.[69] In three studies, HD patients presented longer time to sort items than controls.[55,56,58] One study demonstrated that patients with HD presented poorer confidence to complete categorization tasks.[67]

Language

Three studies did not demonstrate differences between HD patients and controls in language.[58,59,69] The main neuropsychological instrument employed was the controlled oral word association test (COWAT).[59,69] One study demonstrated that HD patients did not differ from patients with OCD in language.[59]

Visuospatial ability

Five out of 22 studies evaluated visuospatial ability in patients with HD,[53,58,59,67,69] mostly with the RCFT.[53,59,69] Three studies demonstrated that HD patients did not differ from controls.[58,67,69] Two studies demonstrated that patients with HD had lower organizational scores on the RCFT.[53,59]

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Social cognition

Only one study evaluated social cognition in patients with HD, applying self-reported questionnaires: the emotional intelligence scale (EIS) and the inventory of interpersonal problems-circumplex version (IIPCV).[56] Patients with HD did not differ in emotional intelligence, but HD patients and patients with mood or anxiety disorders reported higher levels of interpersonal problems than controls.[56]

Discussion

The purpose of this systematic review was to compare cognitive performance in patients with HD and controls. The present systematic review included 22 studies that evaluated 1757 HD patients who were 41 to 72 years old. More than 70% (16/22) of the included studies evaluated executive performance, and contrary to our hypothesis, HD presented impairment only in categorization skills in comparison with controls, particularly at confidence to complete categorization tasks. Regarding attention, episodic memory, working memory, information-processing speed, planning, decision-making, inhibitory control, mental flexibility, language, and visuospatial ability, HD patients did not present impairment when compared with controls. All included studies presented fair quality.

Two studies demonstrated that patients with HD performed poorer at categorization skills only when the items being sorted presented some personal value.[55,57] One study showed that indecision is an important factor in categorizing behavior and raised the possibility that differences would be more pronounced if the experiment employed real personal items rather than items written on cards and a home-based rather clinic-based environment.[55] Another study demonstrated that patients with HD reported indecisiveness on a self-report questionnaire, but their performance on a decision-making task was unimpaired, suggesting the presence of subjective memory difficulties or that these patients have decision-making deficits that are specific to items of personal relevance.[57] The accumulated items and the under-inclusiveness categorization are thought to underlie difficulty in discarding items.[9] For these patients, as different objects are included in a unique category, organization becomes impossible, explaining why so many objects are amassed and disposed in disorganized piles.[12] The only study that compared categorization skills in patients with HD to patients with OCD demonstrated that HD patients took longer to sort personal objects probably because of stronger emotional associations to these items.[55] These findings suggest that the underinclusive categorization of personally relevant objects for these patients is a characteristic of compulsive hoarding.[55]

Cognitive-behavioral, psychodynamic, attachment, and self-determination theories suggest a compensatory process in HD patients where interpersonal problems ("unmet relatedness needs") lead to greater object attachment and the use of possessions for comfort and safety.[73] However, HD patients' relationship with objects is marked by ambivalence and insecurity. On the one hand, they depend on objects for comfort, while on the other hand, the lack of control over possessions and fears about losing items trigger negative emotions such as anger and anxiety.[73] Also, the resulting clutter often leads to conflict with family, friends, and neighbors, which paradoxically worsen social isolation and loneliness among those with HD.[73] Social cognition refers to the ability to identify, manipulate, and adapt behavior based on social information perceived and processed in a specific context.[74] Individuals who hoard seem to exhibit impaired sensitivity to their own and others' emotions and a variety of negative personality traits.[56] Poor insight, difficulties with emotion-based decision-making, and impaired interpersonal relationships in this population suggest possible deficits in social cognition.[56] However, there is a paucity of studies on social cognition in HD patients, and further work on this theme is warranted.

HD patients seem to not demonstrate impairments in attention, episodic memory, working memory, information-processing speed, planning, decision-making, inhibitory control, mental flexibility, language, and visuospatial ability when compared with controls. These findings are inconsistent with previous reviews.[12,13] Different from the most recent review,[13] we used less stringent inclusion criteria. We also chose to include broad cognitive aspects and included studies that compared patients with HD to a clinical control sample rather than a healthy control sample.[58,63,68]

We expected that HD patients present impairment in sustained attention, as supposed by clinical observations that suggest hoarding individuals present difficulty in staying focused on tasks and are easily distracted.[43] One possible confounding factor is this data is due to baseline inattentiveness or the distracting power of emotion once patients with HD experience strong emotions during some tasks.[11] Other systematic reviews were unable to draw firm conclusions about impaired attention in HD patients.[12,13] One possible explanation is that patients with HD could have a more subtle dysfunction in anterior cingulate cortex.[11,13] Another hypothesis is that neuropsychological tests do not capture the multiple cognitive and emotional processes that influence complex behavior, and future studies should compare cognitive functions under stress vs neutral conditions.[13] Interventions that aim to shift biased perceptions about cognitive abilities and improve emotion regulation may hold more promise for the treatment of HD.[75]

The present study has some strengths, such as the inclusion of non-English written studies and the use of NHLBI for the quality assessment of results. As limitations intrinsic to the literature on cognitive functioning in HD, though, sample sizes were small, most samples were not matched for age and education, controls were heterogeneous, tests used to assess cognitive domains and subdomains were broadly different, and data regarding information on comorbidities, medication use, and global cognitive efficiency were mostly unavailable. We also have to consider that the samples of patients with HD may not be representative of the larger population of individuals with HD. Furthermore, the influence of sociodemographic variables like education, socioeconomic, and cultural contexts should be taken into account.[76]

In conclusion, except for categorization skills, the cognitive performance in HD patients does not seem to be impaired when compared with controls. In the future, it will be important to evaluate the relationship between cognitive performance in HD and different phenotypes, neuroimaging studies, genetic and neurobiological findings in order to improve the treatment and prognosis of these patients.

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