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ORIGINAL ARTICLE

Is the Long-term Outcome of Cemented THA Jeopardized by Patients Being Overweight?

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Abstract Although the effect of being overweight on the long- and short-term outcome of THA remains unclear, the majority of orthopaedic surgeons believe being overweight negatively influences the longevity of a hip implant. We asked whether complications and long-term survival of cemented THA differed in overweight patients (body mass index [BMI] > 25 kg/m^2) and obese patients (BMI > 30 kg/m^2) compared with normal-weight patients (BMI < 25 kg/m^2). We retrospectively analyzed 411 consecutive patients (489 THAs) treated with cemented THA between 1974 and 1993. Except for cardiovascular comorbidity, we observed no differences in demographics among these weight groups. We found no differences in the number of intraoperative or postoperative complications. The survival rates for the three BMI groups were similar. The 10-year survival for any revision was 94.9% (95% confidence interval, 91.6%–98.2%), 90.4% (95% confidence interval, 85.6%–95.2%), and 91% (95% confidence interval, 81.2%–100%) for normal-weight, overweight, and obese patients, respectively. Cox regression analysis showed BMI and weight had no major influence on survival rates. The differences in mean Harris hip score at final followup were 4.8 between normal-weight and overweight patients and 7.1 between normal-weight and obese patients. Being overweight and obesity had no influence on perioperative complication rates in this cohort and did not negatively influence the long-term survival of cemented THA.

Level of Evidence: Level III, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Introduction

Whether being overweight influences the fate of a THA is still debated. One study suggests obese patients are more likely to undergo THA for osteoarthritis (OA) of the hip than control patients with lower body mass index (BMI) [7]. Therefore, it is important for the orthopaedic surgeon who is planning the joint arthroplasty to know the effect of obesity on the fate of THA [7, 11, 22]. Although being overweight or obese have a negative influence on health and mobility, it is not certain whether they have a negative influence on the short- and long-term results after THA as well [4, 6, 19, 21].

The assumption that being overweight or obese negatively influences the long-term survival of THA could preclude some obese patients from having joint arthroplasty. Recently, the *Wall Street Journal* mentioned more orthopaedic surgeons refuse to perform THA in obese patients because of the fear of complications [15]. A large international survey of orthopaedic surgeons performed in 12 European countries revealed 80.9% believe the long-term outcome of THA is impaired by being overweight [20]. Several short-term outcome studies, summarized in two reviews [4, 19], however, failed to show a negative influence of obesity on the short-term results of THA.

We asked whether obesity influences the long-term survival, clinical outcomes scores, and perioperative complication rates. We also asked whether BMI and body weight were risk factors for revision.

Materials and Methods

We retrospectively reviewed the medical records of 411 consecutive patients (489 hips) who underwent primary THA between 1974 and 1993. We divided our patients into three groups based on body mass index (BMI) at the time of surgery: (1) patients with a normal body weight (BMI < 25 kg/m^2); (2) patients who were overweight (BMI > 25 kg/m^2); and (3) patients who were morbidly obese (BMI > 30 kg/m^2). One hundred sixty-three patients (201 hips [41%]) had a normal body weight. One hundred forty-two patients (172 hips [35%]) had a BMI greater than 25 kg/m^2 and 35 (42 hips [9%]) of these patients had a BMI greater than 30 kg/m^2. For 106 patients (116 hips [24%]), no BMI (weight and/or height) was documented preoperatively. To avoid selection bias, these patients were included in the overall (survival) analysis. During followup, 164 patients (184 hips) died after a minimum followup of 1 year (mean, 11.6 years; range, 1–29.3 years) and an additional 37 patients (50 hips) were lost to followup after a minimum followup of 0.1 year (mean, 6.8 years; range, 0.1–15.6 years). These patients are included in the survival analysis and radiographic analysis until their last outpatient clinic contact. Of these patients lost to followup, two had a BMI greater than 30 kg/m^2, eight had a BMI greater than 25 kg/m^2, and 12 had a normal BMI; for 16 patients, no BMI was documented.

