УДК 616.728.2-056.52-089.844

DOI: 10.21823/2311-2905-2019-25-1-177-187

# Total Hip Arthroplasty in Patients with Obesity (Meta-analysis of Prospective Studies)

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**Abstract**

***The purpose*** of the study is to evaluate whether patient's obesity affects on duration of total hip arthroplasty, hospital stay, blood loss volume, overall complication and death rates. ***Materials and methods.*** We searched for publications in databases PubMed, EBSCO, Cochrane, WanFang and CNKI databases. The meta-analysis included the results of 24 clinical trials in which 156.914 patients were involved — 46.782 obese and 123.076 patients with normal body mass index (BMI). (Evaluation was performed using Revman 5.3 software). ***Results.*** In patients with BMI >30, the duration of surgery was longer than in patients with normal weight. In this case, OR = -5.14 (95% CI -8.13 … -2.14) min, $p$<0.001. The rate of postoperative dislocations: OR = 0.07 (95% CI 0.59–0.84) $p$<0.001. The rate of infectious complications: OR = 0.56 (95% CI 0.50–0.62) ($p$<0.001) and blood loss volume OR = -181.39 (95% CI -293.26 … -69.52) ml, $p$ = 0.001. Five-years postoperatively, the Harris Hip Score, reflecting the functional results, was relatively lower in obese patients than in patients with normal BMI: OR = 2.85 (95% CI 1.04–4.66), $p$ = 0.002. However, the duration of postoperatively hospital stay was not significantly different between patients with normal and abnormal body weights: OR = 0.30, (95% CI 0.34–0.95) days, $p$ = 0.36. ***Conclusion.*** Excessive subcutaneous fat thickness creates additional technical difficulties in the insertion of the endoprosthesis, which ultimately affects the increase in the surgery time, and blood loss. In patients with greater BMI, the frequency of postoperative dislocations and infectious complications increase, and the functional results of surgical treatment are reduced. Ultimately, obesity adversely affects the clinical efficacy of primary total hip arthroplasty.

**Keywords:** total hip arthroplasty, obesity, meta-analysis.

Cite as: Akhtiamov I.F., Han Hao Zhi, Faizrakhmanova G.M., Garifullov G.G., Ashraf Ismail Yousef [Total Hip Arthroplasty in Patients with Obesity (Meta-analysis of Prospective Studies)]. *Travmatologiya i ortopediya Rossii* [Traumatology and Orthopedics of Russia]. 2019;25(1):177-187. (In Russ.). DOI: 10.21823/2311-2905-2019-25-1-177-187.

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Received: 02.08.2018. Accepted for publication: 18.02.2019.

## Introduction

Turn of the century witnessed a rapidly growing number of people who suffer from obesity and such trend is specific primarily for highly developed countries. Overweight and obesity is peculiar to 1,5 billion of population. Realizing many issues related to obesity we should draw the attention to clear relation of this pathology and arthrosis of large joints [1, 2].

Overweight is responsible for obvious rejuvenation of the main age group with joints pathology. Overweight facilitates faster progress of arthrosis, significantly decreases conservative treatment potential and leads relatively young patients to inevitable joint replacement procedure [3].

Literature analysis indicates not only increase in population of patients with higher BMI but also the prevalence rate of injuries which ranks second among the general morbidity structure according to the official statistics. All the above specifies obesity as a key factor affecting clinical efficiency of hip replacement and, in particular, hip joint arthroplasty [1, 3].

Detailed study of above issue requires attraction of global information sources while there are very few publications in Russia dedicated to this topic.

**The purpose of the study** is to evaluate whether patient's obesity affects on duration of total hip arthroplasty, hospital stay, blood loss volume, overall complication and death rates.

## Materials and Methods

An extensive literature search for clinical research on the following keywords was performed to conduct further meta-analysis: BMI, obesity, total hip replacement, perspective cohort study. Search was conduction in available medical international databases: PubMed, EBSCO, Cochrane, WanFang and CNKI.

Meta-analysis inclusion criteria:

1. Type of research: prospective cohort study of obesity influence on primary hip replacement.
2. Participants: initial parameters of groups with pathology (BMI >25 kg / m$^2$) and with normal BMI — up to 25 kg/m$^2$.
3. Procedure type: hip joint replacement.
4. Criteria: gender, age, etc. (4.1) surgery time, (4.2) frequency of dislocations, (4.3) rate of infectious complications, (4.4) blood loss volume, (4.5) Harris Hip Score and (4.6) hospital stay.

Criteria of exclusion from meta-analysis:

1) nonconformity to inclusion criteria;
2) low quality or absence of predictive cohort study;
3) surgical procedures beyond the scope of primary hip replacement, studied parameters do not correspond to above key criteria;
4) incomplete presentation of studied data;
5) lack of full text of publication.

Methodology of publications was evaluated in accordance with Newcastle-Ottawa Scale (NOS) enabling meta-analysis of heterogeneous subgroups [4]. Scale consists of 8 items, each is ranked between 0 or 1 point; overall maximum score is 9 points.

