Hirschsprung's disease: early diagnosis and long-term outcomes

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CHAPTER 8

Long-term functional outcomes and quality of life in patients with Hirschsprung's disease

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SUMMARY

Background

It is unclear whether functional outcomes improve or deteriorate with age following surgery for Hirschsprung's disease (HD). Our aim was to determine the long-term functional outcomes and quality of life (QoL) in patients with HD by performing a cross-sectional study.

Methods

Patients with pathologically proven HD older than eight years were included. Patients with a permanent stoma or intellectual disability were excluded. Functional outcomes were assessed by Rome IV criteria using the Defecation and Fecal Continence (DeFeC) questionnaire. QoL was assessed by the CHQ-CF87 questionnaire or by the WHOQOL-100 questionnaire. Reference data of healthy controls were available for comparison.

Results

Of 619 patients invited, 55.9% responded (n = 346, median age 18 years, range 8–45). The prevalence of constipation was comparable in pediatric and adult patients (22.0% versus 22.0%) and in patients and controls. Compared to controls, adult patients suffered significantly more often from straining (50.3% versus 36.1%, $P = .011$) and incomplete evacuation (47.4% versus 27.2%, $P < .001$). The prevalence of fecal incontinence, most commonly soiling, was lower in adult patients compared to pediatric patients (16.8% versus 37.6%, $P < .001$), but remained higher than in controls (16.8% versus 6.1%, $P = .003$). Patients with poor functional outcomes scored significantly lower in several QoL domains.

Conclusions

This study has shown that functional outcomes are better in adult patients compared to pediatric patients, but symptoms of constipation and soiling persist in a substantial group of adult HD patients. The persistence of defecation problems are an indication that continuous care is necessary in this specific group of patients.

INTRODUCTION

Hirschsprung's disease (HD) is a congenital absence of ganglion cells of the distal bowel that in most cases presents with severe functional obstruction shortly after birth. Following diagnosis, resection is usually performed to remove the aganglionic bowel and to restore continuity. While many patients may attain normal bowel function following surgery, defecation disorders, such as constipation or fecal incontinence, can persist.[1–11]

It has been postulated that functional outcomes improve as patients grow older, especially after reaching adolescence.[5–7] Other studies, however, have drawn attention to the fact that long-term outcomes of HD in adulthood are far from satisfactory.[2–4] Indeed, one of these studies found that defecation problems actually deteriorated after the patients reached adulthood[3]. Unfortunately, a lack of data on healthy controls hinders interpretation of the majority of these studies.

Persistent defecation disorders, such as constipation and fecal incontinence, can potentially have a negative influence on quality of life (QoL).[12,13] A distinction is often made between generic QoL and health-related QoL, the latter focusing primarily on aspects of life that are directly influenced by an individual's health. In patients with HD the relationship between functional complaints and QoL has been studied previously, but these studies were often performed with health-related QoL questionnaires and only rarely were generic QoL questionnaires used.[14] Moreover, it remains unclear how functional outcomes continue to influence QoL after the transition into adulthood.[14]

The primary aim of this study was to investigate the long-term functional outcomes in different age groups and to compare them with matched controls. Secondarily, we aimed to identify factors associated with poor outcomes and to evaluate the influence of poor functional outcomes on QoL using generic QoL questionnaires.

METHODS

Study design

We reviewed the medical records of all known patients diagnosed with HD in all six pediatric surgical centers in the Netherlands. Inclusion criteria were pathologically proven HD and a minimum age of eight years. The following variables were collected from the records: comorbidities, length of aganglionosis, surgical treatment, episodes of enterocolitis, surgical complications, and additional surgical interventions. Enterocolitis was defined as the presence of symptoms such as abdominal distension, diarrhea, bloody stools, and/or fever with the intention-to-treat as such.[15] Surgical complications were defined as complications that occurred within 30 days and that were the direct result of

the initial surgical intervention (eg, anastomotic leakage, wound infection, adhesions).

