

Assessing anthropometric measurements in patients screened for total knee arthroplasty

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The purpose of this study was to assess whether body circumferences (e.g., waist, hip, thigh, and calf) and body mass index (BMI) differed between surgical and non-surgical candidates for total knee arthroplasty (TKA). A total of 217 subjects were screened from 2014-2017 at the Halifax In-firmiry Orthopaedic Assessment Clinic by two surgeons. Patients were assigned to surgical and non-surgical groups based on the treating surgeon's recommendation for TKA after standard clinical assessment, with no BMI or circumference cutoff used. Post hoc descriptive statistical analyses were conducted on each variable to investigate differences between surgical and non-surgical groups, followed by univariate analysis (i.e., two-tailed t-test, p-value) to examine whether any observed differences were statistically significant. Results showed that BMI, waist circumference (WC), hip circumference (HC), and calf circumference (CC) differed significantly between surgical and non-surgical candidates; BMI, WC, HC, and CC were collectively larger in patients selected as TKA candidates.

Introduction

Osteoarthritis (OA) is the most common age-related form of arthritic disease affecting 1 in 10 Canadians.¹ OA is a degenerative joint disease frequently seen in the knees, hips, and hands. Specifically, OA involves the breakdown of joint cartilage, which results in changes in the underlying bone. The development of OA is slow and worsens over time, leading to swelling, stiffness, and pain. Based on the severity of these symptoms, one can experience limitation of motion, deformity, and disability in which the individual has trouble or completely fails in carrying out daily tasks.² The occurrence of OA is increasing by approximately 1% every year, with an estimated prevalence of 20% by 2026.¹ Among individuals with OA, the knee is the most commonly affected joint in the human body and is associated with significant disability, stiffness, and pain. For patients with advanced or end-stage knee OA, or those who have not responded to conservative management, total knee arthroplasty (TKA) is the standard surgical intervention, particularly in the older population.³

When assessing for TKA surgical candidacy, incorpo-

rating anthropometric measures is common. Anthropometry quantitatively measures muscle, bone, and adipose tissue to assess body composition. Obesity, which increases the risk of cardiovascular disease, diabetes mellitus, and hip/knee osteoarthritis, can also be assessed using anthropometric measurements. The core anthropometric elements include body mass index (BMI), body circumferences (e.g., waist, hip, calves, and thighs), height, skinfold thickness, and weight.⁴

The controversy surrounding BMI cut-off criteria for obesity-related conditions has been an ongoing topic of debate. In the context of total joint arthroplasty, Giori et al. (2018) investigated the trade-off between restricting access to care and avoiding post-surgical complications when enforcing BMI-eligibility criteria.⁵ It was concluded that a 30 kg/m² criterion was not appropriate for determining surgical eligibility because its positive predictive value for major postoperative complications (5.33%) was only marginally better than chance (5.05%). A commonly advocated BMI cut-off criterion for surgical eligibility is >40 kg/m².⁵ Nevertheless, Giori et al. (2018) found that this criterion would result in 14 mor-

bidly obese patients not receiving uncomplicated surgical treatment for every one patient who would have avoided post-surgical complications. Therefore, criticism surrounding BMI and its effectiveness during patient assessment for surgical candidacy has been questioned repeatedly.

BMI does not consider body fat distribution, which is an important factor influencing surgical risk and outcomes.^{6,7} Central obesity, estimated by waist circumference, has been associated with increased postoperative complications following TKA.⁸ Similarly, Janssen et al. (2004) mentioned that BMI is a predictor of mortality and morbidity in chronic diseases but emphasized that BMI alone is not a great predictor of health risk unless coupled with waist circumference. Waist circumference, established as an appropriate tool for measuring abdominal obesity, has become increasingly relevant in assessing surgical risk and health outcomes.⁹ Lim et al. (2021) further supported these findings, exploring whether the risk associated with obesity-related TKA was better defined by waist circumference or BMI. They concluded that both BMI and waist circumference should be used during treatment assessment and preventive measures for obesity-related OA.¹⁰

Recent studies have reported that patients with higher BMI can achieve significant improvements in pain relief and functional status after TKA, with satisfaction levels comparable to those of patients with lower BMI.¹¹ This suggests that strict BMI cutoffs may unnecessarily exclude patients who could benefit greatly from surgery. Therefore, the purpose of this exploratory study was to analyze the relationship between body circumferences (e.g., waist, hip, thigh, and calf) and BMI in surgical and non-surgical TKA candidacy. BMI fails to consider body fat percentage and body fat distribution, which may limit its utility in assessing TKA candidacy.¹² This

study's objective was to investigate the hypothesis that BMI and body circumferences (WC, HC, TC, and CC) would differ between patients selected for TKA and those not selected, and that these measures might provide complementary information in TKA assessment.