### *Statistical analysis*

RevMan 5.2 software was used for statistical analysis. Weighted mean difference (WMD) was used in groups with obesity and with normal BMI to evaluate surgical time in minutes, blood loss in milliliters, Harris Hip Score points and hospital stay with corresponding 95% confidence intervals (C1 = CI); relative risk (RR) was used to evaluate dislocations and infections at endpoints with corresponding 95% (C1 = CI). Evaluation of statistical heterogeneity of studies by I2 index and Q test was done to choose the optimal model of meta-analysis. Twelve index was represented in % — from 0 to 100. *P*>0.05 or I2 less 50% indicated some studies of the same type without heterogeneity. *P*<0.05 or I2 above 50% indicated statistically reliable non-homogeneity in multiple results of research.

## Results

631 articles was studied according to the search strategy. 24 sources were selected in accordance with inclusion and exclusion criteria where treatment of 156914 patients were followed up and analyzed (Table).

*Table*

**The influence of obesity on the THR outcomes (based on the publications included in the meta-analysis)**

| Authors | Number of cases (obesity/norm) | Group BMI (kg/m$^2$) | Follow up term, years | NOS, scale |
|---|---|---|---|---|
| Bowditch M.G., 1999 [5] | 82 (18/64) | <26, 25~30, >30 | <1 | 6 |
| Mclaughlin J.R., 2006 [6] | 198 (95/103) | <25, 25~30, 30~34,9, ≥35 | 10~18 | 7 |
| Kessler S., 2007 [7] | 67 (20/47) | <25, 25~29,9, ≥30 | <1 | 7 |
| Lübbeke A., 2007 [8] | 2495 (589/1906) | <30, ≥30 | 5 | 7 |
| Azodi O.S., 2008 [9] | 2085 (272/1813) | <25, 25~29,9, ≥30 | 3 | 6 |
| Andrew J.G., 2008 [10] | 1059 (264/795) | <30, 30~39,9, ≥40 | 5 | 7 |
| Jackson M.P., 2009 [11] | 268 (134/134) | <30, ≥30 | 0–11 | 8 |
| Dowsey M.M., 2010 [12] | 471 (194/277) | <30, 30~39,9, ≥40 | 1 | 7 |
| Chee Y.H., 2010 [13] | 110 (55/55) | <30, 30~39,9, ≥40 | 5 | 6 |
| Lübbeke A., 2010 [14] | 503 (386/117) | <25, 25~29,9, ≥30 | 5–10 | 7 |
| Bergschmidt P., 2010 [15] | 96 (32/64) | <25, 25~30, 30~35 | 2 | 7 |
| Davis A.M., 2011 [16] | 1617 (521/1096) | <25, 25~30, 30~34,9, ≥35 | 5 | 8 |
| Michalka P.K.R., 2012 [17] | 191 (78/113) | <30, 30~35, >35 | <1 | 8 |
| Raphael I.J., 2013 [18] | 53 (23/30) | <25, 25~30, 30~39,9, ≥40 | <1 | 7 |
| Dienstknecht T., 2013 [19] | 134 (56/78) | <30, ≥30 | <1 | 7 |
| Lai X.Y., 2014 [20] | 228 (67/161) | <25, ≥25 | <1 | 6 |
| Song H.H., 2015 [21] | 104 (60/44) | <30, 30~35, >35 | <1 | 7 |
| Yue C., 2015 [22] | 286 (121/165) | <25, ≥25 | <1 | 6 |
| Lübbeke A., 2016 [23] | 5661 (3406/2255) | <24,9, 25–29,9, 30–34,9, 35–39,9, и ≥40 | 0, 5–18 | 9 |
| Husted H., 2016 [24] | 7194 (4721/2473) | <18,5, >18,5 и <25, >25 и <30, >30 и <35, >35 и <40, >40 | <1 | 9 |
| Jasinski-Bergner S., 2017 [25] | 26 | <25, 25~29,9, ≥30 | <1 | 8 |
| Büchele G., 2017 [26] | 420 (294/126) | <25, 25-<30, 30-<35, ≥35 | 20 | 9 |
| Li W., 2017 [27] | 2040 (1510/530) | <24,9, 25–29,9, 30–34,9, 35–39,9, и ≥40 | <1 | 8 |
| Jeschke E., 2018 [28] | 131576 (20948/110628) | <30, 30–34, 35–39 и ≥40 | <1 | 8 |

### *Surgery Duration*

5 publications reported on surgery time for primary hip replacement. When comparing this parameter in groups with normal BMI and with obesity no heterogeneity was observed ($\chi^2$ = 3.76, $I^2$ = 32%, $p$ = 0.21), the same results were observed after comparing obesity and morbid obesity ($\chi^2$ = 10.65, $I^2$ = 20%, $p$ = 0.29). Use of random effect model the obtained results demonstrated that obesity group statistically significantly differed from the group without obesity WMD = -5.14 (95% CI -8.13…-2.14), $p$<0.001 (minutes). For obesity group no statistically significant difference was observed $p$>0.05 (Fig. 1).

