Obesity Increases Operating Room Times In Patients Undergoing Primary Hip Arthroplasty: A Retrospective Cohort Analysis

Bassam Kadry, MD[1], Clinical Assistant

Christopher D. Press, MD[1*], Resident

Hassan Alosh, MD[2], Resident

Isaac M. Opper[3]

Joe Orsini[3]

Igor A. Popov[3]

Jay B. Brodsky, MD[1], Professor

Alex Macario, MD, MBA[1], Professor

[1] Department of Anesthesiology, Perioperative and Pain Medicine
Stanford University Medical Center
Stanford, CA 94305

[2] Department of Orthopaedic Surgery
Hospital of the University of Pennsylvania
3400 Spruce Street, 2 Silverstein
Philadelphia, PA 19104

[3] Stanford University Economics Department
579 Serra Mall
Stanford, CA 94305

*Corresponding author: Jay B. Brodsky, Department of Anesthesiology, Perioperative and Pain Medicine, H3580 Stanford University Medical Center, Stanford, CA 94305; Phone: (650) 725-65869; Fax: (650) 725-8544; Email: Jbrodsky@stanford.edu

Attribution: Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University Medical Center

Presentations: Abstract Poster Presentation at the Western Anesthesia Regional Conference in Albuquerque, NM on May 10th 2013

Keywords: Obesity; Body mass index; Healthcare; Arthroplasty, replacement, hip.

Introduction:

Using the World Health Organization's (WHO) weight-class definitions, two-thirds

of the adult population in the United States above the age of 60 years are "pre-obese" or

33 "obese".[WHO, 2000; Flegal KM, et al. 2010] Furthermore, the prevalence of obesity is

34 projected to increase by > 33% over the next twenty years.[Finkelstein EA, 2012] The

35 current obesity "epidemic" has had a great impact on healthcare resources, and its

36 effects will increase further as the incidence of obesity continues to rise.[Wolf AM &

37 Colditz, GA 1998; Allison DB, Zannolli R & Narayan KM, 1999] In addition to an

38 increased risk of postoperative complications, hospital readmission rates are increased

39 for obese patients.[Farkas DT, et al. 2012; Reinke CE, et al. 2012] There is evidence

40 that the duration of certain surgical procedures and the total amount of time spent in the

41 operating room (OR) are also increased for obese patients.[Batsis JA, et al. 2009; Wang

42 JL, et al. 2013] This is relevant since longer OR times can be extrapolated to an

43 increase in resource expenditures. Previous research has been conducted looking at the

44 increases in direct cost and length of stay in total hip arthroplasty.[Kremers HA, et al.

45 2014] For example, if not scheduled accurately, an operation running later than planned

46 will increase the potential need for overtime help.[Hirose K, et al. 2011] The increased

47 costs associated with the obese surgical patient are not accompanied by similar

48 increases in third party payments thereby placing financial risk on facilities that care for

49 these patients.[Silber JH, et al. 2012]

50   The goal of this study was to measure the relationship between increasing

51 obesity in patients undergoing total hip arthroplasty (THA) with the various components

52 of OR time in order to determine how obesity contributes to overall case duration. The

53 expected result is an increase in resource utilization for obese surgical patients as

54 measure by perioperative times.

55 **Materials and Methods**:

56   Following IRB approval, the Stanford Translational Research Integrated Database

57   Environment (STRIDE) was utilized to identify all patients who underwent primary THA

58   at Stanford Medical Center from February 1, 2008 through January 1, 2013. STRIDE is

59   a standards-based informatics platform supporting clinical and translational research

60   and includes a clinical data warehouse based on the HL7 Reference Information Model.

61   [Lowe HJ, et al. 2009] This observational research study utilized the STROBE guidelines

62   for improved reporting of the findings.[von Elm E, et al. 2008]

63   Only American Society of Anesthesiologists Physical Status (ASA PS) class 2 or 3

64   patients undergoing primary elective unilateral THA procedures under general

65   anesthesia, with or without spinal for post-operative pain control were included in the

66   study. ASA 1, 4 and 5 patients were removed from the study since they represent a

67   small number of the total hip arthroplasties. Patients were divided into five groups based

68   on WHO BMI classification.[WHO 2000] Group 1- normal-weight (BMI = 18.5-24.9

69   kg/m^2), Group 2 - pre-obese (BMI = 25-29.9 kg/m^2), Group 3 - obese (BMI – 30-34.9

70   kg/m2), and Group 4 - severely obese (BMI = 35-39.9 kg/m^2) and Group 5 - morbidly

71   obese (BMI >= 40.0 kg/m^2).