Methods

Subject Selection

This study was completed at the QEII, involving patients referred for orthopaedic assessment to two experienced arthroplasty surgeons (2014-2017). The local research ethics approved this study, and all patients provided written informed consent. The subjects were chosen based on the following criterion:

Inclusion Criteria:

- 18+ years of age
- Referred for arthroplasty consult
- Primary diagnosis: moderate to severe OA

Exclusion Criteria:

- Unable to walk 50 feet
- Unable to provide consent
- Pregnancy
- Unable to stand for a minimum of 15 minutes without aid

Patients were assigned to the surgical group if the treating surgeon recommended TKA at the assessment visit. The decision was based on standard clinical assessment, including history, physical examination, radiographic severity, symptom burden, functional limitations, and patient preference. No explicit BMI or circumference cutoff was used. Research circumference measurements were not available to the surgeons. A total of 217 subjects were assigned to surgical and non-surgical groups (Table 1).

Table 1 | Subject Demographics

Variables	Surgical (n=112)	Non-surgical (n=105)	Total (n=217)
Age			
n	112	105	217
Mean	64.62	64.73	64.67
Gender, n (%)			
Male	40 (35.71)	48 (45.71)	88 (40.55)
Female	72 (64.29)	57 (54.29)	129 (59.45)
BMI, n (%)			
Normal	5 (4.46)	10 (9.52)	15 (6.91)
Overweight	34 (30.36)	39 (37.14)	73 (33.64)
Obese I	31 (27.68)	32 (30.48)	63 (29.03)
Obese II	20 (17.86)	11 (10.48)	31 (14.29)
Obese III	22 (19.64)	13 (12.38)	35 (16.13)

Note. Age (n, mean), gender [n (%)], and BMI classification [n (%)] are presented for the surgical, non-surgical, and total groups. Normal BMI ranges: 18.5-24.9; Overweight: 25.0-29.9; Obese I: 30.0-34.9; Obese II: 35.0-39.9; Obese III: > 40.0.

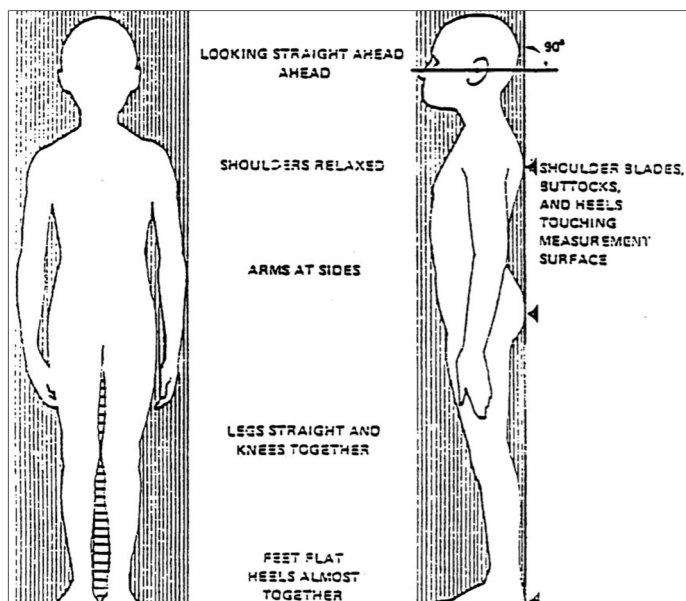


Figure 1 | Subject Positioning for Measuring Height Using a Stadiometer

Note. Depiction of posterior and side view for positioning and body contact points required to accurately measure height using a stadiometer.¹³

Anthropometric Measurements – Weight, Height, BMI

Weight was measured using an electronic scale. The subject's weight was recorded in kilograms. Height was measured using a stadiometer. The subject was positioned appropriately (Figure 1), and the examiner recorded height to the nearest 0.1 cm.¹³ The subject's height was measured in centimeters. Therefore, an alternative BMI equation (2) with respect to the traditional equation (1) was used.¹⁴ Each subject's BMI was calculated using Microsoft Excel (Version 2102; Build 13801.21050).

1. $BMI = \text{weight (kg)} / (\text{height (m)})^2$.
2. $BMI = [\text{weight (kg)} / (\text{height (cm)})^2] \times 10,000$

Anthropometric Measurements – Waist Circumference, Hip Circumference, Thigh Circumference, Calf Circumference

Waist circumference (WC) was measured by placing the subject in the standing position. Landmarking of the affected leg iliac crest was completed using hip palpation from behind the patient. The examiner marked a horizontal line at the high point of the iliac crest. The horizontal line was then crossed to indicate the midaxillary line extending from the subject's armpit and down their torso (Figure 2). The examiner stood on the subject's affected side and placed a measuring tape around the trunk in a horizontal plane at the marked level. Finally, the recorder ensured the measuring tape was parallel to the floor, the tape did not excessively compress the subject's skin, and that the measurement was taken at minimal respiration to the nearest 0.1 cm.¹³

