Safety of bariatric surgery in the elderly

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Original article

Safety of bariatric surgery in the elderly: results from the Dutch National Registry

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Abstract

Background: The increased human life expectancy and prevalence of obesity lead to more elderly people with obesity. As the popularity of bariatric surgery continues to grow, more elderly persons apply for bariatric surgery. However, because of the potentially higher surgical risk in elderly patients, bariatric surgery has been performed in small numbers. Moreover, the literature so far has shown controversial results.

Objective: To determine the safety of bariatric surgery in elderly patients in terms of 2-year morbidity and mortality.

Setting: Dutch nationwide mandatory registry for bariatric surgery.

Methods: A population-based retrospective cohort study. Elderly patients (aged ≥65 years) who received primary bariatric surgery between January 2015 and January 2020 were compared with the general bariatric surgical population (aged 18–65 years).

Results: Of 49,553 patients, 838 elderly patients (1.7%) were included. An intraoperative complication was registered in 1.2% of the elderly patients and 1.1% of the nonelderly patients ($P = .814$). A severe short-term complication (≤30 days) was registered in 38 elderly patients (4.5%) and 1071 nonelderly patients (2.2%) ($P < .001$). The short-term mortality rates were .2% and .1%, respectively ($P = .173$). Bleeding was the most reported short-term complication. Significantly more nonelderly patients had a follow-up visit; 560 elderly patients (66.8%) versus 34,975 nonelderly patients (71.8%) ($P = .002$). The severe midterm complication rate (>30 days to ≤2 years) was significantly higher in nonelderly patients (3.7% versus 1.6%; $P = .008$).

Conclusions: Bariatric surgery in elderly patients is safe in terms of perioperative outcome, mortality, and midterm complication rate. However, elderly patients experienced twice as many severe short-term complications. Bariatric surgery in elderly patients should be recommended on a case-

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Bariatric surgery is the most effective long-term treatment for patients with severe obesity [1]. Like adults with severe obesity, elderly people (aged ≥65 years) are seeking surgical solutions to their obesity. However, the performance of bariatric surgery has been limited in elderly patients. The reasons for this hesitancy include a concern about higher morbidity and mortality rates and cost-effectiveness. Several studies that have examined the safety of bariatric surgery in elderly patients showed controversial results [2,3].

The eligibility criteria for bariatric surgery (International Federation for the Surgery of Obesity and Metabolic Disorders [IFSO] guidelines) were published in 1997, including people aged 18–65 years [4,5]. Based on the increase in human life expectancy since 1997 [6,7], it is questionable whether this age criterion is still valid. Moreover, in the Netherlands, the mean retirement age was 60.7 years in 2002 and 65.6 years in 2020, with more than half the people retiring aged ≥66 years [8]. In addition to this, assessing patients based on their chronological age instead of their biological age is questionable.

Therefore, the aim of this study was to determine the safety of bariatric surgery in elderly patients with severe obesity in the Dutch population in terms of the 2-year morbidity and mortality.

Methods

Study design

A national population-based retrospective cohort study was conducted using pseudoanonymized data from the Dutch nationwide mandatory registry for bariatric surgery, the Dutch Audit for the Treatment of Obesity (DATO). Each Dutch bariatric clinic is obliged to register all bariatric patients in the DATO.

Participants and setting

Inclusion criteria for performing bariatric surgery in the Netherlands between 2015 and 2020 were based on the IFSO guidelines [4,5]. Patients aged ≥18 years who received a primary bariatric procedure between January 1, 2015 (start of the DATO registry [9,10]), and December 31, 2019, in the Netherlands were screened for inclusion. All patients who were registered in the DATO with a date of surgery and a body mass index (BMI) ≥35.0 kg/m^2 prior to surgery were included. Exclusion criteria were revisional bariatric procedures, age <18 years, and BMI <35.0 kg/m^2 prior to surgery.

Elderly was defined as patients aged ≥65 years at the time of surgery, whereas *nonelderly* was defined as patients aged 18 to 65 years. According to Dutch law (Medical Research Involving Human Subjects Act), formal consent was not required for this study.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Outcomes

Primary outcome was morbidity (including intraoperative complications and overall and severe short- and midterm complications) and mortality up to 2 years after surgery. Secondary outcomes included length of hospital stay and readmission rate. Elderly patients were compared with the general bariatric surgical population (people aged 18–65 years).