Following the exclusion of patients who were ineligible for participation (eg, deceased, lived abroad, had a permanent stoma or an intellectual disability), we invited the remaining patients to participate in our study. In case of pediatric patients between 8 to 17 years we asked the parents or caregivers to participate together with the patients, or on their behalf. Upon agreeing to participate, patients received questionnaires on anorectal functioning and QoL. For pediatric patients this entailed the Pediatric Defecation and Fecal Continence (P-DeFeC, see Appendices) questionnaire[16] and the Child Health Questionnaire Child Form (CHQ-CF87).[17] Adult patients received the Defecation and Fecal Continence (DeFeC, see Appendices) questionnaire[16] and the World Health Organization Quality of Life (WHOQOL-100) questionnaire.[18]

Medical ethical approval was obtained for the study and written informed consent was collected of each participant.

Assessment of functional outcomes

The functional outcomes were assessed using patients' answers on the P-DeFeC and DeFeC questionnaires, which allowed us to score Rome IV criteria and assess the use of therapies for constipation and fecal incontinence.

Constipation was defined by the Rome IV criteria for functional constipation.[19] To meet these criteria patients should have at least two of the following symptoms: straining, hard or lumpy stools, incomplete evacuation, anorectal obstruction, manual maneuvers to facilitate defecation, or fewer than three bowel movements a week. Additionally, loose stools should rarely be present without the use of laxatives. Additionally, we assessed the individual symptoms incorporated in the Rome IV criteria for functional constipation that had to occur at least several times a month. Fecal incontinence was defined by the Rome IV criteria for fecal incontinence, ie, recurrent uncontrolled passage of fecal material, including soiling, at least several times a month.[20] Additionally, we assessed several subtypes of fecal incontinence, such as, soiling (ie, the loss of small amounts of feces), urge incontinence (ie, inability to reach the toilet in time), incontinence for solid stool (ie, loss of large amounts of solid feces without having felt urge), and incontinence for liquid stool (ie, loss of watery stools or diarrhea).

By means of the questionnaire we also evaluated the use of laxatives and bowel management at least several times a month as therapy for constipation or fecal incontinence.

Reference data for the P-DeFeC and DeFeC questionnaires were available from studies that had previously been performed in the general Dutch population. This produced 1103 healthy children and adults who did not have a history of bowel surgery and who did not

suffer from somatic diseases that could influence their bowels.[21,22]

Assessment of quality of life

In pediatric patients aged 8 to 17 years QoL was assessed using the CHQ-CF87.[17] The CHQ-CF87 is a generic QoL questionnaire with 87 items that are scored on a four to six-point Likert scale. Following completion, ten multi-item domains and two single-item questions were calculated and converted to a 0-100 point continuum, whereby a higher score indicates better QoL. For our current study we assessed the following domains: behavior, mental health, self-esteem, and general health.