Hip circumference (HC) was measured with the sub-

ject's feet together, their weight evenly distributed on both feet, and standing erect. The examiner ensured the measurement was in the horizontal plane at the maximum extension of the buttocks. The measurement was recorded to the nearest 0.1 cm.¹³

Thigh circumference (TC) measurement involved the subject standing with the affected leg just in front of the unaffected leg, ensuring weight was shifted back on the unaffected leg with precautions for the subject to maintain balance. Measurement around the mid-thigh of the subject's affected leg, perpendicular to the thigh's long axis, was recorded to the nearest 0.1 cm.¹³

Calf circumference (CC) measurement involved the subject standing erect, having their weight distributed evenly on both feet and legs slightly spread apart. Measurement involved placing the measuring tape around the largest circumference of the affected calf. Because maximal calf girth was not apparent for every subject, the examiner moved the measuring tape up and down until maximal circumference was located and aligned in the horizontal plane. Measurement was recorded to the nearest 0.1 cm.¹³

Surgeons did not have access to the body circumference measurements collected for this study; these measurements were collected as part of the research protocol and were not used in clinical decision-making. The surgeons made decisions regarding surgical candidacy based on their standard clinical assessments without knowledge of these measurements.



Figure 2 | Identification of the Iliac Midaxillary Line for Measuring Waist Circumference

Note. Midaxillary line of the iliac crest is located in line with the subject's armpit and marked with a (+) symbol.¹³

Data Analysis

Subject demographics, history, and measurements were captured and analyzed with Microsoft Excel for 217 subjects. Differences in BMI, WC, HC, CC, TC, waist-thigh ratio (WTR), waist-hip ratio (WHR), waist-calf ratio (WCR), thigh-hip ratio (THR), thigh-calf ratio (TCR), and hip-calf ratio (HCR) between surgical and non-surgical groups were evaluated using descriptive statistical analysis and univariate analysis.

Box-whisker plots were formulated for each variable using the graph add-on embedded in Microsoft Excel to conduct descriptive statistical analysis. Each box-whisker plot provided a mean, median, mode, quartiles, outliers, and range value. To assess the difference between surgical and non-surgical groups, percent difference (3) for each variable was calculated using the following formula:

(3) % = [Distance between medians (DBM) / Overall visible spread (OVS)] x 100 (Figure 3)

For sample sizes of approximately 100, a difference between medians greater than one-fifth (20%) of the overall visible spread was used as a descriptive guideline for identifying possible differences between groups.¹⁵ In addition, univariate analysis was done by conducting two-tailed t-tests for each pair of box-whisker plots

using the data analysis add-on in Microsoft Excel. Each t-test provided a p-value, with statistical significance defined as $p < 0.05$. Percent difference was calculated for descriptive purposes only and was not used to determine statistical significance. The relationship between surgical and non-surgical groups for each variable was assessed using descriptive statistical analysis (DSA; i.e., box-whisker plots, percent difference) and univariate analysis (i.e., two-tailed t-tests, p-value; Table 3).

Descriptive Statistical Analysis - Box-Whisker Plots

Box-whisker plots for surgical and non-surgical groups were graphed to conduct DSA (Figure 4 and 5) and percent difference (Figure 3). BMI (20.6%), WC (24.2%), HC (22.0%), and TC (21.5%) were found to be greater than 20% (Table 2), exceeding the descriptive 20% threshold. Furthermore, the percent difference for CC (13.3%) was below 20%. However, the p-value for CC ($p = 0.020$) suggests that the minimal difference between the surgical and non-surgical groups was significant (Table 3). Also, the p-value for TC ($p = 0.297$) indicated that although the percent difference for TC (21.5%) was greater than 20%, the difference seen between the surgical and non-surgical groups was not significant. In contrast, variables WTR (8.77%), WHR (10.7%), WCR (13.3%), THR (15.7%), TCR (16.4%), and HCR (N/A) either resulted below 20% or were not applicable due to the DBM equating zero (Table 2).