### *Frequency of dislocations*

7 papers reported data on dislocation frequency after primary THR and correlation with obesity. No heterogeneity was observed in the studies ($\chi^2$ = 0.00, $I^2$ = 0%, $p$ = 0.58) and ($\chi^2$ = 0.00, $I^2$ = 0%, $p$ = 0.87). Fixed effect models were used. Dislocation frequency in patients with excessive BMI was higher and statistically significant as compared to the group without obesity, RR = 0.07 (95% CI 0.59–0.84) $p$<0.001 (cases). However, frequency dislocation between patients with obesity and morbid obesity did not demonstrated statistically significant differences $p$>0.05 (Fig. 2).

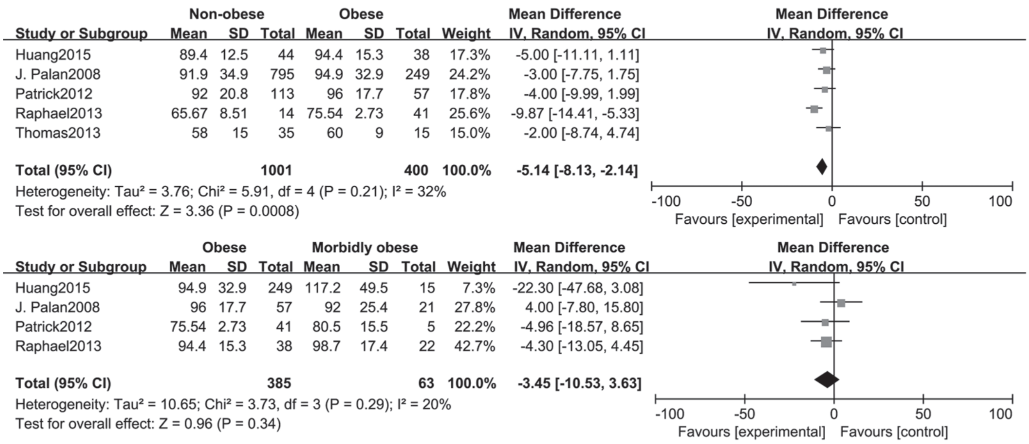


**Fig. 1.** Comparison of THR time between obese and non-obese patients, min

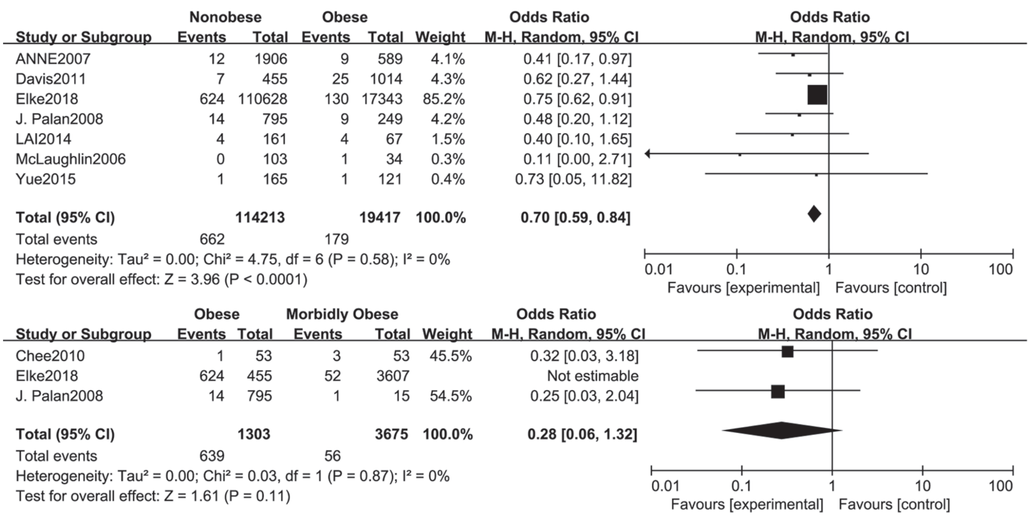


**Fig. 2.** Comparison of postoperative hip dislocation rate between obese and non-obese patients

*Periprosthetic infection*

5 publications reported infection of postoperative wound after THR. No heterogeneity was observed between the study ($\chi^2$ = 6.82, I2 = 41%, $p$ = 0.15) and ($\chi^2$ = 0.52, $I^2$ = 41%, $p$ = 0.92). Application of fixed effect model demonstrated that infection rate in obesity was higher and statistically significant as compared to the control group RR = 0.56 (95% CI 0.50–0.62), $p$<0.001 (cases) as well as in group with obesity was higher and statistically significant in comparison with obesity group and morbid obesity group RR = 0.28 (95% CI 0.24–0.33), $p$<0,001 (Fig. 3).

*Blood loss*

7 publications reported the volume of blood loss during THR. Non-homogeneity was reported for the studies ($\chi^2$ = 16.03, $I^2$ = 81%, $p$<0.001). Application of random effect model demonstrated that blood loss in obesity group as compared to group with normal weight had a higher and statistically significant values WMD = -181.39 (95% CI -293.26 ... -69.52), $p$ = 0.001 (ml) (Fig. 4).