Sample size power analysis was performed assuming a 10-year survival rate of 95% in normal-weight individuals. We assumed a difference of 10% survival rate in overweight patients was of clinical importance. When using a power of 0.8 and an alpha of 0.05, a sample size of 159 hips is needed per group. Our number of patients with a BMI greater or less than 25 kg/m^2 therefore seems sufficient.

For maximum followup, 210 patients (255 hips) were available. The minimum followup in these 210 patients was 10 years (mean, 14.9 years; range, 10–28.1 years). We then compared long-term survivorship, functional outcome, and perioperative complication rate. The average age at the time of surgery was 67 years (range, 22–88 years). One hundred seventeen (24%) of these patients were male (Table 1). The indication for THA was idiopathic OA in 235 hips (48%), acetabular dysplasia in 165 hips (34%), rheumatoid arthritis in eight (2%), avascular necrosis in 30 (6%), posttraumatic in 23 (5%), and other causes in 28 (4%). Apart from cardiologic comorbidity, which occurred more often in overweight and obese patients (Fisher's exact test, $p = 0.028$ for BMI > 30 kg/m^2 versus BMI < 30 kg/m^2 and $p = 0.044$ for BMI > 25 kg/m^2 versus BMI < 25 kg/m^2), we observed no differences between the patients who were obese or overweight and the normal-weight patients (Table 1). The average BMI of all patients was 25.3 kg/m^2 (range, 17.9–41.1 kg/m^2).

The same prosthetic implant and surgical procedure were used in all patients. All patients were placed in a supine position and all had an anterolateral approach and a cemented Weber Rotation THA System (Allopro, Baar, Switzerland) implanted [5]. This system consists of a wrought CoNiCrMo alloy stem (Protasul® 10; Sulzer AG, Winterthur, Switzerland) with a cylindrical neck (the trunnion) made of a cast CoCrMo alloy (Protasul® 2) composite welded to the stem, which is grit-blasted with glass particles. The 32-mm head was made from Protasul® 2 or Al_2O_3 ceramic (Biolox®; Feldmühle, Plochingen, Germany) and placed on a Protasul® 2 cylinder. The stem

Table 1. Demographic data per BMI group shown in number and percentage

Demographics and comorbidity	BMI < 25 kg/m^2 (n = 201 hips)	BMI > 25 kg/m^2 (n = 172 hips)	p Value*	BMI > 30 kg/m^2 (n = 42 hips)	p Value*
Age (years)‡	65.0 (21–83)	65.7 (22–87)	0.50	64.0 (49–79)	0.56
Percent idiopathic osteoarthritis	90 (44.8%)	82 (42.7%)	0.46	23 (54.8%)	0.22
Female	152 (75.6%)	134 (69.8%)	0.63	30 (71.4%)	0.84
Comorbidity					
Central nervous system	14 (7.0%)	17 (8.9%)	0.35	5 (11.9%)	0.33
Respiratory	11 (5.5%)	10 (5.2%)	1.0	5 (11.9%)	0.16
Cardiovascular§	43 (21.4%)	51 (26.6%)	0.07	16 (38.1%)	0.03
Diabetes	8 (4.0%)	9 (4.7%)	0.62	4 (9.5%)	0.12

* p values show comparison with the group with a BMI of less than 25 kg/m^2; ‡age is given as an average, with range in parentheses; age was compared using a t test; §cardiovascular comorbidity is higher ($p < 0.05$) in the group with a BMI of greater than 30 kg/m^2; for all the other demographic data, no differences were found using a Fisher's exact test; BMI = body mass index.

and the nonhighly crosslinked polyethylene Weber socket were cemented using low-viscosity Sulfix® (Sulzer AG) cement. Until the 1980s, we used two types of cups, a flat type and a hemispheric type. Because of the inferior results of the flat type, their use was discontinued. In this study, 112 flat type and 377 hemispheric type sockets were used. The percentages of flat cups used were not different among the weight groups.