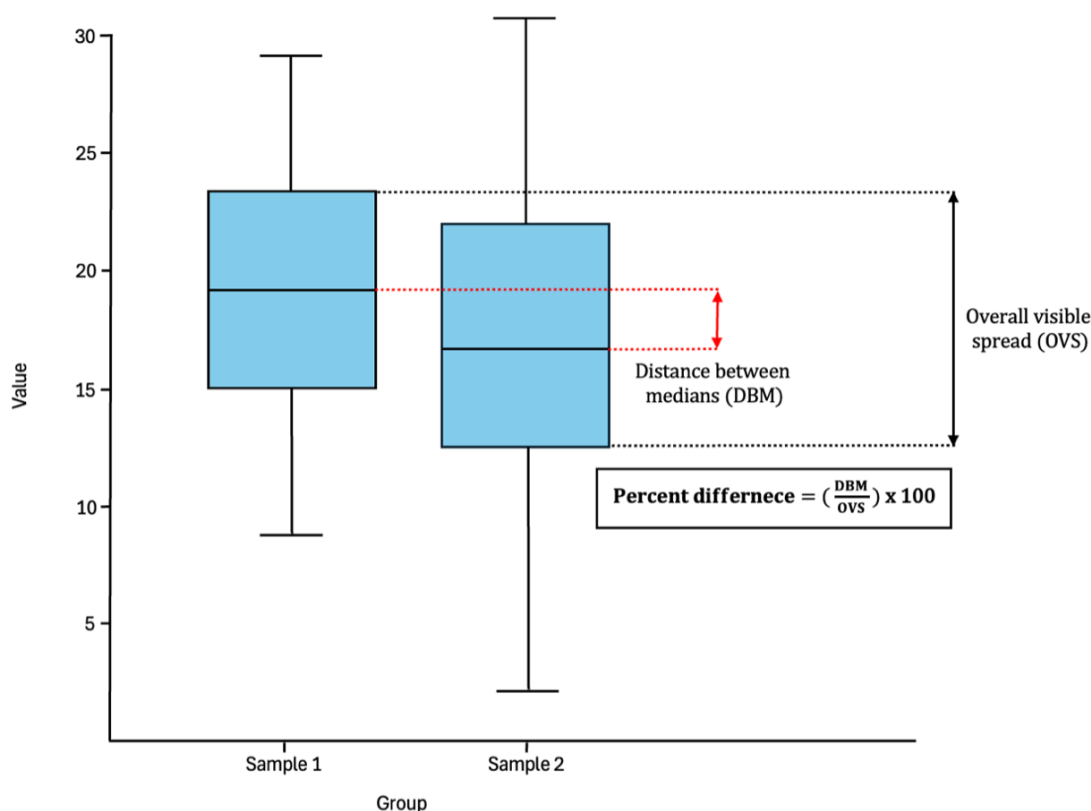


Figure 3 | Percent Difference

Note. A general example illustrating the parameters used to calculate the percent difference between two box-whisker plots.¹⁵