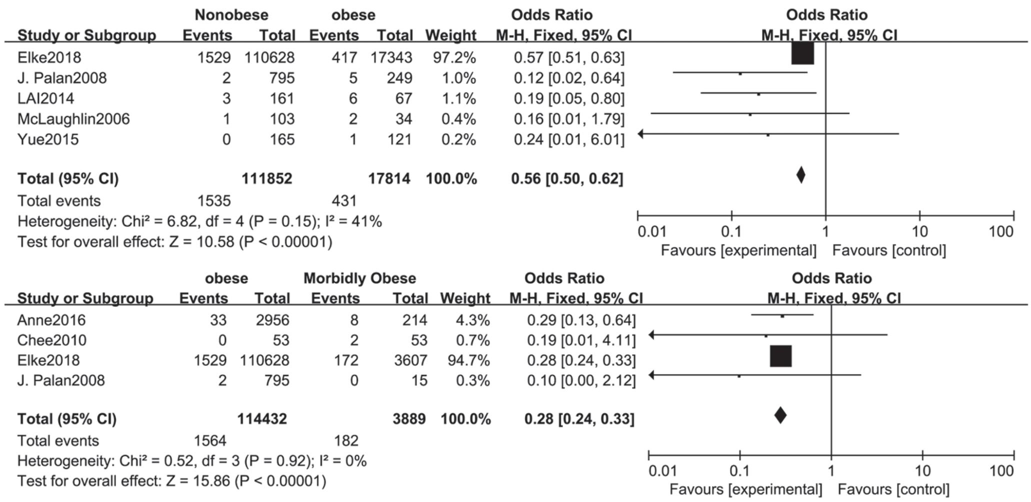


**Fig. 3.** Comparison of postoperative infection rate between obese and non-obese patients

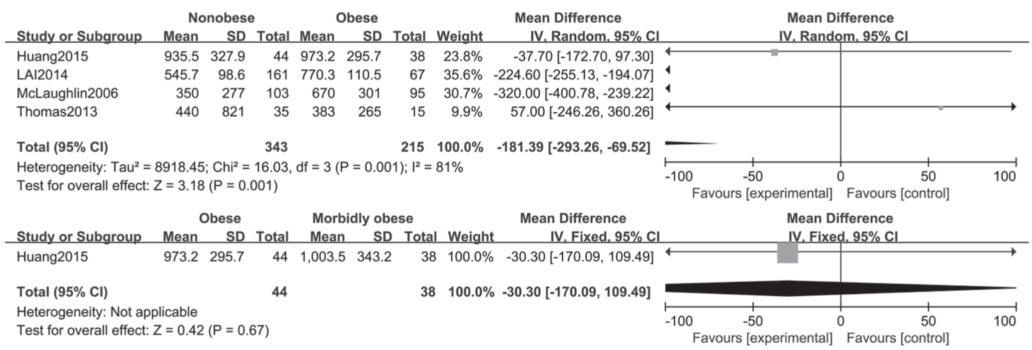


**Fig. 4.** Comparison of blood loss between obese and non-obese patients, ml

### *Harris Hip Score assessment*

8 publications reported Harris Hip scores after THR. Heterogeneity in the studies was observed ($\chi^2$ = 6.74, $I^2$ = 41%, $p$ = 0.15). Application of random effect model demonstrated that obesity group statistically significantly differed from group with normal weight WMD = 2.85 (95% CI 1.04–4.66), $p$ = 0.002 (HHS at 5-year follow up) (Fig. 5).

Another publication reported evaluation of physical component on Short Form-36 (Physical Component Summary, PCS) and pain evaluation on HOOS (Hip disability and Osteoarthritis Outcome Score). Patients with BMI≥40 kg/m$^2$ demonstrated worse PCS parameters in six months after THR ($p$<0.001). Non the less, mean preoperative and postoperative score variations did not significantly differed by BMI ($p$ = 0.07). Patients with higher BMI had lower initial pain score by HOOS ($p$<0.001) but more significant improvement between pre- and postoperative measurements ($p$<0.001) [27].

### *Hospital stay*

4 papers reported hospital stay after THR. No heterogeneity was observed for the studies for comparison of normal BMI with obesity ($\chi^2$ = 0.00, $I^2$ = 0%, $p$ = 0.87) and for comparison of obesity and morbid obesity ($\chi^2$ = 0.00, $I^2$ = 0%, $p$ = 0.47). Random effect models were applied which did not reveal statistically reliable difference as compared to the group without obesity, WMD = 0.30 (95% CI 0.34–0.95), $p$ = 0.36 (days), and as compared with obesity group and morbid obesity group, WMD = 0.26, 95% CI [-0.84, 1.35], $p$ = 0.64 (days) (Fig. 6)