We (DH, RKM, FHRdM) obtained Harris hip scores (HHS) for patients whose THA was not revised at final followup.

We (DH, FHRdM) performed a radiographic analysis using the weightbearing pelvic and lateral radiographs taken at the latest followup. Loosening of the stem was ranked according to Harris et al. [8] and loosening of the cup according to Hodgkinson et al. [9]. For both components, loosening was scored as definitive, probable, possible, or no loosening. Loosening was scored by comparing the radiographs at last followup with previous radiographs.

Complications were retrieved from the clinical charts. We noted the presence of hematoma when patients underwent exploratory surgery for suspected hematoma. Early infection was defined as requiring antibiotic treatment and/or débridement within 3 months after the operation.

A survival analysis was performed using the Life Table Method using revision for aseptic loosening, revision for any reason, and radiographic loosening (definitive loosening) as end points. We performed survivorship analysis for the acetabular and femoral component separately and for both components combined. Because all patients were seen annually or biannually, all could be included in the survival analysis until their last followup. Equality of the survival curves for the normal-weight, overweight, and obese patients were compared using a log rank test. Differences in HHS among the three study groups were evaluated using analysis of variance. A difference greater than 4 points was considered clinically important [10]. We also compared BMI as a continuous variable with the HHS at maximum followup by means of Pearson correlation analysis to explore the overall influence of BMI on outcome. Differences in loosening between the normal-weight, overweight, and obese patients were evaluated using Fisher's exact test. Differences in perioperative and postoperative complications were compared using Fisher's exact test. Cox regression analysis was performed for survival of the implant (any revision) with weight and BMI as risk factors.

Results

We observed no differences between the survival rates for normal-weight patients and overweight patients and morbidly obese and normal-weight patients for all end points using a log rank test (Table 2; Fig. 1). Fifty four patients (64 hips) underwent revision surgery, of which five hips were revised for septic loosening, 54 for aseptic loosening of at least one of the components, and five for other reasons (periprosthetic fractures and heterotopic ossifications). The rate of infection causing septic loosening was similar in patients with a BMI of between 25 kg/m^2 and 30 kg/m^2 ($n = 4$) and with a normal body weight ($n = 1$) ($p = 0.13$).

Patients with a BMI greater than 30 kg/m^2 had lower ($p = 0.02$) HHS than patients with a BMI less than 25 kg/m^2 and patients with a BMI greater than 25 kg/m^2 had lower ($p = 0.02$) HHS than patients with a BMI less than 25 kg/m^2 (Table 3). The differences in average HHS between the three groups were greater than 4 points, indicating these differences were clinically relevant. Body mass index showed a poor correlation ($rho = -0.17$; $p = 0.024$) with HHS.

Several local and systemic complications occurred, which were similarly distributed among the normal-weight, overweight, and obese patients (Table 4). We observed no differences in the rates of radiographic loosening among the normal-weight versus overweight patients ($p = 0.30$) and normal-weight versus obese patients ($p = 0.47$) (Table 5).

Body mass index and body weight were not risk factors for revision (Exp[B] = 1.00 [95% confidence interval, 0.93–1.08] and Exp[B] = 1.01 [95% confidence interval, 0.99–1.03], respectively).

Discussion

The influence of being overweight on the long- and short-term outcome of THA is controversial in the literature but the majority of orthopaedic surgeons believe being overweight negatively influences the longevity of a hip implant [20]. Because the issue is controversial, we asked whether obesity influences the long-term survival, clinical outcomes scores, and perioperative complication rates, and whether BMI and body weight were risk factors for revision.