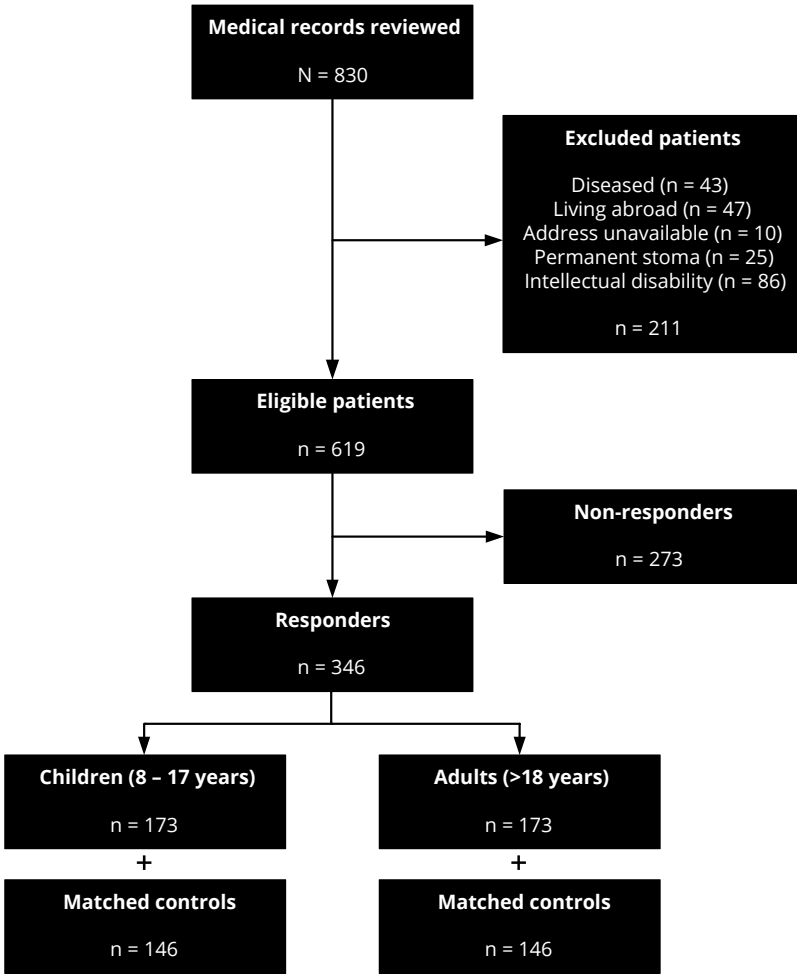

Figure 1
Study flow diagram

In adult patients we assessed QoL using the WHOQOL-100.[18] The WHOQOL-100 consists of 100 items covering six domains and a general evaluative facet (overall QoL and general health). The items are scored on a five-point Likert scale. Calculated domain scores range between 4 and 20 points, whereby a higher domain score indicates better QoL. For our current study we used the following domains: overall QoL, physical health, psychological health, and social relationships.

Reference data of the healthy Dutch population were available for both CHQ-CF87[23] and WHOQOL-100 questionnaires (with courtesy of Dr. J. de Vries, University of Tilburg).[24]

Statistical analysis

Data were analysed with SPSS 23.0 for Windows (IBM SPSS Statistics, IBM Corporation, Armonk, NY). Proportions were reported as prevalence percentages with 95% confidence intervals (CIs). Quantitative variables were either reported as means with SDs or as medians with ranges. Statistical tests were limited to the chi-square, Mann-Whitney, and t tests. Univariate and multivariate logistic regression analyses were used to test the association of potential risk factors with the likelihood of fecal incontinence and were reported as odds ratios (ORs) with 95% CIs. The multivariate analysis was built using variables that tended towards significance ($P < .100$) in the univariate analyses. Two-sided P values of less than .050 were considered statistically significant.

RESULTS

Patient characteristics and drop-out analysis

Based on our inclusion criteria we identified 830 patients eligible for inclusion. We excluded 211 patients who had died (n = 43), who lived abroad (n = 47), whose addresses were unavailable (n = 10), or who were unable to complete one of the questionnaires because of a permanent stoma (n = 25) or intellectual disability (eg, Down syndrome, n = 86). The most common reasons for a permanent stoma were postoperative complications (n = 7), persistent constipation (n = 5), and severe intellectual disability (n = 3). Thus, a total of 619 patients received an invitation to participate in our study (Figure 1).

Following invitation, 55.9% (n = 346) of patients and their parents or caregivers agreed and completed the questionnaires (Table 1). These 346 patients consisted of 173 pediatric patients aged 8 to 17 years and 173 adult patients. Additional patient characteristics are listed in Table 1. The drop-out analysis only showed a significant difference in median age between non-responders and responders (22 years, range 8–50, versus 18 years, range 8–45, respectively, $P = 0.004$, Table 1). The patients who responded (n = 346) were randomly matched 1:1 with the controls on sex and age. Because of the high prevalence