72   The following parameters were retrieved: age, gender, height, weight, surgeon

73   (14 surgeons), anesthesiologist (116 anesthesiologists) and ASA PS. Patients who had

74   placement of central lines or arterial lines were excluded from the study since these

75   interventions could be a confounding variable for increased length of perioperative time.

76   Time stamps were retrieved from the STRIDE database. The data points

77   collected were time of (a) Admission to pre-op Unit, (b) Entry into operating room, (c)

78   Anesthesia handoff, (d) Surgery start, (e) Surgery end, (f) Out of operating room, (g)

79   Post-Anesthesia Care Unit (PACU) admission, (h) PACU discharge, and (i) Hospital

80   discharge day and time.
81   The primary outcome variable of the study was total OR Time, which is the time

82   interval beginning when a patient entered the OR (b) until the moment the patient

83   physically left the OR (f).

84   Secondary outcome variables included:

85   1. Induction Time defined as the time from Entry into OR (b) to Anesthesia Handoff

86   (c). (Anesthesia handoff is the time the anesthesiologist completed his/her work

87   and turned the patient over to the surgical team for positioning, preparation, and

88   draping).

89   2. Operation time defined as the interval from Surgery Start (d) to Surgery End (e).

90   3. Emergence Time defined as the interval from Surgery End (e) to Out of Operating

91   Room (f).

92   4. Recovery Room Time defined as the interval from PACU Admission (g) to PACU

93   Discharge (h).

94   5. Total Hospital Length of Stay defined as the interval from the Admission to Pre-op

95   Unit (a) to Hospital Discharge (i).

96   All time data points were collected and recorded into the electronic medical record by

97   pre-operative, operating, and recovery room nurses who were unaware of study, as data

98   was analyzed retrospectively.

99   **Statistical Analysis:**

100   Observations taken from the STRIDE database, which already excluded patients

101   based on ASA, central line and/or arterial line placement, and regional anesthesia,

102   resulted in 1,613 patients. The top 1% and bottom 1% times for each data interval were

103   excluded as a means of removing incorrectly entered data points and ensuring outliers

104   did not drive the results (185 patients removed). Patients with a BMI of greater than 50

105   kg/m² or less than 18.5 kg/m2 were removed from the study due to a paucity of data

106   points(96 patients removed). These two procedures would cause a wide variability in

107   induction times and could be representative of in ability to get a non-invasive blood

108   pressure or peripheral intravenous access or could be due to severity of illness. By

109   removing these few occurrences from our dataset, we reduce the possibility of variability

110   due to covariates and had a total of 1332 patients remaining. All data points for the time

111   intervals were available for these patients, except 1 was missing for induction time (1331

112   observations), 4 were missing for operation time (1328 observations), and 568 were

113   missing for recovery time (764 observations).   The patients were grouped by body

114   mass index as defined by the WHO classifications (stated above in this section). For the

115   primary and each secondary outcome variable the mean and standard deviations were

116   calculated. We estimated regression parameters separately for each time component of

117   the case. In the data analysis BMI is an indicator variable. The database accessible

118   covariates that can affect case duration were included as regressors (e.g. patient age,

119   gender, height, and ASA PS classification) **Table 5**. These were included to remove any

120   variability in demographics, size, and severity of illness between our patient's in their

121   BMI groupings. Multiple t-test assuming unequal variance were performed to compare

122   the Group 1 (normal weight) BMI patients to each successively higher BMI grouping.

123   This analysis was repeated for the primary and each secondary outcome variables.

124   A graphical regression analysis was performed to quantify the relationship

125   between BMI (kg/m²) and total operating room time, induction time, total operation time,

126   emergence time, recovery room time, and length of hospital stay. Using Stata

127   (StataCorp LP, College Station, Texas) a kernel weighted local polynomial regression to

128   examine potential non-linearity in the relationship between BMI, the continuous variable,

129   and procedure duration was performed. In the graphical analysis the covariates are not

130   controlled for. This method traces out average total OR time and induction time for each

131   BMI value without making any parametric assumptions.

132   **Results**:

133   A total of 1332 patients were included in this study. There were no statistically

134   significant differences in age, gender, height, and ASA PS classification between the

135   different study groups. **Table 1**

136   Group 1 (normal-weight) patients undergoing THA had a mean Total OR Time of

137   138.9 mins, Group 3 (obese) patients 146.3 mins, and Group 5 (morbidly obese)

138   patients 167.9 mins. **Table 2, Figure A** The difference in mean times with adjusted and

139   unadjusted values are presented in **Tables 3 and 4.** Controlled values are presented in

140   **Table 5**.

141   There was also a direct association between increasing BMI and the length of

142   many of the individual components of total OR Time based on t-test between higher BMI

143   groups when compared to Normal BMI group. Incremental BMI group increase was

144   associated with a greater incremental time increase at higher BMIs.