We note several limitations of our study. First, we did not study wear. It could be hypothesized that more body weight causes more wear. Although it can be expected that excessive wear may influence the rate of revision, we did not see a difference in revision rates between the weight groups [2]. Second, we studied only patients with cemented THA. Our analysis may not be valid for uncemented THA. One study of 300 patients with the cementless PM prosthesis suggested obesity negatively influenced medium-term survival, showing a twofold increase in loosening/revision rate in obese patients [6]. Another recent study

Table 2. Survival rates

Number at risk and revisions	All	BMI < 25 kg/m^2	BMI > 25 kg/m^2	BMI > 30 kg/m^2
Number at risk				
At start	489	201	172	42
At 10 years	336	161	122	30
At 15 years	181	92	69	14
At 20 years	49	29	17	4
Any revision				
At 10 years	92.4 (89.8–95.0)	94.9 (91.6–98.2)	90.4 (85.6–95.2)	91.0 (81.2–100)
At 15 years	83.7 (79.4–88.0)	85.9 (80.0–91.8)	83.1 (76.2–90.0)	79.5 (61.5–97.4)
At 20 years	72.6 (64.5–96.4)	75.6 (65.5–85.6)	68.3 (53.0–83.6)	79.5 (61.5–97.4)
Aseptic stem loosening				
At 10 years	95.1 (92.9–97.2)	96.6 (93.9–99.3)	94.2 (90.3–98.1)	91.0 (81.2–100)
At 15 years	89.3 (85.7–92.9)	91.4 (86.6–96.2)	87.5 (81.1–93.9)	79.5 (61.5–97.4)
At 20 years	84.1 (78.1–90.0)	85.2 (76.4–94.0)	82.7 (73.8–91.6)	79.5 (61.5–97.4)
Aseptic cup loosening				
At 10 years	96.9 (95.1–98.6)	97.7 (94.4–100)	97.2 (94.5–99.9)	97.1 (91.4–100)
At 15 years	90.0 (86.4–93.5)	89.6 (84.3–94.9)	91.5 (85.9–97.1)	84.9 (67.5–100)
At 20 years	79.9 (72.3–98.5)	79.4 (69.7–89.0)	80.0 (66.4–93.6)	84.9 (67.5–100)
Aseptic loosening, both components				
At 10 years	94.0 (91.6–96.4)	96.0 (93.1–98.9)	92.8 (88.5–97.1)	91.0 (81.2–100)
At 15 years	85.9 (81.8–90.0)	86.7 (80.8–92.6)	86.1 (79.4–93.0)	79.5 (61.5–97.4)
At 20 years	74.5 (66.3–82.7)	85.2 (76.4–94.0)	70.8 (55.1–86.5)	79.5 (61.5–97.4)
Radiographic stem loosening				
At 10 years	94.9 (92.7–97.1)	96.5 (93.7–99.3)	94.0 (89.9–98.1)	91.0 (81.2–100)
At 15 years	88.9 (85.1–92.7)	91.1 (86.1–96.1)	86.7 (79.8–93.6)	78.7 (59.8–97.6)
At 20 years	78.1 (70.7–85.5)	78.9 (68.3–98.5)	77.5 (65.8–98.5)	63.0 (31.5–98.5)
Radiographic cup loosening				
At 10 years	96.8 (95.0–98.6)	97.6 (95.2–99.9)	97.1 (94.3–99.9)	97.1 (91.4–100)
At 15 years	89.3 (85.5–93.1)	84.9 (79.4–90.4)	90.8 (84.7–96.9)	84.2 (65.6–100)
At 20 years	76.6 (68.5–84.7)	76.2 (65.8–86.6)	76.1 (61.6–98.5)	67.3 (34.2–100)
Radiographic loosening, both components				
At 10 years	93.4 (91.0–95.8)	95.9 (93.5–98.3)	92.6 (88.2–97.4)	91.0 (81.2–100)
At 15 years	85.1 (80.8–89.4)	85.6 (81.3–89.9)	85.4 (78.4–92.4)	78.7 (59.8–97.6)
At 20 years	67.4 (58.4–76.4)	69.6 (60.6–78.6)	63.5 (46.9–80.1)	50.0 (16.1–83.8)

Values are expressed as percentages, with 95% confidence intervals in parentheses; BMI = body mass index.

suggested no difference in the outcome of uncemented THA in obese versus normal-weight patients, although a high revision rate for the acetabular component was present [13].