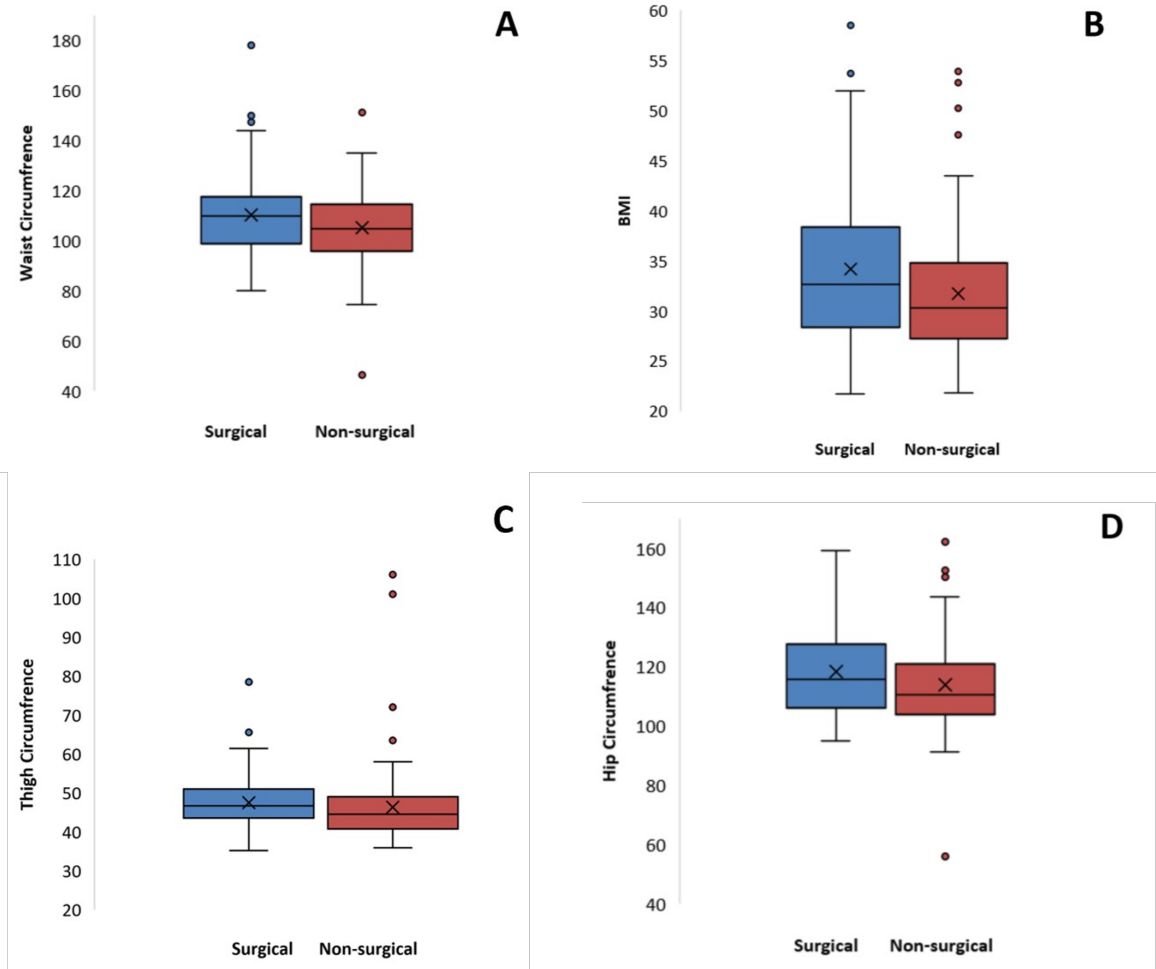


Figure 4 | Anthropometric Variables with Percent Difference Exceeding 20%

Note. In each box-whisker plot, the "X" represents the mean, the box gives the interval between the 25% and 75% percentiles, and the horizontal line within the box represents the median. The whisker indicates the range, and the dots depict outliers within the data.

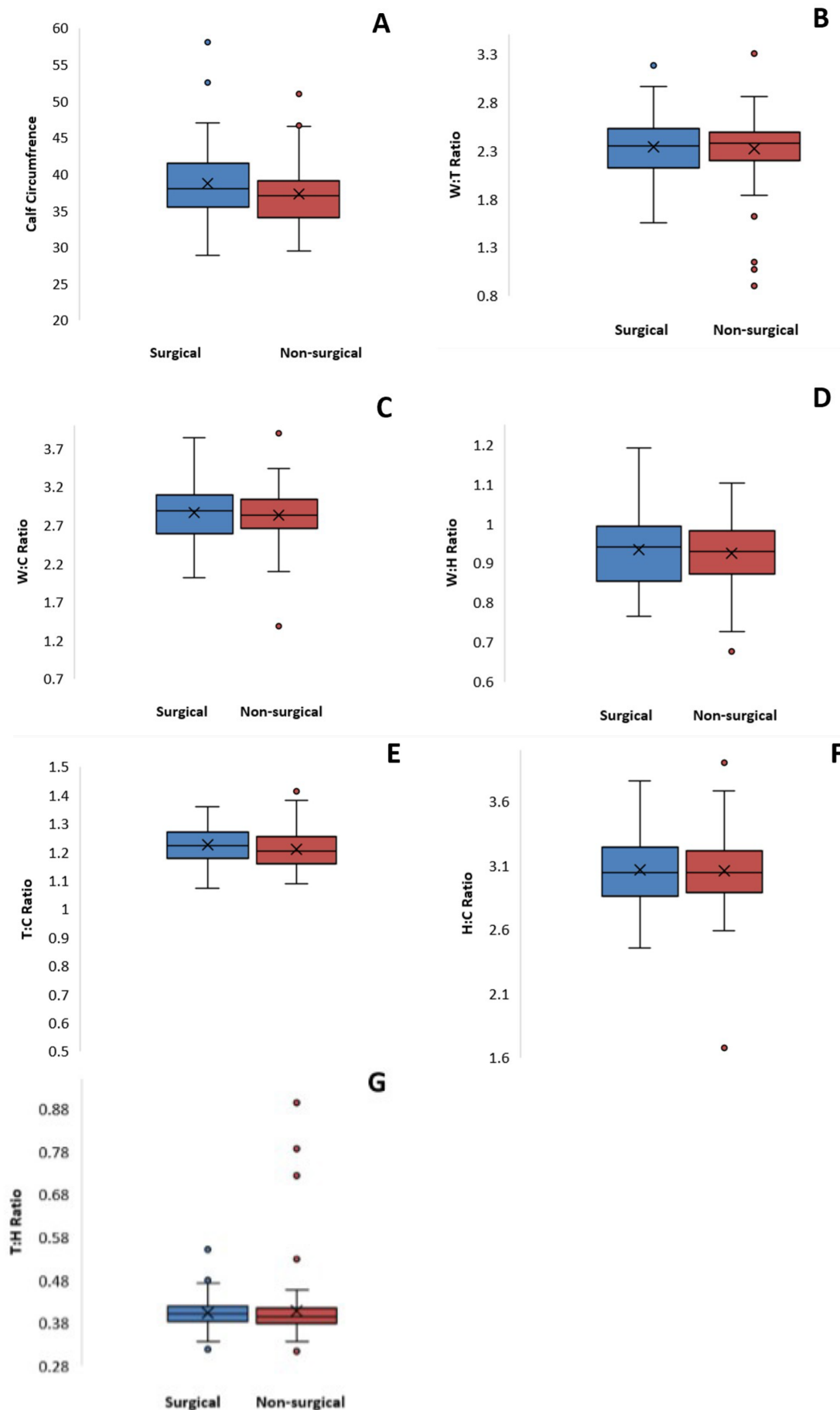


Figure 5 | Anthropometric Variables with Percent Difference Below 20%

Note. In each box-whisker plot, the "X" represents the mean, the box gives the interval between the 25th and 75th percentiles, and the horizontal line within the box represents the median. The whisker indicates the range, and the dots depict outliers within the data.