Variables

All variables were derived from the DATO and included basic demographic characteristics (i.e., age, sex, comorbidities, and BMI), type of bariatric procedure, length of hospital stay, and postoperative complications.

Complications

An *intraoperative complication* was defined as any significant deviation from the ideal intraoperative course occurring between skin incision and skin closure. A *short-term complication* was defined as a complication ≤30 days after the bariatric surgery (excluding intraoperative complications). A *midterm complication* was defined as a complication >30 days up to 2 years after the bariatric surgery.

Both short- and midterm complications were categorized according to the Clavien–Dindo Classification (CDC) of surgical complications [11] (Appendix 1). A *severe complication* was defined as a complication categorized as CDC grade III or higher.

Bariatric procedures

The bariatric procedures were divided into 3 groups: (1) sleeve gastrectomy (SG), (2) gastric bypass (including Roux-en-Y gastric bypass [RYGB] and 1-anastomosis and banded bypass), and (3) other (including gastric band,

biliopancreatic diversion, and single-anastomosis duodenoileostomy). A brief description of how the SG and RYGB procedures are performed in the Netherlands is presented in Appendix 2.

Follow-up

In the Netherlands, patients have routine follow-up appointments at the outpatient clinic at 3, 6, 12, and 18 months and then at 2, 3, 4, and 5 years after bariatric surgery. All periodic routine follow-up appointments must be reported to the DATO. For this study, all patients with at least 1 registered follow-up visit at 1, 2, 3, 4, or 5 years postoperatively were included in the analysis for midterm complications.

Statistics

All analyses were performed on the patient level; for every patient, only 1 complication, the most severe one, was included (unless stated otherwise). Missing values were not replaced.

Descriptive statistics were used as appropriate. Differences in categorical baseline variables between elderly and nonelderly patients were compared using the χ^2 test or the Fisher exact test for small numbers. Differences in continuous baseline variables were compared using the unpaired *t* test unless stated otherwise.

Univariate and multivariate logistic regression analyses were performed to determine the effect of elderly on the risk of complications and mortality. Multivariate regression analysis was performed to correct for known confounders, including preexisting obesity-related co-morbidities and sex, and for potential other confounders, defined as variables associated with the outcome $P < .1$ in the univariate analysis.

The effect of age as a continuous variable on the primary outcome as well as on several secondary outcomes was analyzed using univariate and multivariate logistic analyses. In a secondary analysis, age as an ordinal variable (10-year age categories) was included in the model.

Statistical analyses were performed using IBM SPSS Statistics version 24.0 (IBM, Armonk, NY, USA), and $P < .05$ was considered statistically significant.

Results

Participants

A total of 50,694 unique patients were registered during the study period. After exclusion of patients with a BMI <35.0 kg/m^2 or missing a BMI value, 49,553 patients were included, of which 838 (1.7%) were elderly (Fig. 1). Of the elderly patients, 231 (27.6%) were 65 years of age, 288 (34.4%) were 66 years of age, 158 (18.9%) were 67 years of age, 92 (11.0%) were 68 years of age, 39 (4.7%) were 69 years of age, and 30 (3.6%) were 70 years of age or older at the time of bariatric surgery. The proportion of bariatric procedures in elderly patients has increased from 1.1% in 2015 to 2.4% in 2019.

At baseline, the obesity-related co-morbidities (type 2 diabetes, hypertension, dyslipidemia, and obstructive sleep