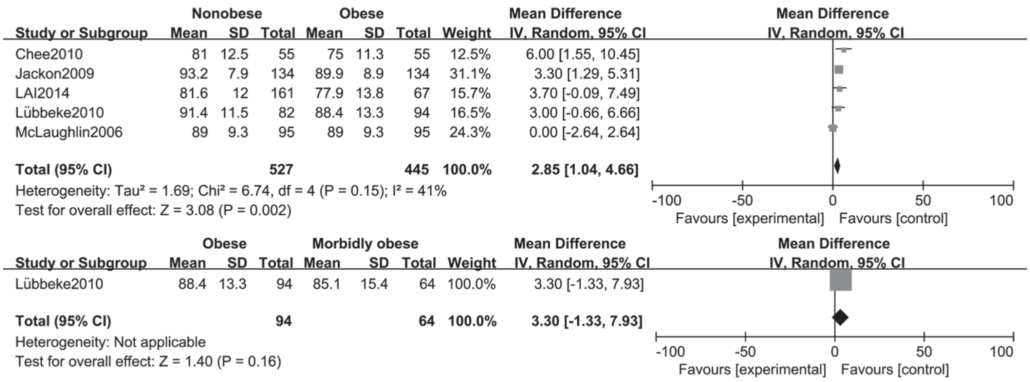


**Fig. 5.** Comparison of postoperative Harris Hip Scores between obese and non-obese patients, points

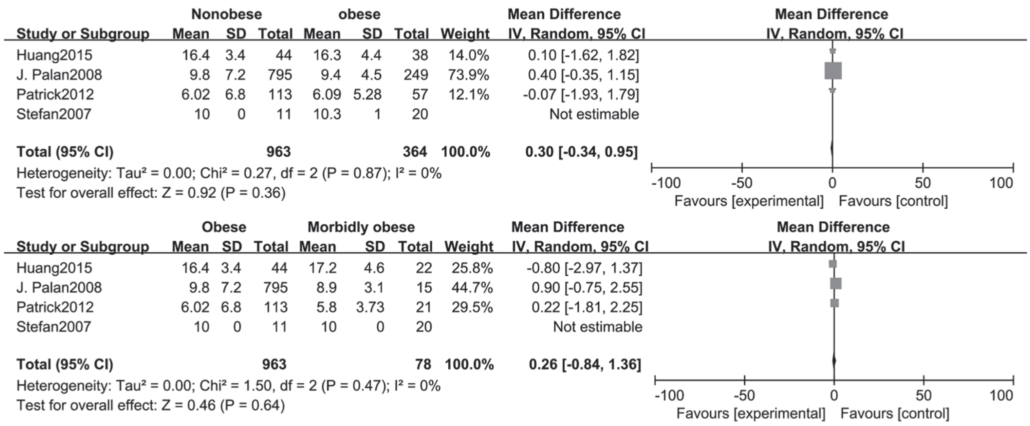


**Fig. 6.** Comparison of postoperative hospital stay between obese and non-obese patients, days

### *Rate of fatal outcomes*

One publication reported rate of fatal outcomes after THR. Random effect models were applied, the result did not demonstrate statistically reliable difference as compared to the group without obesity, RR = 1.11 (95% CI 0.88–1.40), $p>0.05$. However, fatal outcomes demonstrated statistically significant difference when compared with obesity group and morbid obesity group, RR = 0.50 (95% CI 0.33–0.74), $p<0.001$ (Fig. 7).

### *Rate of complications*

Two publications reported general complications after THR. No heterogeneity was observed for the studies ($\chi^2$ = 0.19, $I^2$ = 42%, P = 0.19). Application of fixed effect models demonstrated statistically significant complications rate in group with obesity as compared to control group, RR = 0.37(95% CI 0.15–0.95), $p<0.05$ (cases), also complications rate was higher and statistically significant as compared to obesity group and morbid obesity group, RR = 0.37 (95% CI 0.5–0.95) $p<0.05$ (Fig. 8).