Table 1
Patient characteristics and drop-out analysis

	Non-responders No. (%)	Responders No. (%)	*P* value
Overall	273 (100.0)	346 (100.0)	
Sex			.373
Men	224 (82.1)	274 (79.2)	
Women	49 (17.9)	72 (20.8)	
Age (years, median, range)	22 (8 – 50)	18 (8 – 45)	.004
Comorbidities	26 (9.5)	33 (9.5)	.999
Length of aganglionosis			.804
Ultrashort	5 (1.8)	10 (2.9)	
Rectosigmoid	222 (81.3)	282 (81.5)	
Long segment	23 (8.4)	29 (8.4)	
Total colonic	23 (8.4)	25 (7.2)	
Preoperative enterocolitis	30 (11.0)	46 (13.3)	.395
Primary surgical treatment			.443
Surgical reconstruction	265 (97.1)	337 (97.4)	
Sphincterectomy	3 (1.1)	4 (1.2)	
Other	2 (0.7)	0 (0.0)	
None/conservative	3 (1.1)	5 (1.4)	
Surgical reconstructions			.166
Duhamel	149 (56.2)	210 (62.3)	
Soave	1 (0.4)	1 (0.3)	
Rehbein	80 (30.2)	73 (21.7)	
Swenson	0 (0.0)	1 (0.3)	
Transanal endorectal pull-through	35 (13.2)	52 (15.4)	
Postoperative complication	26 of 270 (9.6)	36 of 341 (10.6)	.706
Postoperative enterocolitis	24 of 270 (8.9)	47 of 341 (13.8)	.061
Redo pull-through	15 of 270 (5.6)	23 of 341 (6.7)	.546

of male patients, we were unable to match 52 patients to appropriate controls. This did not result in significant differences in sex or age between the group of HD patients (n = 346) and the control group (n = 294).

Functional outcomes in pediatric patients

The prevalence of constipation was comparable between pediatric patients and their controls (22.0% versus 14.3%, respectively). Nevertheless, pediatric patients suffered from symptoms, such as, straining, incomplete evacuation, and anorectal obstruction significantly more often (Table 2). Compared to controls, pediatric patients used laxatives

(30.6% versus 4.1%, $P < .001$) and bowel management (17.9% versus 0.7%, $P < .001$) to treat constipation significantly more often.

The overall prevalence of fecal incontinence was significantly higher in pediatric patients compared to pediatric controls (37.6% versus 6.1%, $P < .001$). The most common subtype of fecal incontinence in pediatric patients was soiling (34.7%), followed by incontinence for solid stool (6.9%) and liquid stool (8.7%), which were all significantly more prevalent compared to controls (Table 2). Lastly, 11.0% of the pediatric patients used bowel management to treat fecal incontinence, whereas this was merely 0.7% in controls ($P < .001$).

Functional outcomes in adult patients

The prevalence of constipation was comparable between adult patients and adult controls (22.0% versus 19.0%, $P = .520$). Compared to controls, adult patients suffered from symptoms, such as straining and incomplete evacuation, significantly more often (Table 2). Using laxatives was not significantly higher in adult patients compared to their control group, whereas they did retain a higher prevalence of bowel management to treat constipation (8.1% versus 0.7%, $P = .002$, Table 2).

The overall prevalence of fecal incontinence remained significantly higher in adult patients compared to their controls (16.8% versus 6.1%, $P = .003$). This was mainly the result of a significantly higher prevalence of soiling (16.8% versus 4.1%, $P < .001$), which was the only significant difference in subtypes of fecal incontinence (Table 2).

Comparison of functional outcomes in pediatric and adult patients

The prevalence of constipation between pediatric and adult patients was equal (22.0% versus 22.0%). Nevertheless, in comparison to pediatric patients, adult patients reported straining and manual maneuvers when defecating more often (Table 2). For the treatment of constipation, pediatric patients used laxatives (30.6% versus 5.2%, $P < .001$) and bowel management (17.9% versus 8.1%, $P = .007$) significantly more often than adult patients.