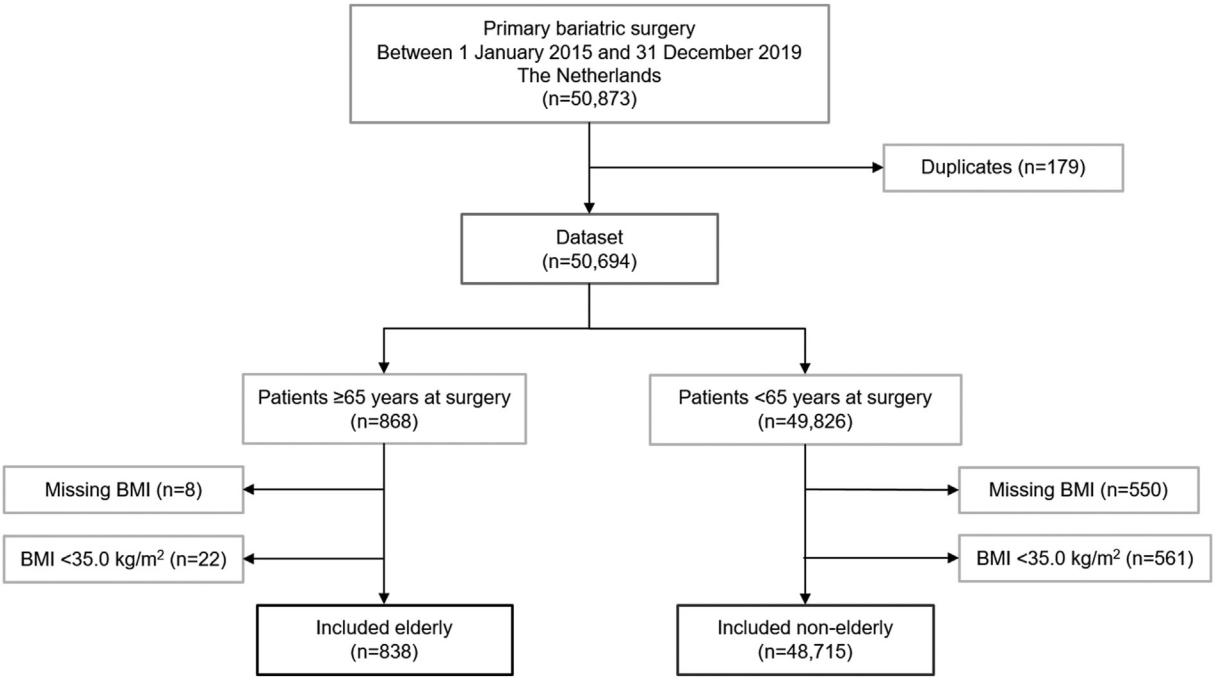

Fig. 1. Flowchart of inclusion.

Table 1
Baseline characteristics

Characteristic	Total (n = 49,553)	Nonelderly (n = 48,715)	Elderly (n = 838)	*P* value
Age, yr ± SD	44.2 ± 11.6	43.8 ± 11.3	66.5 ± 1.6	<.001
Female, n (%)	39,007 (78.7)	38,454 (78.9)	553 (66.0)	<.001
Preoperative weight, kg ± SD	124.4 ± 19.9	124.4 ± 19.9	122.1 ± 19.7	.001
Preoperative BMI, kg/m^2 ± SD	43.1 ± 5.3	43.1 ± 5.3	43.2 ± 5.6	.892
Type 2 diabetes, n (%)	9868 (19.9)	9422 (19.3)	446 (53.2)	<.001
Hypertension, n (%)	17,245 (34.8)	16,612 (34.1)	633 (75.5)	<.001
Dyslipidemia, n (%)	9594 (19.4)	9214 (18.9)	380 (45.3)	<.001
OSA, n (%)	8991 (18.1)	8692 (17.8)	299 (35.7)	<.001

SD = standard deviation; BMI = body mass index; OSA = obstructive sleep apnea.

apnea [OSA]) were significantly more prevalent among elderly compared with nonelderly patients (Table 1).

Surgery

The majority of bariatric procedures were performed laparoscopically (elderly patients, 99.8%; nonelderly patients, 99.9%). Gastric bypass was the most frequently performed bariatric procedure (elderly patients, 76.6%; nonelderly patients, 76.8%), followed by the SG (elderly patients, 22.7%; nonelderly patients, 22.8%).

Intraoperative complications

An intraoperative complication was registered in 547 patients (1.1%), 10 (1.2%) in elderly and 537 (1.1%) in nonelderly patients ($P = .8$ in both uncorrected and corrected analyses). In 28 patients (all nonelderly), >1 intraoperative complication was reported. In total, 558 intraoperative complications were noted, of which perforation (n = 188), bleeding (n = 148), liver injury (n = 75), and spleen injury (n = 68) were the most frequent (similar between the 2 groups, all $P > .3$). Intraoperative mortality was not reported. Six nonelderly patients were admitted to the intensive care unit because of single-organ failure (n = 4) or multiorgan failure (n = 2). Median hospital stay was 1 day (1, 2) for both groups ($P = .976$).