Our data suggest BMI and weight do not influence the long-term survival of cemented THA. We also found no differences in the incidence of THA-related complications for the overweight patients undergoing THA. Cardiovascular comorbidity was more common in the obese patients; however, we observed no differences in perioperative cardiac complications.

The percentage of overweight and obese individuals in our study is lower than those reported in American studies. In a study including 1071 American patients undergoing THA, 36% of the patients had a BMI greater than 30 kg/m^2 [16]. In The Netherlands, the annual incidence of obesity (BMI > 30 kg/m^2) gradually inclined from 5% in 1981 to 7% in 1993 and 10% in 2005 [3]. In our study, 9% had a BMI greater than 30 kg/m^2. For the overweight patients (BMI > 25 kg/m^2), these percentages were 33% in 1981 and 37% in 1993 and 35% in our study. Because OA is more common in overweight patients, we believe these percentages indicate our patient group is comparable to the average Dutch population [7]. This also indicates absence of a selection bias. All patients were operated on in our hospital regardless of their weight. Another major

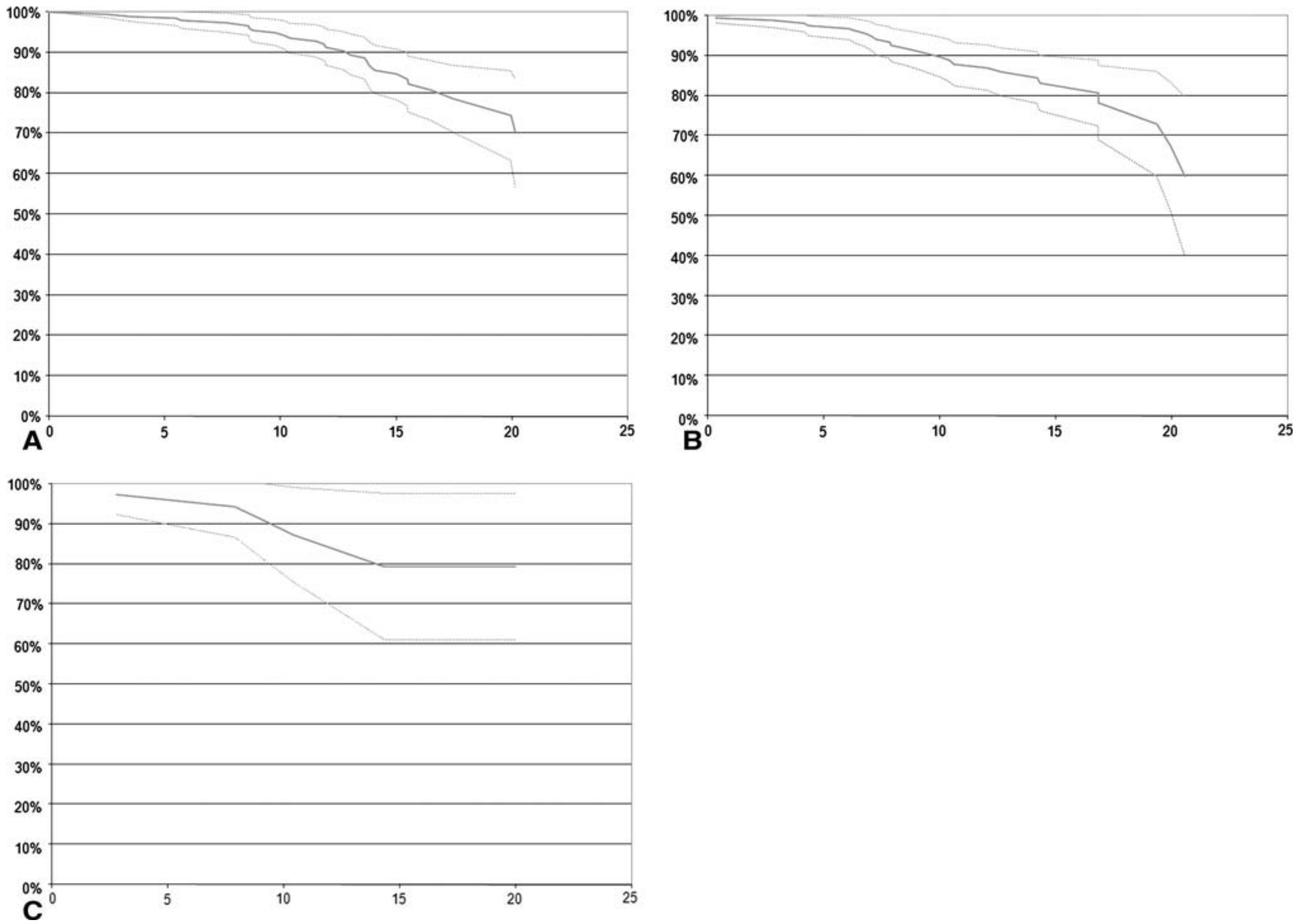

Fig. 1A–C Survival rates are shown for patients with (**A**) a BMI less than 25 kg/m^2, (**B**) a BMI greater than 25 kg/m^2, and (**C**) a BMI greater than 30 kg/m^2. The x-axis shows years and the y-axis shows survival rates. The solid line represents survival rate and the dotted lines represent the 95% confidence intervals.

Table 3. Average Harris hip score per BMI group

BMI < 25 kg/m^2	BMI > 25 kg/m^2	BMI > 30 kg/m^2
91.6 (89.3–93.9)	86.8 (83.5–90.1)*	83.7 (74.5–92.3)*

Values are expressed as averages, with 95% confidence intervals in parentheses; * difference with group with a BMI of less than 25 kg/m^2 ($p = 0.02$); BMI = body mass index.

difference between our Dutch population and the American population is extreme obesity (BMI > 40 kg/m^2) was low in our country before 1993. We had only two patients who had a BMI greater than 40 kg/m^2 (neither had revision and had HHS of 87 and 90). This low number of patients with a BMI greater than 40 kg/m^2 means our study does not supply an answer for the long-term fate of THAs in these extremes.