The overall prevalence of fecal incontinence was lower in adult patients compared to pediatric patients (16.8% versus 37.6%, $P < .001$). The subtypes of fecal incontinence, such as, soiling, incontinence for solid stool, and incontinence for liquid stool were all significantly less prevalent in adult patients compared to pediatric patients (Table 2). Lastly, only 1.7% of the adult patients required bowel management for their fecal incontinence, compared to 11.0% of pediatric patients ($P = .017$).

Table 2
Functional outcomes in pediatric and adult patients

	Children (8 – 17 years)			Adults (> 18 years)			Children vs. adults
	Patients	Controls		Patients	Controls		Patients
	No. (%)	No. (%)	*P* value	No. (%)	No. (%)	*P* value	*P* value
Overall	173 (100.0)	147 (100.0)		173 (100.0)	147 (100.0)		
Constipation							
Prevalence of constipation (Rome IV)	38 (22.0)	21 (14.3)	.077	38 (22.0)	28 (19.0)	.520	.999
Constipation symptoms							
Straining	64 (37.0)	32 (21.8)	.003	87 (50.3)	53 (36.1)	.011	.013
Lumpy or hard stools	5 (2.9)	14 (9.5)	.012	11 (6.4)	9 (6.1)	.931	.125
Incomplete evacuation	68 (39.3)	13 (8.8)	< .001	82 (47.4)	40 (27.2)	< .001	.129
Anorectal obstruction	39 (22.5)	17 (11.6)	.010	44 (25.4)	25 (17.0)	.068	.529
Manual maneuvers	0 (0)	3 (2.0)	.059	10 (5.8)	7 (4.8)	.686	.001
Fewer than three bowel movements per week	12 (6.9)	12 (8.2)	.678	18 (10.4)	19 (12.9)	.482	.252
Laxative usage	53 (30.6)	6 (4.1)	< .001	9 (5.2)	6 (4.1)	.636	< .001
Bowel management for constipation	31 (17.9)	1 (0.7)	< .001	14 (8.1)	1 (0.7)	.002	.007
Fecal incontinence							
Prevalence of fecal incontinence (Rome IV)	65 (37.6)	9 (6.1)	< .001	29 (16.8)	9 (6.1)	.003	< .001
Subtypes of fecal incontinence*							
Soiling	60 (34.7)	6 (4.1)	< .001	29 (16.8)	6 (4.1)	< .001	< .001
Urge incontinence	7 (4.0)	2 (1.4)	.148	2 (1.2)	3 (2.0)	.525	.091
Incontinence for solid stool	12 (6.9)	3 (2.0)	.039	2 (1.2)	3 (2.0)	.525	.006
Incontinence for liquid stool	15 (8.7)	2 (1.4)	.004	5 (2.9)	5 (3.4)	.793	.021
Bowel management for fecal incontinence	19 (11.0)	1 (0.7)	< .001	3 (1.7)	0 (0.0)	.109	.017

* Respondents often suffered from various types of fecal incontinence

Factors associated with fecal incontinence

In the univariate analyses sex, length of aganglionosis, and postoperative complication were not significantly associated with fecal incontinence, whereas age group and redo pull-through procedures were significantly associated with fecal incontinence (Table 3). The multivariate analysis showed that adult patients were significantly less likely to report fecal incontinence than pediatric patients (OR 0.38; 95% CI, 0.21–0.66). Patients who required a redo pull-through were significantly more likely to suffer from fecal incontinence (OR 3.30; 95% CI, 1.31–8.48), compared to patients who had only undergone one procedure. There was no significant interaction between the variables.

Comparison of functional outcomes and quality of life

The QoL questionnaires were completed by 150 pediatric patients and 160 adult patients, because 36 patients omitted the QoL questionnaire after completing the questionnaire on anorectal functioning.