Short-term complications (≤30 days)

Including all CDC grades of short-term complications, 58 elderly patients (6.9%) experienced a complication compared with 2468 nonelderly patients (5.1%) ($P = .015$). However, this difference was not significant after correction for baseline differences ($P = .305$; Appendix 3 – Table 8). Table 2 shows the CDC grades of patients with short-term complications. Bleeding was the most reported short-term complication (3.8% of elderly versus 1.5% of nonelderly patients; $P < .001$), followed by anastomotic leakage (.6% elderly versus .5% nonelderly patients; $P = .811$) (Table 3).

A severe short-term complication (CDC grade III or higher) was registered in 38 elderly patients (4.5%) and 1071 nonelderly patients (2.2%; $P < .001$). Also, after correction of baseline variables, being elderly was independently associated with an increased risk of severe short-term complications (odds ratio [OR] = 1.707; 95% confidence interval [CI], 1.218–2.392; $P = .002$). Nevertheless, short-term readmission and mortality rates were not statistically different (Table 2). Short-term mortality rate remained

Table 2
Short-term complications

Complication	Total (n = 49,553)	Nonelderly (n = 48,715)	Elderly (n = 838)	*P* value
Within 30 d,* n (%)	2526 (5.1)	2468 (5.1)	58 (6.9)	.015
Severe, within 30 d,* n (%)	1109 (2.3)	1071 (2.2)	38 (4.5)	<.001
Clavien–Dindo classification,* n (%)				
Grade 0 (no complication)	47,027 (94.9)	46,247 (94.9)	780 (93.1)	
Grade I	1139 (2.3)	1125 (2.3)	14 (1.7)	
Grade II	247 (.5)	241 (.5)	6 (.7)	
Grade IIIa	169 (.3)	163 (.3)	6 (.7)	
Grade IIIb	810 (1.6)	789 (1.6)	21 (2.5)	
Grade IVa	74 (.1)	67 (.1)	7 (.8)	
Grade IVb	27 (.1)	25 (.1)	2 (.2)	
Grade V	29 (.1)	27 (.1)	2 (.2)	
Unknown	31 (.1)	31 (.1)	0 (0)	
Readmission within 30 d,* n (%)	1160 (2.3)	1140 (2.3)	20 (2.4)	.930
Mortality within 30 d, n (%)	29 (.1)	27 (.1)	2 (.2)	.086

* Only the most severe complication has been registered for each patient.

Table 3
Types of short-term complications

Complication	Total (n = 49,553)	Nonelderly (n = 48,715)	Elderly (n = 838)	*P* value
Total number of complications,* n (%)	2623 (5.3)	2560 (5.3)	63 (7.5)	.003
Surgical complications,* n (%)	1814 (3.7)	1761 (3.6)	53 (6.3)	<.001
Type of surgical complication, n (%)				
Bleeding	753 (1.5)	721 (1.5)	32 (3.8)	<.001
Anastomotic leakage	273 (.6)	268 (.6)	5 (.6)	.811
Intestinal obstruction	100 (.2)	100 (.2)	0 (0)	
Vomiting	94 (.2)	93 (.2)	1 (.1)	
Intraabdominal abscesses	89 (.2)	89 (.2)	0 (0)	
Wound infection	72 (.1)	70 (.1)	2 (.2)	
Bowel injury	40 (.1)	40 (.1)	0 (0)	
Anastomotic stricture	39 (.1)	39 (.1)	0 (0)	
Marginal ulcer	13 (0)	13 (0)	0 (0)	
Wound dehiscence	12 (0)	11 (0)	1 (.1)	
Sepsis	8 (0)	5 (0)	3 (.4)	
Bile leakage	2 (0)	2 (0)	0 (0)	
Liver failure	2 (0)	2 (0)	0 (0)	
Port infection	1 (0)	1 (0)	0 (0)	
Other	316 (.6)	307 (.6)	9 (1.1)	
General complications,*,† n (%)	687 (1.4)	665 (1.4)	22 (2.6)	.002
Type of general complication, n (%)				
Pulmonary	164 (.3)	159 (.3)	5 (.6)	
Cardiac	70 (.1)	65 (.1)	5 (.6)	
Thrombotic	22 (0)	21 (0)	1 (.1)	
Other	431 (.9)	420 (.9)	11 (1.3)	

* Analyzed on complication level, so in case a patient experienced more than 1 complication, all complications are scored/included.