Table 2 | Percentage Difference Results

Variables	Calculated Result (%)
BMI (kg/m ²)	20.6*
WC (cm)	24.2*
HC (cm)	22.0*
CC (cm)	13.3
TC (cm)	21.5*
WTR	8.77
WHR	10.7
WCR	13.3
THR	15.7
TCR	16.4
HCR	N/A

Note. Percent difference: % = [Distance between medians (DBM)/Overall visible spread (OVS)] x 100. Not applicable (N/A): the difference between medians = 0; therefore, the formula could not be applied.
 *Percent difference exceeded the 20% descriptive threshold. Statistical significance was determined by p-values in Table 3.

Univariate Analysis – Two-tailed t-tests

Two-tailed t-tests were conducted to generate a p-value for each variable (Table 3). The purpose of the univariate analysis was to see whether differences between surgical and non-surgical groups obtained through DSA (i.e., percent difference) were significant. The alpha (α = significance value) was set to 0.05. The p-values for BMI (p = 0.0095), WC (p = 0.024), and HC (p = 0.034; Table 3) suggested that the difference between the surgical and non-surgical groups was significant. In comparison, p-values for WTR (p = 0.613), WHR (p = 0.488),

WCR (p = 0.495), THR (p = 0.482), TCR (p = 0.117), and HCR (p = 0.802) implied that no significant difference was found between the surgical and non-surgical groups (Table 3).

Although the percent difference for CC was below the 20% descriptive threshold (13.3%), the two-tailed t-test indicated a statistically significant difference between groups (p = 0.020). Conversely, although the percent difference for TC exceeded 20% (21.5%), the t-test indicated no statistically significant difference (p = 0.297).

Table 3 | Univariate Analysis and Descriptive Statistics for Surgical and Non-surgical Groups

Variables	$\bar{x}$ Surgical	$\bar{x}$ Non-surgical (=n)	P-value (α = 0.05)	$\bar{x}$ Total (=n)
BMI (kg/m ²)	34.2 (112)	31.7 (105)	0.0095*	33.0 (217)
WC (cm)	110.1 (112)	105.2 (105)	0.024*	107.8 (217)
HC (cm)	118.2 (112)	113.9(105)	0.034*	116.1 (217)
CC (cm)	38.7 (111)	37.3 (103)	0.020*	38.0 (214)
TC (cm)	47.5 (112)	46.3 (105)	0.297	46.9 (217)
WTR	2.34(112)	2.31 (105)	0.613	2.33 (217)
WHR	0.933 (112)	0.925 (105)	0.488	0.930 (217)
WCR	2.86 (111)	2.83 (103)	0.495	2.84 (214)
THR	0.402 (112)	0.407 (105)	0.482	0.405 (217)
TCR	1.22 (111)	1.21 (103)	0.117	1.22 (214)
HCR	3.06 (111)	3.05 (103)	0.802	3.06 (214)

Note. Body mass index (BMI), waist circumference (WC), hip circumference (HC), calf circumference (CC), thigh circumference (TC), waist-thigh ratio (WTR), waist-hip ratio (WHR), waist-calf ratio (WCR), thigh-hip ratio (THR), thigh-calf ratio (TCR), hip-calf ratio (HCR). The mean ($\bar{x}$), and sample size (=n) for surgical, non-surgical, and total groups are shown for each variable. Two-tailed t-tests were performed to compare anthropometric measurements and ratios between surgical and non-surgical groups. * p < 0.05

Discussion

This study investigated whether anthropometric measurements differed between TKA candidates and non-candidates. It was hypothesized that BMI and body circumferences (WC, HC, TC, and CC) would differ between patients selected for TKA and those not selected. Significant differences were found between surgical and non-surgical groups for BMI, waist circumference (WC), hip circumference (HC), and calf circumference (CC), with all four measures being higher in patients selected as TKA candidates. In contrast, waist-thigh ratio (WTR), waist-hip ratio (WHR), waist-calf ratio (WCR), thigh-hip ratio (THR), thigh-calf ratio (TCR), and hip-calf ratio (HCR) did not show significant differences between surgical and non-surgical groups, suggesting that ratios of paired circumferences may be less informative than individual circumference measures in this context. Interestingly, thigh circumference (TC) was the only individual body circumference measure with no statistically significant difference between groups, which may warrant further investigation.