Several publications report on the short-term results of THA in the obese in which the HHS after surgery are compared between obese and normal-weight patients. The literature contains controversial data suggesting either similar or worse outcomes for obese patients undergoing THA. Two large studies reported lower HHS in obese patients after short-term followup [1, 14]. Both showed lower HHS with an average difference of 5 points, but neither compared the preoperative HHS among the different groups. The clinical relevance of these small differences in the postoperative HHS without a comparison of the preoperative HHS is debatable, especially because other studies showed no differences in postoperative HHS between the several weight groups [18]. Another study suggested the level of activity is lower, which continues to be so after THA [12]. The same problem occurs in our study because no preoperative HHS was available for analysis. If patients who are more obese have initial lower HHS and similar improvement as normal-weight patients after the arthroplasty, the same difference remains. Although our data suggest differences between the average HHS in the weight groups, the differences between the mean HHS were small (4.8 and 7.1). However; the only study on the responsiveness and discriminative ability of

Table 4. Complications per BMI group

Complication	All (n = 489 hips)	BMI < 25 kg/m^2 (n = 201 hips)	BMI > 25 kg/m^2 (n = 172 hips)	p Value*	BMI > 30 kg/m^2 (n = 42 hips)	p Value*
Venous thromboembolism	2 (0.4%)	1 (0.5%)	0		0	
Cardiac	6 (1.2%)	1 (0.5%)	4 (2.3%)	1.0	2 (4.8%)	1.0
Respiratory	3 (0.6%)	1 (0.5%)	1 (0.6%)	1.0	1 (2.4%)	0.31
Abdominal	4 (0.8%)	2 (1.0%)	1 (0.6%)	1.0	0	
Other systemic (including urinary tract infection)	18 (3.7%)	8 (4.0%)	9 (5.2%)	0.62	1 (2.4%)	1.0
Hematoma	10 (2.0%)	6 (3.0%)	2 (1.2%)	0.30	2 (4.8%)	0.63
Early infection	5 (0.8%)	2 (1.0%)	3 (1.7%)	0.67	0	
Intraoperative complication	24 (4.9%)	11 (5.5%)	11 (6.4%)	0.67	2 (4.8%)	1.0
Any complication	68 (13.9%)	30 (14.9%)	28 (16.3%)	0.78	6 (14.3%)	1.0