145   Patients in Group 1 had a mean Induction Time of 21.4 mins, Group 3 patients

146   23.7 mins, while Group 5 patients required 28.2 mins. **Figure B** Group 5 patients had a

147   longer mean Operation Time of 103.0 mins versus 86.1 mins for Group1 patients.

148   **Figure C** For Group 1 patients, the mean Emergence Time equaled 9.1 mins compared

149   to 10.9 mins for Group 5. There were no statistically significant differences in mean

150   Recovery Time between groups. Group 5 patients had a significant increased mean

151   Length of Hospital Stay, 3.9 days compared to 3.5 days for Group 1 patients. **Table 2**

152   **Discussion**:

153   As the number of obese patients continues to rise so does the demand for joint

154   arthroplasty procedures. Therefore, elucidating the impact of obesity on perioperative

155   costs is becoming ever more relevant.[Perka C, et al. 2000; Kurtz S, et al. 2007] Our

156   study of 1332 patients undergoing primary THA procedures at an academic medical

157   center found that obesity predictably lengthens both induction and surgical times. The

158   induction time is greater as expected due to longer times in moving, positioning, and

159   pre-oxygenating obese patients. The greatest single contributor to the increased

160   perioperative time requirements was the time needed by the surgeon to actually perform

161   the operation (Operation Time). Based on this information our facility has begun a pilot

162   project to schedule surgical time duration for THA cases by utilizing the difference in

163   mean time between patient's BMI using **Table 3, Table 4 and Table 5**, which provides

164   the absolute difference in mean time for each time interval when compared to a normal

165   weight patient and controls.

166   The reasons increasing weight lengthens both anesthesia and surgical times are

167   multifactorial but could be related to difficulties transferring patients to the OR table, with

168   airway management, with moving the patient to the lateral decubitus position once

169   anesthetized, and because excessive fat can interfere with intraoperative surgical

170   exposure. [Raphael IJ, et al. 2013] Obesity was not associated with longer recovery

171   time, probably because discharge from the recovery room is often dictated by non-

172   medical issues such as waiting for personnel to transport the patient to the ward or the

173   availability of a ward bed.

174   It is estimated that by 2030, the number of primary THA operations will rise by

175   174%, and a significant number of these patients will be obese.[Kurtz S, et al. 2007]

176   Health systems will have to absorb the additional financial burden of performing THA

177   procedures on obese patients. Those private orthopedic practices with a focus on

178   maintaining a predictable volume and minimizing costly complications may become

179   reticent in accepting obese patients. Besides the economic impact, the medical co-

180   morbidities associated with obesity pose management challenges for both surgeons and

181   anesthesiologists. With recent protocols penalizing health care providers for hospital

182   readmissions and postoperative complications, private practitioners may be less

183   incentivized to perform THA procedures on the obese. These factors all underscore that

184   public payer health systems may be required to absorb much of the financial

185   repercussions of increased resource utilization for obese surgical patients.

186   Throughout the US there is wide variability reported for actual operating room

187   costs depending on whether fixed costs or variable costs are included and on the

188   specific resources consumed by each patient.[Shippert R, 2005; Macario A, 2010]

189   Besides the increased operating room time costs attributable to obesity, our study also

190   noted expensive increased postoperative hospital length of stay. In addition, other

191   studies have also shown that obese patients have a higher rate of prosthesis failure, hip

192   dislocations, and wound infection.[Perka C, et al. 2000; Sadr AO, et al. 2008] Currently

193   pay-for-performance policies do not take into account obesity as a cause for increased

194   costs in the perioperative setting.[Hirose K, et al. 2011; Dowsey MM, Liew D & Choong

195   PFM, 2011] Some facilities may choose not to operate on the morbidly obese unless

196   reimbursement is changed, especially if hospitals are penalized for readmissions under

197   changing health policy regulations. We believe it would be worthwhile to evaluate the

198   usefulness of a comprehensive protocol approach to the care of the morbidly obese

199 surgical patient to ensure that appropriate pre-habilitation, proper equipment,

200 experienced nurses, and other resources are allocated to these patients.

201   In our analysis, the mean operation and induction times plateau and begin to

202 decrease as the extremes of BMI are reached. The confidence interval widens as the

203 BMI increases, which is a result of a limited number of morbidly obese patients

204 undergoing hip arthroplasty as compared to normal BMI, overweight, and obese patients

205 undergoing this operation.

206   This study has inherent limitations in the fact that it is a single-center

207 retrospective electronic chart-review. The time points collected by preoperative, OR, and

208 recovery room nurses may have some errors, but should affect the BMI groups similarly.