Obesity is a well-established risk factor for osteoarthritis (OA), and knee OA is a common condition leading to total knee arthroplasty (TKA).^{2,11} Previous studies indicate that BMI alone is not a strong predictor of obesity-related health risks. Combining BMI with waist circumference may improve risk assessment.^{6,7,9} However, other anthropometric body circumferences have not been extensively considered. In this study, HC and CC also demonstrated significant differences between surgical and non-surgical groups, in addition to BMI and WC. Thus, HC and CC, in addition to BMI and WC, may warrant further investigation as part of TKA assessment.

Moreover, several outliers were observed. For example, the box-whisker plot for BMI portrayed six outliers—two for surgical and four for non-surgical candidates (Figure 4B). Among these, two subjects had the same BMI (53 kg/m²); however, one was a surgical candidate (Subject A), and the other received non-surgical management (Subject B). WC and HC reflect fat distribution, which BMI does not capture.^{6,9} Subject A had a lower WC (119 cm) and HC (144 cm) but a higher CC (52.5 cm) compared to Subject B, who had a WC of 151 cm, HC of 162 cm, and CC of 46.0 cm. Both subjects had similar TC measurements (Subject A: 65.5 cm; Subject B: 63.5 cm). Similar patterns were observed among other outliers in the BMI, WC, HC, and CC plots (Figures 4 and 5). These examples illustrate how circumference measures may provide additional information beyond BMI, although these observations are exploratory and require confirmation in larger samples.

Limitations

This study has several limitations that warrant careful consideration when interpreting the results. First, the

relatively small sample size of 217 subjects, while adequate for preliminary analysis, may limit the statistical power and generalizability of the findings. Recruiting patients from only two experienced arthroplasty surgeons at a single institution further introduces potential selection bias. These patients may not represent all individuals with knee osteoarthritis (OA), as referral patterns, surgeon preferences, and institutional practices could influence which patients are considered for total knee arthroplasty (TKA), thereby affecting the outcomes.

Second, the study did not control for potential confounding variables that could influence both anthropometric measurements and TKA candidacy. Factors such as comorbidities (e.g., diabetes, cardiovascular disease), severity of OA, pain levels, functional status, physical activity levels, and socioeconomic status were not accounted for, which may result in biased estimates and limit causal inferences. Moreover, our reliance on univariate analysis without adjusting for multiple comparisons or confounders may lead to Type I errors or false associations. Multivariate techniques like regression models would have been more appropriate to adjust for confounding factors and assess the independent effects of each anthropometric measurement on TKA candidacy.

Third, measurement error is a limitation, as anthropometric measurements can be subject to inter-observer variability despite standardized protocols. Small inconsistencies in measuring techniques for waist circumference (WC), hip circumference (HC), thigh circumference (TC), and calf circumference (CC) could affect data accuracy and reliability. Using more precise tools or repeated measurements could mitigate this issue. Additionally, we did not measure knee circumference, which may provide additional information about localized adiposity and its potential relationship with surgical-site complications. Future studies should evaluate knee circumference in relation to surgical outcomes.

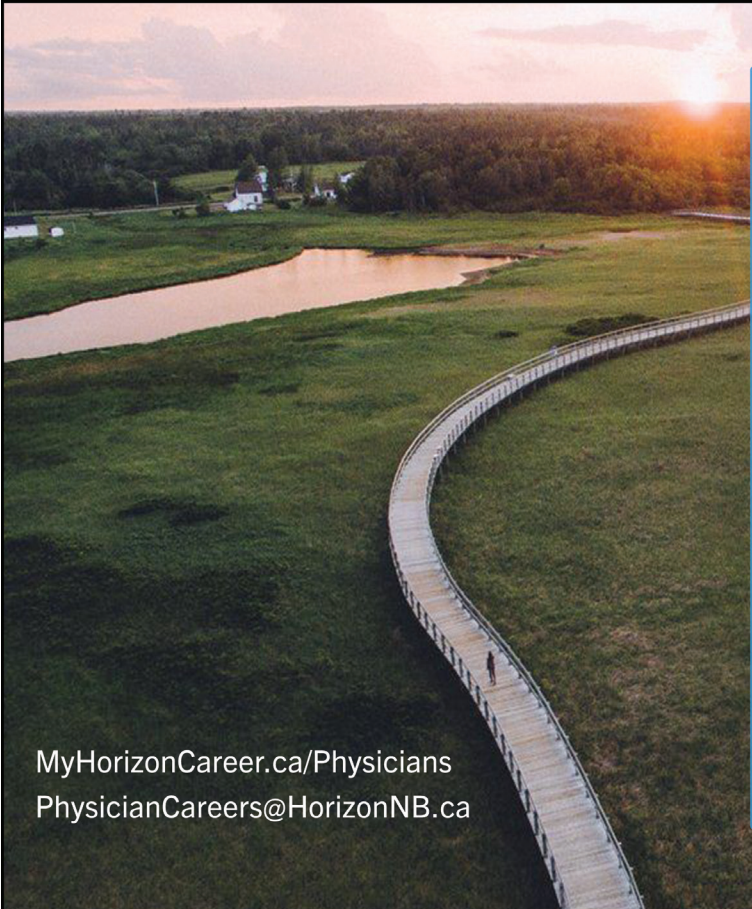
Lastly, the study did not evaluate postoperative outcomes or complications, limiting our ability to assess whether the identified anthropometric factors are associated with surgical success or patient satisfaction. This limitation is crucial, as understanding the relationship between anthropometric measurements and surgical outcomes is essential for translating research findings into clinical practice.