* p values are given for the comparison with the group with a BMI of less than 25 kg/m^2 (Fisher exact test); BMI = body mass index.

Table 5. Radiographic analysis of the unrevised hips

Component	Definitive loosening		Probable loosening		Possible loosening	
	Number of hips	Time until loosening (years)*	Number of hips	Time until loosening (years)*	Number of hips	Time until loosening (years)*
Acetabular†	2	18.3 (18.2–18.3)	2	16.2 (13.9–18.4)	15	15.9 (9.0–23.0)
Femoral‡	6	18.9 (15.9–22.6)	1	23.2	11	17.9 (14.0–22.8)

* Values are expressed as averages, with ranges in parentheses; †according to the criteria of Hodgkinson et al. [9]; ‡according to the criteria of Harris et al. [8].

the HHS showed a difference of 4 points is enough to be clinically relevant, indicating our measured differences are clinically relevant [10]. However, the correlation of HHS with BMI as a continuous variable was poor (rho = −0.17), but the content validity of the HHS is poor, eg, a large ceiling effect is visible, which could influence the correlation coefficient measured (Fig. 2).

In a review of patient characteristics affecting the outcome of THA, a body weight greater than 70 kg was mentioned as a factor that negatively influences the outcome of THA [23]. They suggest weight alone is a much stronger predictor for the outcome than BMI because height has no influence on the prosthesis. In our series, neither body weight nor BMI influenced outcome.

One study stated patients who underwent bariatric surgery before having THA had an excellent outcome, although the average postoperative BMI of 29 kg/m^2 still indicated overweight. The main question we would ask is whether the outcome would have been worse if no bariatric surgery was performed [17].

We do not intend to suggest being overweight has no risks. We believe it is important to motivate overweight patients to lose weight. Being overweight could increase the rate of OA and has an increased risk for several nonorthopaedic morbidities [7]. However, should a (cemented) THA be necessary in an overweight or obese patient, the arguments that survival is shorter in obese patients and that obese patients have a higher risk of perioperative complications do not seem valid.

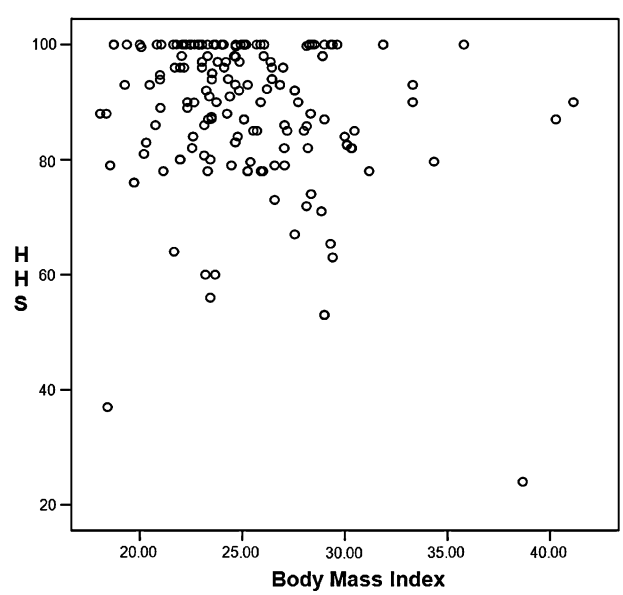

Fig. 2 A scatterplot shows HHS versus BMI. The ceiling effect of the HHS can be seen.

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