209 In the case of recovery times, a large number of the entered values were not recorded

210 by the STRIDE database properly limiting the power of our recovery time results. The

211 multiple t-test analysis is an inherent limitation in that we can only view each t-test alone,

212 since there is inherent correlation between time intervals. We decided to report the most

213 straightforward and easily understood test in the presentation of the data. Despite this, it

214 is apparent from the data presented that the higher the BMI the longer the OR time will

215 be. This will hold true however the data is reported. An inherent limitation in

216 retrospective non-randomized studies is the fact that causal inferences can be

217 mistakenly made, but we are confident in this study, which is supported by current

218 available literature. As can be seen in figure A and Figure B, the case time and

219 decreases slightly and the confidence interval widens. Outliers were removed as

220 mentioned above in the statistical analysis section. At the higher end of BMI there is a

221 paucity of data which leads to these potentially deceptive graphical representations. The

222 majority of total hip arthroplasties at our institution are performed under general

223 anesthesia, with or without spinal for post-operative pain control. At a majority of

224   institutions across the country spinal anesthesia alone is the anesthetic plan of choice.

225   Despite this we believe that operation time and other secondary outcomes could be of

226   use.

227   **Conclusion**: We found that for patients undergoing THA, increasing BMI was

228   associated with increased total OR time. Also increasing BMI was associated with longer

229   hospital stays after THA. Operating room scheduling and plans for resource utilization

230   should recognize that the same THA procedure will require more time in a morbidly

231   obese patient than in a normal-weight or pre-obese patient. These considerations can

232   potentially reduce the increased healthcare costs associated with performing surgery on

233   obese patients.

234 **Acknowledgments**:

235 We wish to acknowledge the contribtuions of Annie Katz, MD, Resident, Internal

236 Medicine, Stanford University Medical Center, Stanford, CA, USA for critical analysis of

237 the proposal and manuscript, Pietro Tebaldi, PhD, Stanford University, Stanford, CA,

238 USA for aiding in data analysis, and John Brock-Utne, MD, Professor of Anesthesiology,

239 Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University

240 Medical Center, Stanford, CA, USA for critical analysis of the abstract.

241 **References**:

242   1. Allison DB, Zannolli R & Narayan KM. 1999. The direct health care costs of

243   obesity in the United States. American Journal of Public Health; 89:1194–9.

244   2. Batsis JA, Naessens JM, Keegan MT, Wagie AE, Huddleston PM, Huddleston

245   JM. 2009. Impact of body mass on hospital resource use in total hip arthroplasty.

246   Public Health Nutrition 12:1122-32.

247   3. Dowsey MM, Liew D & Choong PFM. 2011. Economic burden of obesity in

248   primary total knee arthroplasty. Arthritis Care & Research 63:1375–81.

249   4. Farkas DT, Moradi D, Moaddel D, Nagpal K, Cosgrove JM. 2012. The impact of

250   body mass index on outcomes after laparoscopic cholecystectomy. Surgical

251   Endoscopy 26:964–9.

252   5. Finkelstein EA, Khavjou OA, Thompson H, Trogdon JG, Pan L, Sherry B, Dietz

253   W. 2012. Obesity and severe obesity forecasts through 2030. American Journal

254   of Preventive Medicine 42:563–70.

255   6. Flegal KM, Carroll MD, Ogden CL, Curtin LR. 2010. Prevalence and trends in

256   obesity among US adults, 1999-2008. Journal of the American Medical

257   Association 303:235–41.

258   7. Hirose K, Shore AD, Wick EC, Weiner JP, Makary MA. 2011. Pay for obesity?

259   Pay-for-performance metrics neglect increased complication rates and cost for

260   obese patients. Journal of Gastrointestinal Surgery 15:1128–35.

261   8. Kremers H, Visscher S, Kremers W, Naessens J, Lewallen D. 2014. Obesity

262   increases length of stay and direct medical costs in total hip arthroplasty. Clinical

263   orthopaedics and related research 472:1232-9.

264   9. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. 2007. Projections of primary and

265   revision hip and knee arthroplasty in the United States from 2005 to 2030. The

266   Journal of Bone and Joint Surgery American 89:780–5.

267   10. Lowe HJ, Ferris TA, Hernandez PM, Weber SC. 2009. STRIDE--An integrated

268   standards-based translational research informatics platform. AMIA . Annual

269   Symposium Proceedings / AMIA Symposium AMIA Symposium 2009:391–5.

270   11. Macario A. 2010. What does one minute of operating room time cost? Journal of

271   Clinical Anesthesia 22:233–6.

272   12. Perka C, Labs K, Muschik M, Buttgereit F. 2000. The influence of obesity on

273   perioperative morbidity and mortality in revision total hip arthroplasty. Archives of

274   Orthopaedic and Trauma Surgery 120:267–71.

275   13. Raphael IJ, Parmar M, Mehrganpour N, Sharkey PF, Parvizi J. 2013. Obesity and

276   operative time in primary total joint arthroplasty. The Journal of Knee Surgery

277   26:95–100.