We first compared the mean QoL domain scores of both pediatric and adult patients to reference data of the general population (Figure 2). Pediatric patients had significantly lower scores on behavior (81 versus 85, $P < .001$), self-esteem (76 versus 79, $P = .008$), and general health (73 versus 82, $P < .001$), compared to the reference data (Figure 2A). Compared to their respective reference data set, adult patients had significantly higher scores on overall QoL (16 versus 15, $P = .001$), physical health (16 versus 15, $P = .002$), psychological health (16 versus 15, $P < .001$), and social relationships (16 versus 15, $P = .002$) (Figure 2B).

Subsequently, we analyzed how the presence of constipation and fecal incontinence resulted in different QoL domain scores (Table 4). In pediatric patients, the constipated group had significantly lower median scores on all four the domains tested compared to the non-constipated group (Table 4). Pediatric patients with fecal incontinence only had significantly lower scores on the domains behavior (83 versus 77, $P = .010$) and general health (81 versus 74, $P = .017$), compared to pediatric patients without fecal incontinence. The only significant difference between constipated and non-constipated adult patients was in the domain psychological health (16 versus 15, $P = .025$). Lastly, the only significant difference between continent and fecally incontinent adult patients was in the domain of physical health (16 versus 15, $P = .018$).

DISCUSSION

This nationwide study shows that functional outcomes were better in adult patients compared to pediatric patients, but that defecation disorders persisted in a substantial

Table 3
Prevalence and likelihood of fecal incontinence

	Total	Prevalence of fecal incontinence			Likelihood of fecal incontinence			
					Univariate logistic regression		Multivariate logistic regression	
	No. (%)	%	95% CI	*P* value	Odds ratio (95% CI)	*P* value	Odds ratio (95% CI)	*P* value
Overall	346 (100.0)	27.2	22.5–31.9					
Sex				.175				
Men	274 (79.2)	28.8	23.4–34.2		Reference			
Women	72 (20.8)	20.8	11.2–30.4		0.65 (0.35–1.21)	.177		
Age groups				< .001				
Pediatric patients (8 – 17 years)	173 (50.0)	37.6	30.3–44.9		**Reference**		Reference	
Adult patients (>18 years)	173 (50.0)	16.8	11.1–22.4		**0.33 (0.20–0.55)**	**< .001**	0.35 (0.21–0.58)	< .001
Length of aganglionosis				.482				
Ultrashort	10 (2.9)	20.0	-10.2–50.2		0.70 (0.15–3.38)	.660		
Rectosigmoid	282 (81.5)	26.2	21.1–31.4		Reference			
Long segment	29 (8.4)	27.6	10.3–44.9		1.07 (0.45–2.52)	.876		
Total colonic	25 (7.2)	40.0	19.4–60.6		1.87 (0.81–4.35)	.144		
Postoperative complication				.777				
No	305 (89.4)	27.2	22.3–32.2		Reference			
Yes	36 (10.6)	25.0	10.1–39.9		0.89 (0.40–1.97)	.769		
Redo pull–through				.001				
No	323 (93.4)	25.1	20.3–29.8		**Reference**		Reference	
Yes	23 (6.6)	56.5	34.6–78.4		**3.88 (1.64–9.20)**	**.002**	3.54 (1.46–8.62)	.005

Boldface indicates outcomes that were significant in the univariate analyses and subsequently included in the multivariate analysis

group of adult HD patients. Moreover, patients who required a redo pull-through procedure were more likely to suffer from fecal incontinence. In this group of patients, defecation disorders, especially constipation, negatively influenced QoL domains, whereby the differences were more prominent in pediatric patients than in adult patients.

Interestingly, the prevalence of constipation in both pediatric and adult HD patients was comparable to their respective control groups. These findings warrant reflection. First, the true prevalence of constipation in the HD patients may be masked by the more frequent use of laxatives and bowel management compared to the controls. If true, this could also mean that the prevalence of constipation may decrease as the HD patients grow older, because the use of laxatives and rectal irrigations was significantly lower in the adult patients than in the pediatric patients. Second, as indicated by the increased frequency of symptoms we found in this study, it may be that both pediatric and adult patients experience more severe forms of constipation.