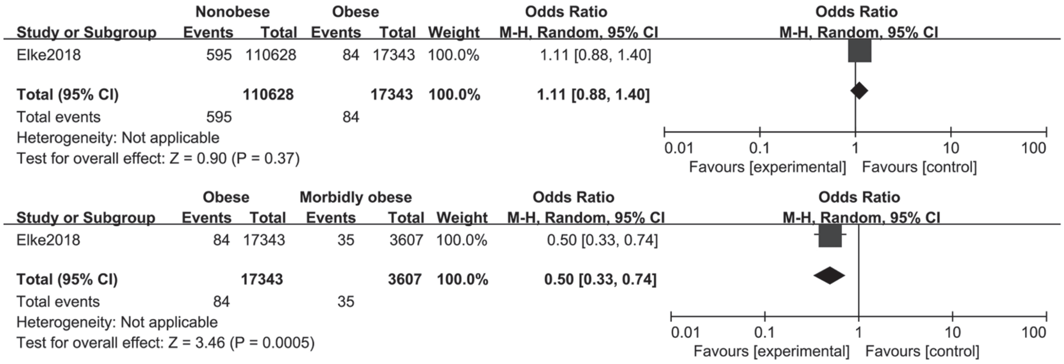


**Fig. 7.** Comparison of patient groups by rate of fatal outcomes after THR, cases

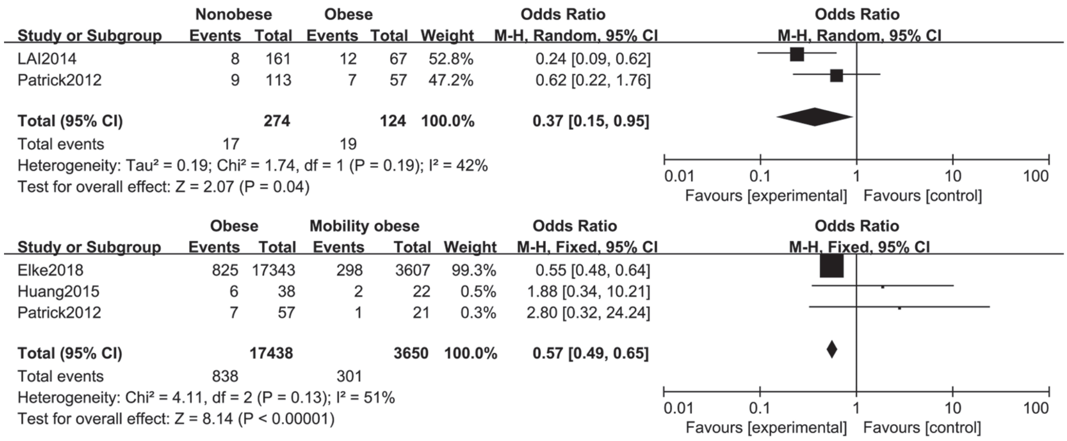


**Fig. 8.** Comparison of general postoperative complications rate between obese and non-obese patients, cases

## Discussion

Unhealthy food and sedentary lifestyle resulted in gradual obesity increase of world population [29]. However, some recent prospective research provide no unambiguous conclusions and their results are controversial [17–19]. Some researches support the opinion that patients with higher BMI do not demonstrate statistically significant difference in surgery time, hospital stay and complications rate as compared to patients without obesity. Other works consider obesity as a factor of significant influence in respect of above mentioned parameters [10, 11, 18]. A number of medical centers restrict arthroplasty procedures for patients with obesity until BMI is reduced until acceptable values [30].

Basing on the present analysis the authors can declare that surgeries of obese patients took more time than for patients from control group. This is related to bigger physical and time efforts for patient positioning, larger surgical wound which complicates implantation of prosthesis.

Haverkamp D. et al. (2011) observed that longer surgery time needed for THR in patients with obesity more often results in such complications as infection, high intra- and postoperative blood loss and deep vein thrombosis of lower limbs [31]. Comparative analysis of postoperative complications rate in patients with various BMI who underwent THR demonstrated that complications rate with BMI <30 kg/m$^2$ is 25%, with BMI of 30–40 kg/m$^2$ — 31%, and with BMI >40 kg/m$^2$ — 38% [32].

Available literature provides scarce information for analysis of correlation between BMI and THR surgery time, however, Zhao W. et al. state a reliable increase of surgery time depending on Adolphe Quetelet index (1869). Mean BMI increase per 1 kg/m$^2$ results in procedure timing increase at 0.838 min [33]. Kessler S. et al. (2007) reported that obesity might not only increase the time of THR procedure but to result in postoperative complications during patient mobilization: patient can have a high blood loss during surgery, delayed wound healing, higher risk and rate of infection as well as risk of peri-prosthetic fractures[7].

Chee Y.H. et al. (2010) in their study consider that obesity increases the rate of complications after THR [13]. In particular, meta-analysis demonstrated that dislocation frequency was higher in patients with obesity which accords with previous studies [7]. Higher complications rate in obese patients can occur due to bigger volume of fat and muscular tissue which can complicate and lengthen the procedure especially at the incision stage and during prosthesis implantation [33]. Challenging surgical incision, long surgery and insufficient of perfusion increases the chances for superficial and deep infection [34]. Obese patients experience not only a bigger trauma of soft tissues but also increased pressure on the prosthesis which might result in its early wear, loosening and dislocation [7, 31].

Meta-analysis allowed to specify that Harris Hip scores in the group with obesity were significantly different from scores in control group. In the present study the evaluation of hip function by HHS was a reliable functional criteria which demonstrated that obese patients had significantly worse treatment outcomes as compared to patients with normal weight. Intraoperative blood loss during THR is the cause for subsequent anemia which affects postoperative clinical and functional restoration [35, 36].

No significant difference in time of hospital stay was observed for compared groups while there were no significant differences in medical care terms. All patients stayed at hospital in a standard manner from admission until discharge. No significant variances in hospital stay was observed for patients with obesity and without except for cases of any complications in postoperative period.

Osteoarthritis in patients with obesity abruptly restricts their functional abilities forcing people to have sedentary lifestyle and aggravating pathological BMI. Pain syndrome, movement limitations and muscular atrophy inevitably results in radical surgery for such patients. Complicated arthroplasty and higher complications risk prevents some clinics from performing surgical treatment of obese patients. Thus, we have a stalemate with the only way out guided by mutual interest of physician and patients in successful treatment outcome and efforts to minimize procedure risks.

Focused, high quality, clinical prospective studies with large statistical sampling are needed to elaborate clinical recommendations for treatment of patients with high BMI. It's necessary to re-evaluate the criteria of patients selection for procedure of total hip replacement depending on BMI and selection of appropriate implants.