278   14. Reinke CE, Kelz RR, Zubizarreta JR, Mi L, Saynisch P, Kyle FA, Even-Shoshan

279   O, Fleisher LA, Silber JH. 2012. Obesity and readmission in elderly surgical

280   patients. Surgery 152:355–62.

281   15. Sadr AO, Adami J, Lindström D, Eriksson KO, Wladis A, Bellocco R. 2008. High

282   body mass index is associated with increased risk of implant dislocation following

283   primary total hip replacement: 2,106 patients followed for up to 8 years. Acta

284   Orthopaedica 79:141–7.

285   16. Shìppert R. 2005. A Study of Time-dependent Operating Room Fees and How to

286   Save $100,000 by Using Time-Saving Products. Amercian Journal of Cosmetic

287   Surgery 22:25–34.

288   17. Silber JH, Rosenbaum PR, Kelz RR, Reinke CE, Neuman MD, Ross RN, Even-

289   Shoshan O, David G, Saynisch PA, Kyle FA, Bratzler DW, Fleisher LA. 2012.

290   Medical and financial risks associated with surgery in the elderly obese. Annals of

291   Surgery 256:79–86.

292   18. von Elm E, Altman D, Egger M, Pocock S, Gotzsche P, Vandenbroucke J. 2008.

293   The strengthening the reporting of oberservational studies in epidemiology

294   (STROBE) statement: guidelines for reporting observational studies. Journal of

295   Clinical Epidemiology 61:344-9.

296   19. Wang JL, Gadinsky NE, Yeager AM, Lyman SL, Westrich GH. 2013. The

297   Increased Utilization of Operating Room Time in Patients with Increased BMI

298   during Primary Total Hip Arthroplasty. The Journal of Arthroplasty 28:680–3.

299   20. WHO. Obesity: preventing and managing the global epidemic. Report of a WHO

300   consultation. World Health Organization Technical Report Series 2000. 894:i–xii,

301   1–253.

302   21. Wolf AM & Colditz GA. 1998. Current estimates of the economic cost of obesity in

303   the United States. Obesity Research 6:97–106.

Demographic variables

Table 1: Demographic variables – associated standard deviation (when appropriate) and p-value Comparing Normal BMI to other BMI Groupings.

BMI Range	18.5 - 24			25 - 29			30 - 34			35 - 39			40 - 50		
VARIABLES		SD	p		SD	p		SD	p		SD	p		SD	p
Age (mean)	62.92	14.50	-	63.77	11.93	0.53	62.20	12.13	0.48	61.29	9.80	0.45	59.02	9.54	0.39
ASA 2 total (percent)	175 (49%)	-	-	241 (48%)	-	0.53	122 (45%)	-	0.55	48 (43%)	-	0.56	29 (44%)	-	0.56
Male total (percent)	115 (32%)	-	-	281 (56%)	-	0.69	147 (54%)	-	0.68	49 (44%)	-	0.60	23 (35%)	-	0.52
Height in meters (mean)	1.69	0.11	-	1.72	0.11	0.62	1.72	0.10	0.62	1.70	0.10	0.57	1.68	0.10	0.50
Number of Patients	357	-	-	502	-	-	270	-	-	111	-	-	66	-	-

Outcomes Table

Table 2: Outcomes Table (Mean-listed in minutes except Total Hospital Time, standard deviation (SD), p-value: heteroscedastic T-Test Results Comparing Interval Times of Normal BMI to other BMI Groupings)

BMI Range	18.5 - 24.9			25 - 29.9			30 - 34.9			35 - 39.9			40 - 50			
VARIABLES	Mean	SD	p	Mean	SD	p	Mean	SD	p	Mean	SD	p	Mean	SD	p	Total Number
Total Time in OR	138.9	1.4	-	141.7	1.2	0.152	146.3	1.8	<0.001	156.3	2.9	<0.0005	167.9	3.8	<0.0005	1332
Induction Time	21.4	0.4	-	21.8	0.4	0.475	23.7	0.5	<0.001	26.3	0.8	<0.0005	28.2	1.1	<0.0005	1331
Operation Time	86.1	1.2	-	87.4	0.9	0.425	90.3	1.4	0.022	97.6	2.4	<0.0005	103.0	2.9	<0.0005	1328
Emergence Time	9.1	0.3	-	9.1	0.2	0.921	9.2	0.3	0.784	9.5	0.4	0.452	10.9	0.7	0.006	1332
Recovery Time	184.8	3.9	-	174.8	3.2	0.136	167.7	4.5	0.031	184.9	7.9	0.994	174.6	8.0	0.474	764
Total Hospital Stay (Days)	3.5	0.1	-	3.5	0.1	0.801	3.5	0.1	0.949	3.6	0.1	0.233	3.9	0.1	0.001	1332
Number of Patients	362	-	-	512	-	-	275	-	-	113	-	-	70	-	-	1332

Adjusted Difference

Table 3: Difference in mean times when compared to normal BMI patients (BMI 18.5-24.9), adjusted.