In contrast to the prevalence of constipation, we found the prevalence of fecal incontinence to be significantly higher in HD patients compared to controls, ie 37.6% in the pediatric patients and 16.8% in the adult patients. It is important to note, however, that pediatric patients more often suffered from severe subtypes of fecal incontinence, such as solid stool and liquid stool, whereas adult patients often reported soiling. This means that both the prevalence and severity of fecal incontinence may decrease with increasing age, whereas adult HD patients do retain a significantly higher prevalence of soiling.

Table 4
Comparison of functional outcomes and quality of life

	Constipation (Rome IV criteria)			Fecal incontinence (Rome IV criteria)		
	No	Yes		No	Yes	
Domains	Median (range)	Median (range)	*P* value	Median (range)	Median (range)	*P* value
CHQ-CF87 (n = 150)						
Behavior	82 (21 – 99)	76 (46 – 97)	.010	83 (61 – 99)	77 (21 – 98)	.010
Mental health	81 (50 – 100)	76 (42 – 97)	.021	81 (42 – 100)	77 (50 – 100)	.056
Self-esteem	77 (30 – 100)	73 (41 – 100)	.013	75 (41 – 100)	77 (30 – 100)	.877
General health	80 (21 – 100)	69 (19 – 99)	.004	81 (19 – 100)	74 (26 – 100)	.017
WHOQOL-100 (n = 160)						
Overall QoL	16 (10 – 20)	16 (7 – 20)	.055	16 (9 – 20)	16 (7 – 20)	.319
Physical health	16 (8 – 20)	15 (7 – 20)	.077	16 (10 – 20)	15 (7 – 20)	.018
Psychological health	16 (10 – 20)	15 (10 – 19)	.025	16 (10 – 20)	15 (10 – 20)	.204
Social relationships	16 (9 – 20)	15 (9 – 19)	.079	16 (9 – 20)	16 (9 – 20)	.141

In contrast to our results, a recent study by Neuvonen and colleagues concluded that fecal incontinence would eventually diminish to a prevalence not significantly different to that of the healthy controls, even though the prevalence of soiling persisted to well over 40% in their adult subgroup.[6] It therefore seems that fecal continence may improve with age, but that problems do persist well into adulthood. The persistence of impaired fecal continence could have various causes. First, fecal incontinence in these patients may result from damage to the anal sphincter during reconstructive surgery.[25] Second, impaired continence may result from more severe constipation in HD patients,[21] which could be the result of persistently absent rectoanal inhibitory reflex, stenosis of the anal sphincter following surgery, or absent pelvic floor coordination.[26] Third, the absence of a rectal reservoir following surgery and subsequent increased defecation frequency may