**Competing interests:** the authors declare that they have no competing interests.

**Funding:** the authors have no support or funding to report.

## References

1. Sun A.R., Panchal S.K., Friis T., Sekar S., Crawford R., Brown L., Xiao Y, Prasadam I. Obesity-associated metabolic syndrome spontaneously induces infiltration of pro-inflammatory macrophage in synovium and promotes osteoarthritis. *PLoS One.* 2017;12(8):e0183693. DOI: 10.1371/journal.pone.0183693.
2. Liu Y., Hazlewood G.S., Kaplan G.G., Eksteen B., Barnabe C. Impact of Obesity on Remission and Disease Activity in Rheumatoid Arthritis: A Systematic Review and Meta-Analysis. *Arthritis Care Res (Hoboken).* 2017;69(2):157-165. DOI: 10.1002/acr.22932.
3. Craik J.D., Bircher M.D., Rickman M. Hip and knee arthroplasty implants contraindicated in obesity. *Ann R Coll Surg Engl.* 2016;98(5):295-299. DOI: 10.1308/rcsann.2016.0103.
4. Rybrova O.Yu., Fedyaeva V.K. [Questionnaire for assessing the risk of systematic errors in non-randomized comparative studies: the Russian version of the Newcastle-Ottawa scale]. *Meditsinskie tekhnologii. Otsenka i vybor* [Medical technology. Evaluation and selection]. 2016;(3):14-19.(In Russ.).
5. Bowditch M.G. Villar R.N. Do obese patients bleed more? A prospective study of blood loss at total hip replacement. *Ann Royal College Surg Engl.* 1999;81(3):198-200.
6. Mclaughlin J.R. Lee K.R. The outcome of total hip replacement in obese and non-obese patients at 10- to 18-years. *Bone Joint J.* 2006;88(10):1286-1292. DOI: 10.1302/0301-620x.88b10.17660.
7. Kessler S, Käfer W. Overweight and obesity:two predictors for worse early outcome in total hip replacement. *Obesity*. 2007;15(11):2840-2845. DOI: 10.1038/oby.2007.337.
8. Lübbeke A., Stern R., Garavaglia G., Zurcher L., Hoffmeyer P. Differences in outcomes of obese women and men undergoing primary total hip arthroplasty. *Arthritis Rheum.* 2007;57(2):327-334. DOI: 10.1002/art.22542.
9. Sadr Azodi O., Adami J., Lindström D., Eriksson K.O., Wladis A., Bellocco R. High body mass index is associated with increased risk of implant dislocation following primary total hip replacement:2 106 patients followed for up to 8 years. *Acta Orthop.* 2008 79(1):141-147. DOI: 10.1080/17453670710014897.
10. Andrew J.G., Palan J., Kurup H.V., Gibson P., Murray D.W., Beard D.J. Obesity in total hip replacement. *J Bone Joint Surg.* 2008;90(4):424-429. DOI: 10.1302/0301-620x.90b4.20522.
11. Jackson M.P., Sexton S.A., Yeung E., Walter W.L., Walter W.K., Zicat B.A. The effect of obesity on the midterm survival and clinical outcome of cementless total hip replacement. *J Bone Joint Surg Br.* 2009;91(10):1296-1300. DOI: 10.1302/0301-620x.91b10.22544.
12. Dowsey M.M., Liew D., Stoney J.D., Choong P.F. The impact of obesity on weight change and outcomes at 12 months in patients undergoing total hip arthroplasty. *Med J Aust.* 2010;193(1):17-21. DOI: 10.5694/j.1326-5377.2010.tb03734.x.
13. Chee Y.H., Teoh K.H., Sabnis B.M., Ballantyne J.A., Brenkel I.J. Total hip replacement in morbidly obese patients with osteoarthritis: results of a prospectively matched study. *J Bone Joint Surg Br.* 2010;92(8):1066-1071. DOI: 10.1302/0301-620x.92b8.22764.
14. Lübbeke A., Garavaglia G., Barea C., Roussos C., Stern R., Hoffmeyer P. Influence of obesity on femoral osteolysis five and ten years following total hip arthroplasty. *J Bone Joint Surg Am.* 2010 92(10):1964-1972. DOI: 10.2106/jbjs.i.00749.
15. Bergschmidt P., Bader R., Finze S., Tokar I., Kundt G., Mittelmeier W. Impact of preoperative variables on the functional and radiological outcome of an uncemented femoral stem: a prospective two-year follow-up. *Hip Int.* 2010;20(2):187-197. DOI: 10.1177/112070001002000209.
16. Davis A.M., Wood A.M., Keenan A.C., Brenkel I.J., Ballantyne J.A. Does body mass index affect clinical outcome post-operatively and at five years after primary unilateral total hip replacement performed for osteoarthritis. *J Bone Joint Surg Br.* 2011;93(9):1178-1182. DOI: 10.1302/0301-620x.93b9.26873.

17. Michalka P.K., Khan R.J., Scaddan M.C., Haebich S., Chirodian N., Wimhurst J.A. The influence of obesity on early outcomes in primary hip arthroplasty. *J Arthroplasty.* 2012;27(3):391-396. DOI: 10.1016/j.arth.2011.05.012.

18. Raphael I.J., Parmar M., Mehrganpour N., Sharkey P.F., Parvizi J. Obesity and operative time in primary total joint arthroplasty. *J Knee Surg.* 2013;26(2):95-99. DOI: 10.1055/s-0033-1333663.