BMI Range	25-29.9			30-34.9			35-39.9			40-50			
	Difference	95% CI	p	Difference	SD	p	Difference	SD	p	Difference	SD	p	Total Number
Total Time in OR	3.48	±0.170	0.077	7.49	±0.268	0.001	16.89	±0.558	<0.001	27.25	±0.859	<0.001	1332
Induction Time	0.38	±0.051	0.518	2.27	±0.080	<0.001	4.87	±0.167	<0.001	6.80	±0.258	<0.001	1331
Operation Time	2.03	±0.136	0.196	4.40	±0.215	0.016	11.15	±0.448	<0.001	15.53	±0.686	<0.001	1328
Emergence Time	-0.08	±0.031	0.823	0.04	±0.046	0.914	0.33	±0.099	0.534	1.65	±0.151	0.011	1332
Recovery Time	-9.28	±0.587	0.171	-16.23	±0.950	0.044	-0.17	±1.567	0.987	-12.59	±3.351	0.382	764
Total Hospital Stay (Days)	0.00	±0.00	0.998	-0.03	±0.011	0.780	0.18	±0.023	0.148	0.76	±0.036	<0.001	1332
Total Number	512			275			113			70			1332

Unadjusted Difference

Table 4. Difference in mean times when compared to normal BMI patients (BMI 18.5-24.9), unadjusted.

BMI Range	25-29.9			30-34.9			35-39.9			40-50			
	Difference	95% CI	p	Difference	SD	p	Difference	SD	p	Difference	SD	p	Total Number
Total Time in OR	2.794	±0.169	0.153	7.435	±0.269	0.001	17.460	±0.565	<0.001	28.980	±0.869	<0.001	1332
Induction Time	0.412	±0.050	0.475	2.286	±0.079	<0.001	4.886	±0.167	<0.001	6.825	±0.247	<0.001	1331
Operation Time	1.247	±0.135	0.425	4.163	±0.215	0.022	11.530	±0.455	<0.001	16.940	±0.695	<0.001	1328
Emergence Time	-0.339	±0.133	0.921	0.108	±0.047	0.784	0.400	±0.098	0.534	1.761	±0.151	0.010	1332
Recovery Time	-99.984	±0.580	0.136	-17.100	±0.936	0.031	0.077	±1.416	0.994	-10.270	±3.341	0.474	764
Total Hospital Stay (Days)	-0.023	±0.007	0.773	-0.057	±0.011	0.550	0.167	±0.024	0.189	0.753	±0.036	<0.001	1332
Number of Patients	512			275			113			70			1332

Controls

Table 5 - Controls: difference in time points holding all other control variables constant. The Sex column is the difference in mean time between males and females with all other variables held constant. The Age column is the difference in mean time between an individual and another 1 year younger with all other variables held constant. The Height column is the difference in mean time between for an individual and another 1 inch shorter with all other variables held constant. The ASA column is the difference in mean time between ASA 3 and ASA 2 with all other variable held constant.

BMI Range	Sex			Age			Height			ASA			Total Number
	Difference	SD	p	Difference	SD	p	Difference	SD	p	Difference	SD	p	
Total Time in OR	1.072	±0.186	0.620	-0.372	±0.008	<0.001	-22.730	±1.862	0.024	3.430	±0.362	0.026	1332
Induction Time	0.374	±0.056	0.564	0.009	±0.002	0.631	-2.483	±0.558	0.412	0.490	±0.108	0.289	1331
Operation Time	0.383	±0.151	0.824	-0.328	±0.006	<0.001	-20.520	±1.484	0.011	1.794	±0.288	0.146	1328
Emergence Time	0.443	±0.033	0.245	-0.013	±0.001	0.247	-2.067	±0.329	0.245	0.498	±0.064	0.067	1332
Recovery Time	2.490	±0.674	0.748	0.255	±0.026	0.748	-68.030	±6.780	0.065	8.572	±1.287	0.118	764
Total Hospital Stay (Days)	-0.012	±0.008	0.895	0.005	±0.000	0.039	-0.925	±0.0779	0.029	0.183	±0.015	0.005	1332
Total Number	512			275			113			70			1332