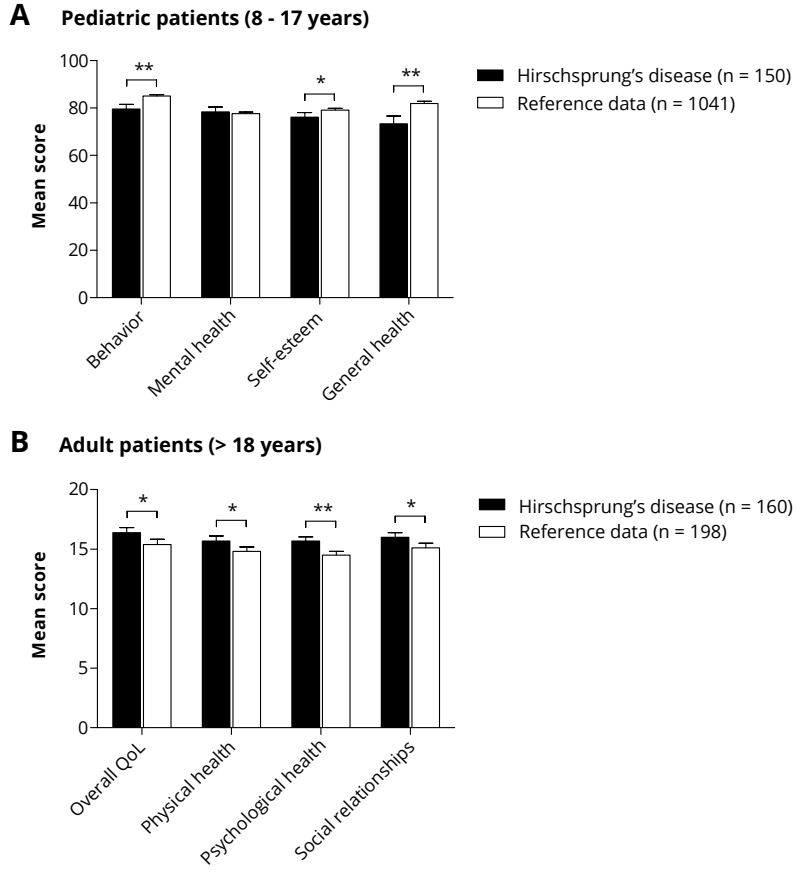

Figure 2

(A) CHQ-CF87 and (B) WHOQOL-100 domain scores of pediatric and adult patients, respectively, compared to reference data from healthy controls. Bars denote mean scores with the 95% CIs. A single asterisk denotes $P < .050$, a double asterisk denotes $P < .001$.

further contribute to impaired fecal continence. Lastly, our results showed that patients who required a redo pull-through procedure were significantly more likely to suffer from fecal incontinence. A recent study by Dingemans and colleagues indeed showed that short-term outcomes were complicated by a relatively high rate of soiling and fecal incontinence following redo pull-through procedure.[27] Important to note, however, is their finding that other functional symptoms, such as constipation and abdominal pain, improve following the redo procedure. It remains unclear to what extent the redo procedure itself contributed to the impaired fecal continence, because it may already have been worse in these patients prior to their redo procedure. We therefore merely conclude that a redo procedure may ultimately be necessary in some patients, but that one should be cautious about promising favorable functional outcomes, because the prevalence of fecal incontinence in patients after redo remains high.

In terms of QoL our results showed that pediatric HD patients had significantly lower QoL domain scores compared to the reference data. These differences may partially be explained partially by poor functional outcomes, because we found that constipation and fecal incontinence negatively influence several QoL domains. In contrast to pediatric patients, adult patients scored better on all four the domains tested compared to their respective reference data sets. This could be the result of improved functional outcomes in adult patients compared to pediatric patients. A more plausible explanation for this finding may be that adult patients develop better coping strategies to deal with their complaints. By way of illustration, adults may have more options to adapt their lives to accommodate for any defecation disorders, whereas children are often bound by fixed schedules, such as school and after-school activities.

The strength of this study was the high number of participants, thanks to all six pediatric surgery centers in the Netherlands taking part, and the relatively high response rate of 55.9%. One limitation of this study was the significant age difference in the drop-out analysis, even though the remaining variables all proved to be statistically non-significant. The difference in age between respondents and non-respondents was most likely the result of the high response rate of pediatric patients, supported by their parents, whom we found to be more motivated to participate than were adult patients. We attempted to overcome this possible inclusion bias by performing our analyses in separate age groups and by performing age and sex-matched comparisons with controls. Another limitation may be cross-sectional design of this study. A longitudinal design would have been preferable to analyze the influence of aging on functional outcomes.

Conclusions

The results of this nationwide study show that functional outcomes are better in adult

patients compared to pediatric patients, although symptoms of constipation and soiling do persist in a substantial group of adult HD patients. One factor associated with poor functional outcomes was a redo pull-through procedure, following which patients are significantly more likely to suffer from fecal incontinence. Poor functional outcomes negatively influence QoL in pediatric patients, whereas this influence diminishes partially upon reaching adulthood, indicating better coping strategies in adult patients. Persistent constipation symptoms and soiling indicate that counseling and transitional care are recommended in a specific group of patients.

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