Metabolic Surgical Unit of the Hospital das Clínicas, University of São Paulo Medical School. The inclusion criteria were age between 18 and 60 years, a body mass index (BMI) between 40 and 60 kg/m^2 and a Timed Up and Go (TUG) $\leqslant$10 seconds. The exclusion criteria were as follows: patients with functional disability (TUG $>$10) (13), treatment with steroid medication for any reason or the use of artificial devices such as an orthosis or a prosthesis. Twenty-three patients were excluded: 5 subjects with BMI $<$40 kg/m^2, 7 with BMI $>$60 kg/m^2, and 11 with musculoskeletal disorders (7 subjects with TUG results $>$10 seconds and 4 subjects with artificial devices). Then, 132 patients (100 females and 32 males) were enrolled in the study, including 87 patients with a BMI between 40 and 49.9 kg/m^2 (the A group) and 45 patients with a BMI $\geqslant$50 kg/m^2 (the B group).

Body composition was determined by bioelectrical impedance analysis (BIA) under constant conditions (with subjects appropriately hydrated and at the same time of day). The body composition analyzer (InBody230, Biospace Co., Gangnam-gu, Seoul, South Korea) was a segmental impedance device that uses a tetrapolar 8-point tactile electrode system, and the measured weight range was 10 to 250 kg. Impedance measurements were performed by utilizing 2 different frequencies (20 and 100 kHz) at each segment (the right arm, left arm, trunk, right leg, and left leg). The participant was positioned in an orthostatic position on a platform with lower electrodes for the feet and two brackets (the upper electrodes) gripped on hands. Data output was calculated in percentages (%) and included FM, FFM, trunk FFM, and appendicular FFM (the sum of the FFM values for the right arm, left arm, right leg, and left leg). The Biodex® Multi-joint System 3 dynamometer (Biodex Medical Systems, Inc., Shirley, NY, USA) was used to measure isokinetic extension (Ext) and flexion (Flex) MVC torques for both legs.

The dynamometer was calibrated before each test, and a strap was used to attach the dynamometer's arm 3 cm above the lateral malleolus. Straps were also applied across the chest, pelvis and mid-thigh regions. Participants remained seated on the dynamometer chair, with the hip and knee joints at 90° flexion, and performed four submaximal contractions involving Ext and Flex of the knees during a warm-up period to familiarize themselves with their MVCs and produce consistent results. Participants then executed two series of four uninterrupted repetitions of Ext and Flex of both legs, first with the dominant member and subsequently with the non-dominant member, at an angular velocity of 60°/s, with a 60-second interval between series. During the testing period, standardized encouragement (e.g., "You are doing well") was provided to all volunteers to ensure that strength during the contractions was maximized (14). The MVC variables that were assessed included absolute Ext and Flex torques (Nm), Ext and Flex torques relative to the body weight (Nm/Bw) and Ext and Flex torques relative to FFM (Nm/FFM) (15,16).

Statistical analyses

The sample size was estimated based on an expected effect size of 10% for the relationships between FFM and the Ext and Flex MVC torques and a significance threshold of 5% ($p<0.05$). The calculated minimum sample size was 132 subjects. All data are presented as the mean ± standard deviation, median, first quartile and third quartile. Unpaired t-tests were used for comparisons between groups when normality was not rejected by the Anderson Darling test. In case of rejection of normality, we used the Mann-Whitney test when the variables were homogeneous and the t test and Brunner Munzel test when the variables were heterogeneous. Homogeneity (or homoscedasticity) was verified by the Bartlett test. Associations were evaluated using Pearson and Spearman correlations.

Ethical considerations

Informed consent was obtained from all participants included in this study. All study procedures were conducted in accordance with the ethical standards of relevant institutional and/or national research committees and thus satisfied the standards set forth in the Declaration of Helsinki in its revised version from 1975 and its amendments in 1983, 1989, and 1996. This study was approved by the Hospital das Clínicas Ethical Committee, University of São Paulo Medical School (no. 01038912.6.0000.0068).

RESULTS

The anthropometric characteristics, body composition and absolute and relative MVC torques of individuals are listed in Table 1. There were no differences between the dominant and non-dominant lower limbs with respect to absolute extension (156.76 ± 43.67; 156.15 ± 46.2, p=0.992) or flexion (72.52 ± 23.56; 71.45 ± 21.6, p=0.901). Therefore, only the dominant member was considered for analysis.

The anthropometric characteristics, body composition and absolute and relative MVC torques of subjects grouped by obesity grade are provided in Table 2. There were no significant differences between the two groups with respect to age or height. Significant between-group differences were detected for all body composition variables. Both groups exhibited similar mean values of absolute Ext and Flex MVC torques. However, Ext MVC torque relative to body weight (BW) and FFM was significantly reduced in the B group.

The correlations between absolute MVC torques and total and segmental body composition for the patient groups are listed in Table 3. The absolute Ext and Flex MVC torques had weak associations with FFM. However, there was a moderate association with absolute extension torque and fat with free

Table 1 - Anthropometric characteristics, body composition, and absolute and relative maximum voluntary contraction torques for obese patients.

	Mean ± SD	Median	1° Q - 3° Q
Age (years)	40.5 ± 9.79	41	33.25-47.75
Height (cm)	1.62 ± 0.1	1.61	1.56-1.67
Weight (kg)	126.13 ± 19.64	122.35	111.93-136.85
IMC	47.65 ± 4.89	47.2	43.95-51.18
FFM%	49.27 ± 4.18	48.27	46.5-51.47
FFMLL%	50.72 ± 5.46	49.93	46.96-53.99
FM%	50.73 ± 4.18	51.73	48.53-53.5
FMLL%	49.28 ± 5.46	50.07	46.01-53.04
Ext (Nm)	156.45 ± 43.57	150.75	123.88-183.48
Ext (Nm/Bw)	123.53 ± 29.4	122.9	102.06-141.15
Ext (Nm/FFM)	250.91 ± 47.67	249.14	219.49-278.68
Flex (Nm)	71.98 ± 21.98	67.75	55.84-82.2
Flex (Nm/Bw)	56.95 ± 15. 68	56.62	46.15-67.35
Flex (Nm/FFM)	115.58 ± 26.87	114.89	97.52-132.42

Note: SD: standard deviation; BMI: body mass index; FFM: fat-free mass; FM: fat mass; Ext: extension; Flex: flexion; Nm: newton-meter; Nm/Bw: newton-meter/body weight; Nm/FFM: newton-meter/fat-free mass.