Figure 1

Total case time

Figure 1: Legend: Total Case time (patient in room to patient out of room in minutes) and BMI Polynomial Regression Line (blue line) with 95% CI (gray); (Epanechnikov kernel of degree 0, Bandwidth of 3.24, pwidth of 4.86) ¥ <!--[if !supportFootnotes]-->[b] <!--[endif]--> ¥ The differences in the bandwidth are due to differences in the variance of outcome variables.
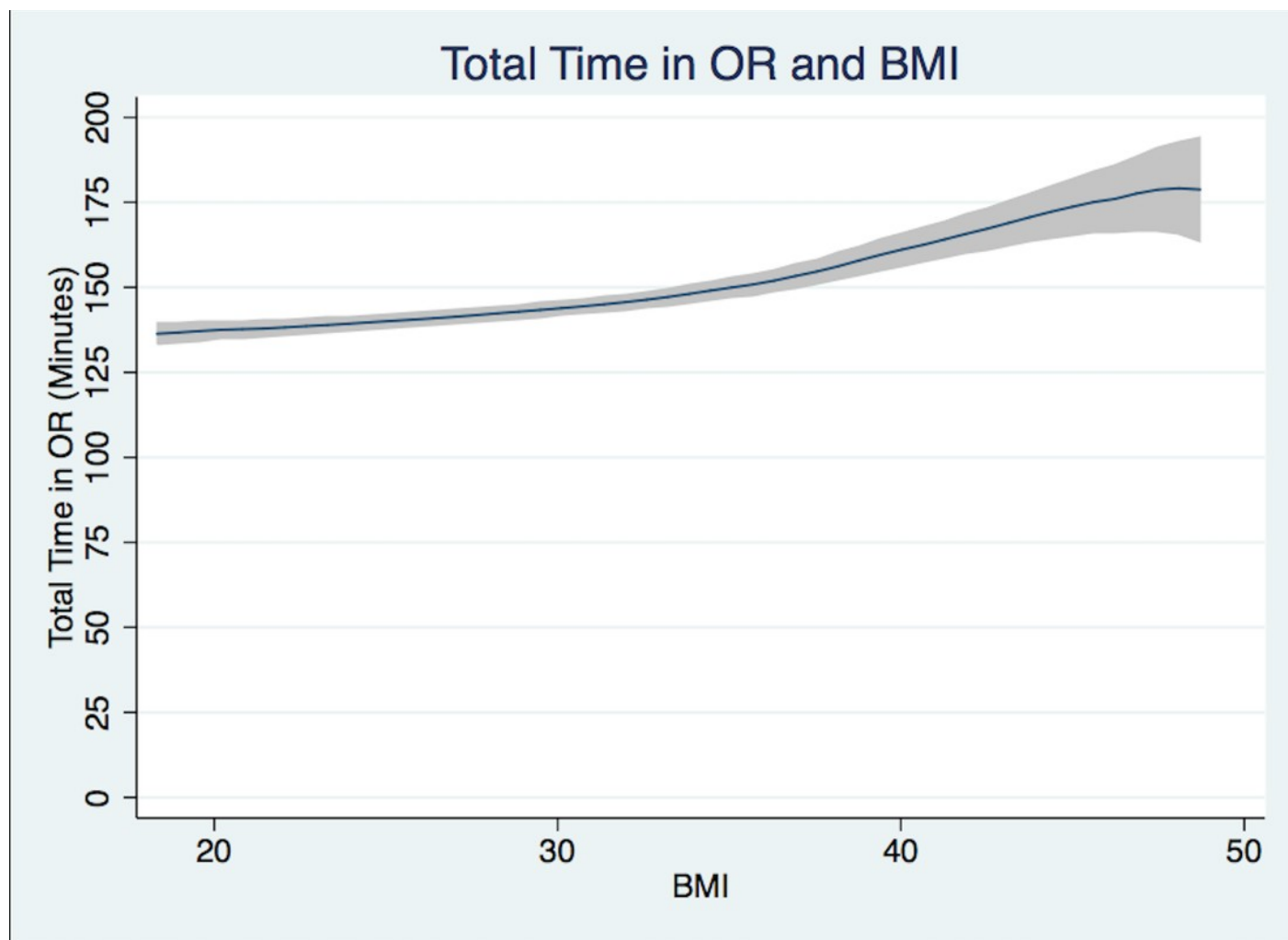
Figure 2