19. Dienstknecht T., Lüring C., Tingart M., Grifka J., Sendtner E. A minimally invasive approach for total hip arthroplasty does not diminish early postoperative outcome in obese patients:a prospective randomised trial. *Int Orthop.* 2013; 37(6):1013-1018. DOI: 10.1007/s00264-013-1833-5.

20. Lai X.Y., Zhong Y.C., Lai G.S. et al. The influence of obesity on total hip replacement. *Modern Preventive Medicine.* 2014;41(19):3507-3509.

21. Song H.H. Fan W.M. Liu F et al. [Effect of obesity on the early curative effect of primary hip arthroplasty]. *Jiangsu Med J.* 2015(12):1438-1440. DOI:10.19460/j.cnki.0253-3685.2015.12.027. (In Chinese.)

22. Yue C., Xie J.W., Tan Z. et al. The influence of obesity on early complications during primary total hip arthroplasty: a prospective study. *Orthop J China.* 2015;23(17):1537-1541. DOI: 10. 3977 /j. issn. 1005-8478.2015.17.01.

23. Lübbeke A., Zingg M., Vu D., Miozzari H.H., Christofilopoulos P., Uçkay I., Harbarth S., Hoffmeyer P. Body mass and weight thresholds for increased prosthetic joint infection rates after primary total joint arthroplasty. *Acta Orthop.* 2016;87(2):132-8. DOI: 10.3109/17453674.2015.1126157.

24. Husted H., Jørgensen C.C., Gromov K., Kehlet H., Lundbeck Foundation Center for Fast-track Hip and Knee Replacement Collaborative Group. Does BMI influence hospital stay and morbidity after fast-track hip and knee arthroplasty? *Acta Orthop.* 2016;87(5):466-472. DOI: 10.1080/17453674.2016.1203477.

25. Jasinski-Bergner S., Radetzki A.L., Jahn J., Wohlrab D., Kielstein H. Impact of the body mass index on perioperative immunological disturbances in patients with hip and knee arthroplasty. *J Orthop Surg Res.* 2017;12(1):58. DOI: 10.1186/s13018-017-0557-4.

26. Büchele G., Günther K.P., Brenner H., Puhl W., Stürmer T., Rothenbacher D., Brenner R.E. Osteoarthritis-patterns, cardio-metabolic risk factors and risk of all-cause mortality: 20 years follow-up in patients after hip or knee replacement. *Sci Rep.* 2018;8(1):5253. DOI: 10.1038/s41598-018-23573-2.

27. Li W., Ayers D.C., Lewis C.G., Bowen T.R., Allison J.J., Franklin P.D. Functional gain and pain relief after total joint replacement according to obesity status. *J Bone Joint Surg Am.* 2017;99(14):1183-1189. DOI: 10.2106/JBJS.16.00960.

28. Jeschke E., Citak M., Günster C., Halder A.M., Heller K.D., Malzahn J. et al. Obesity increases the risk of postoperative complications and revision rates following primary total hip arthroplasty: an analysis of 131,576 total hip arthroplasty cases. *J Arthroplasty.* 2018;33(7):2287-2292. DOI: 10.1016/j.arth.2018.02.036.

29. Kee J.R., Mears S.C., Edwards P.K., Barnes C.L. Modifiable risk factors are common in early revision hip and knee arthroplasty. *J Arthroplasty.* 2017;32(12):3689-3692. DOI: 10.1016/j.arth.2017.07.005.

30. Craik J.D., Bircher M.D., Rickman M. Hip and knee arthroplasty implants contraindicated in obesity. *Ann R Coll Surg Engl.* 2016;98(5):295-299. DOI: 10.1308/rcsann.2016.0103.

31. Haverkamp D., Klinkenbijl M.N., Somford M.P., Albers G.H., van der Vis H.M. Obesity in total hip arthroplasty--does it really matter? A meta-analysis. *Acta Orthop.* 2011;82(4):417-422. DOI: 10.3109/17453674.2011.588859.

32. Deakin A.H., Iyayi-Igbinovia A., Love G.J. A comparison of outcomes in morbidly obese, obese and nonobese patients undergoing primary total knee and total hip arthroplasty. *Surgeon.* 2018;16(1):40-45. DOI: 10.1016/j.surge.2016.10.005.

33. Zhao W., Wang L., Yuan H. [Effect of BMI on operation time of total hip replacement]. *J Practic Orthop.* 2014:20(10):938-941. DOI: 10.13795/j.cnki.sgkz.2014.10.021. (In Chinese).

34. McClung C.D., Zahiri C.A., Higa J.K., Amstutz H.C., Schmalzried T.P. Relationship between body mass index and activity in hip or knee arthroplasty patients. *J Orthop Res.* 2000;18(1):35-39. DOI: 10.1002/jor.1100180106.

35. Parratte S., Pesenti S., Argenson J.N. Obesity in orthopedics and trauma surgery. *Orthop Traumatol Surg Res.* 2014;100(1 Suppl):S91-97. DOI: 10.1016/j.otsr.2013.11.003.

36. Münter K.H., Clemmesen C.G., Foss N.B., Palm H., Kristensen M.T. Fatigue and pain limit independent mobility and physiotherapy after hip fracture surgery. *Disabil Rehabil.* 2018;40(15):1808-1816. DOI: 10.1080/09638288.2017.1314556.

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