It is important to emphasize that this study was intended for research purposes only and not as a basis for patient selection in clinical practice. The findings are exploratory and should not influence clinical decision-making without further validation. Future research with larger, more diverse populations and robust methodological designs is necessary to confirm these preliminary findings and determine their clinical significance.

Conclusion

BMI, WC, HC, and CC differed significantly between TKA candidates and non-candidates. These exploratory findings suggest that anthropometric measures other than BMI may provide additional information relevant to TKA assessment and warrant further investigation in multivariable studies.

1. Lagace, C., Perruccio, A., DesMeules, M., Badley, E. Arthritis in Canada: An ongoing challenge. Ottawa, Ontario: Public Health Agency of Canada; 2003.
2. Centers for Disease Control and Prevention. "Osteoarthritis." CDC - Centers for Disease Control and Prevention. <https://www.cdc.gov/arthritis/osteoarthritis/>
3. Kamlay, P., et al. Clinical and functional outcomes following primary total knee arthroplasty in patients with knee osteoarthritis: A prospective study. *Cureus*. 2025;**17**(6):e86944. doi:10.7759/cureus.86944
4. Casadei, K., Kiel, J. "Anthropometric Measurement." NCBI. 2021. <https://www.ncbi.nlm.nih.gov/books/NBK537315/>
5. Giori, N.J., et al. Risk reduction compared with access to care: Quantifying the tradeoff of enforcing a body mass index eligibility criterion for joint replacement. *J Bone Joint Surg Am*. 2018;**100**(7):539-45. doi:10.2106/JBJS.17.00120
6. Ross, R., et al. Waist circumference as a vital sign in clinical practice: A consensus statement from the IAS and ICCR Working Group on Visceral Obesity. *Nat Rev Endocrinol*. 2020;**16**:177-89. doi:10.1038/s41574-019-0310-7
7. Stefan, N., Schick, F., Häring, H.U. Causes, characteristics, and consequences of metabolically unhealthy normal weight in humans. *Cell Metab*. 2017;**26**(2):292-300. doi:10.1016/j.cmet.2017.07.008
8. Gordon, A.M., Nian, P.P., Hameed, D., Vakharia, R.M., Mont, M.A. Increased waist circumference is associated with severe postoperative medical complications following total knee arthroplasty: Understanding waist circumference and relation to body mass index. *J Arthroplasty*. 2025;**40**(7 Suppl 1):S188-S193. doi:10.1016/j.arth.2025.03.039
9. Janssen, I., Katzmarzyk, P.T., Ross, R. Waist circumference and not body mass index explains obesity-related health risk. *Am J Clin Nutr*. 2004;**79**(3):379-84. doi:10.1093/ajcn/79.3.379
10. Lim, Y.Z., et al. Obesity defined by body mass index and waist circumference and risk of total knee arthroplasty for osteoarthritis: A prospective cohort study. *PLoS One*. 2021;**16**(1):e0245002. doi:10.1371/journal.pone.0245002
11. Baghbani-Naghadehi, F., et al. Does obesity affect patient-reported outcomes following total knee arthroplasty? *BMC Musculoskelet Disord*. 2022;**23**:55. doi:10.1186/s12891-022-04997-4
12. Godziuk, K., Hawker, G.A. Obesity and body mass index: Past and future considerations in osteoarthritis research. *Osteoarthritis Cartilage*. 2024;**32**(6):452-59. doi:10.1016/j.joca.2024.02.003
13. Centers for Disease Control and Prevention. "National Health and Nutrition Examination Survey III - Body Measurements (Anthropometry)." 1988. <https://www.cdc.gov/nchs/data/nhanes3/manuals/anthro.pdf>
14. Centers for Disease Control and Prevention. "CDC - Calculating BMI using the metric system - BMI for Age Training Course - DNPAO." 2014. https://www.cdc.gov/nccdphp/dnpao/growthcharts/training/bmiage/page5_1.html
15. Wild, C.J., Pfannkuch, M., Regan, M., Horton, N.J. Towards more accessible conceptions of statistical inference. *J R Stat Soc Ser A Stat Soc*. 2011;**174**(2):247-295.



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