Induction time

Figure 2: Legend: Induction Time (from patient in room to handoff from anesthesiologist to surgeon in minutes) and BMI Polynomial Regression Line (blue line) with 95% CI (gray); (Epanechnikov kernel of degree 0, Bandwidth of 2.2, pwidth of 3.3) ¥ <!--[if ! supportFootnotes]-->[b] <!--[endif]--> ¥ The differences in the bandwidth are due to differences in the variance of outcome variables.
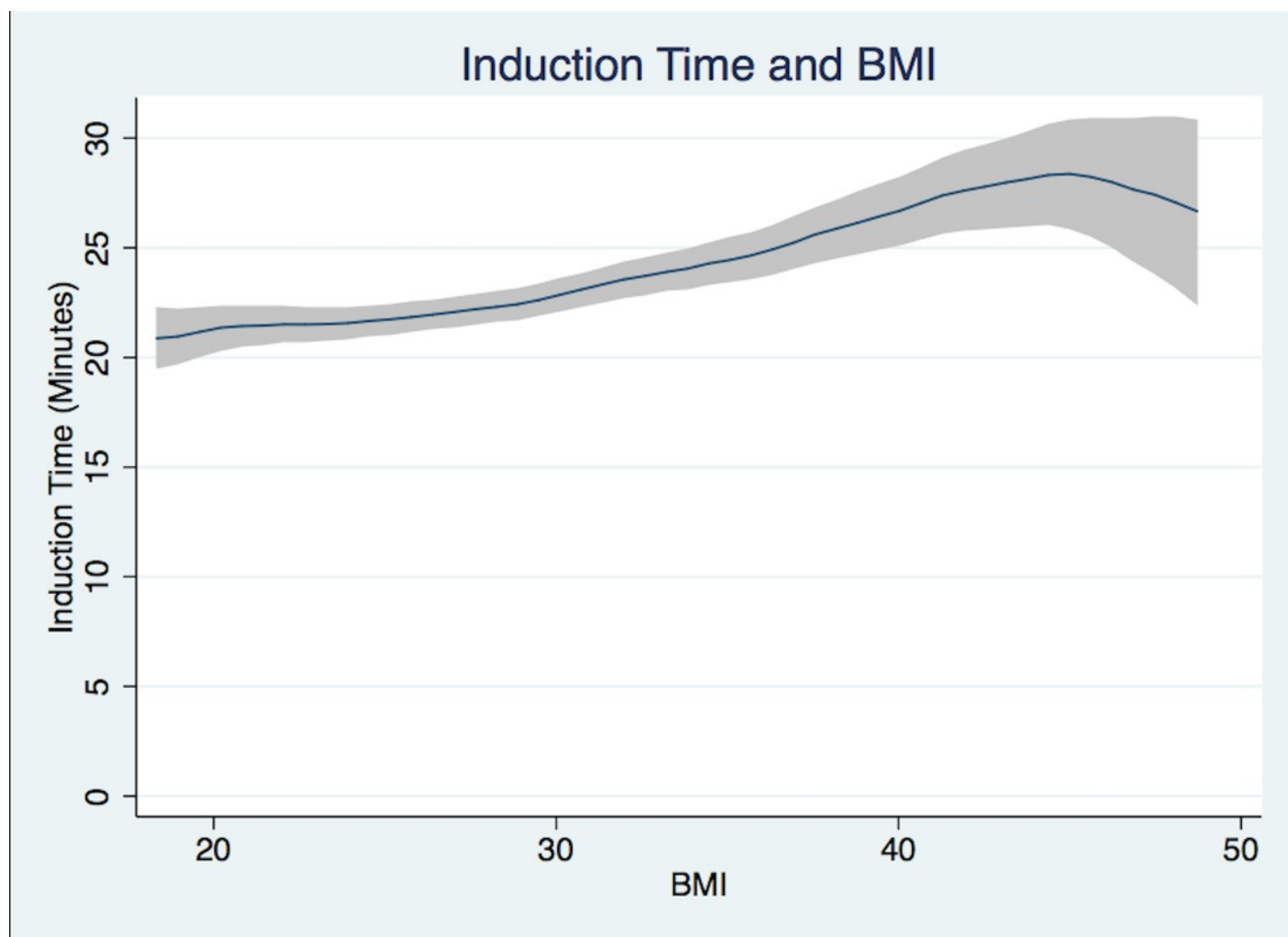
Figure 3

Operation time

Figure 3: Legend: Operation Time (from surgery start time to surgery end time in minutes) and BMI Polynomial Regression Line (blue line) with 95% CI (gray); (Epanechnikov kernel of degree 0, Bandwidth of 3.02, pwidth of 4.53) ¥ <!--[if !supportFootnotes]-->[b] <!--[endif]--> ¥ The differences in the bandwidth are due to differences in the variance of outcome variables.