† Pulmonary (e.g., infection, pleural effusion), cardiac (e.g., myocardial infarct, arrhythmia), thrombotic (e.g., deep vein thrombosis, pulmonary embolism).

statistically not different after correction for baseline differences in multivariate analysis ($P = .173$).

Multivariate analysis identified being elderly (OR = 1.707; $P = .002$) as a risk factor for a severe short-term complication. Other risk factors were female sex, preoperative BMI, hypertension, and OSA. Furthermore, SG was associated with more severe short-term complications than gastric bypass (Appendix 3 – Table 9).

In elderly patients, relatively more general complications were noted, 22 (2.6%) versus 665 (1.4%) in nonelderly patients ($P = .003$). However, after multivariate analysis, only a trend toward significance was seen (OR = 1.519; $P = .061$; Appendix 3 – Table 10).

Midterm complications (>30 days to ≤2 years)

In 35,535 of the 49,553 patients (71.7%) at least 1 follow-up moment was registered. Significantly more nonelderly patients had a follow-up: 34,975 nonelderly patients (71.8%) versus 560 elderly patients (66.8%) ($P = .002$). Table 4 presents the yearly follow-up numbers.

In contrast to short-term complications, overall midterm complication rate as well as severe midterm complication rate were significantly higher in nonelderly compared with elderly patients as well as after correction of baseline characteristics in multivariate analysis (Table 5; Appendix 3 – Tables 11 and 12). The mortality rate was .1% for nonelderly patients and .4% for elderly patients ($P = .054$), which remained not significantly different after correction for baseline variables ($P = .079$). The mean number of days between surgery and midterm complications was 321 days (±188 days). The types of midterm complications are presented in Table 6, with internal herniation being the most frequently reported complication.

Sensitivity analyses

Age as a continuous factor was identified as an independent risk factor for (severe) short- and midterm complications (Table 7). However, being elderly was not an independent risk factor for a short-term complication (including all CDC grades; $P = .305$). Looking at age as an ordinal variable (10-year age categories), with every 10-year increase in age, a higher odds ratio for severe-short term complications was noted (Table 7).

Discussion

This is the first Dutch nationwide study examining complication and mortality rates in elderly patients undergoing primary bariatric surgery. This study indicates that bariatric surgery in elderly patients tends to be safe in the short and midterm because there was no perioperative mortality, and severe short-term complications and mortality

Table 4
Follow-up numbers

Follow-up moment	Total		Nonelderly		Elderly	
	Total number	n (%)	Total number	n (%)	Total number	n (%)
1 yr	49,553	33,578 (67.8)	48,715	33,035 (67.8)	838	543 (64.8)
2 yr	38,848	18,156 (46.7)	38,262	17,878 (46.7)	586	278 (47.4)
3 yr	28,950	9285 (32.1)	28,557	9147 (32.0)	393	138 (35.1)
4 yr	18,516	3620 (19.6)	18,287	3578 (19.6)	229	42 (18.3)
5 yr	8593	387 (4.5)	8501	383 (4.5)	92	4 (4.3)

rates were low (4.5% and .2%, respectively), and the midterm complication rate was only 1.4% in elderly patients. Nonetheless, the severe short-term complication rate was twice as high in elderly patients than in nonelderly patients, even after correction for baseline variables (P = .002). The perioperative safety outcome in elderly patients is comparable to that in nonelderly patients. In the general eligible population for bariatric surgery in northwestern Europe, an intraoperative complication rate of 6.5% has been reported [12]. Giordano et al. [13] showed a significant increase in intraoperative complication rate in elderly patients (aged ≥55 years) compared with patients aged <55 years, with rates of 14.4% and 5.3%, respectively. Furthermore, it has been reported that elderly patients are more likely to have a prolonged hospital stay, by 1 day, on average, but a lower readmission rate compared with nonelderly patients [14,15]. The findings of this study show an overall intraoperative complication rate of 1.1%, not significantly different between elderly and nonelderly patients (P = .803). Furthermore, conversion to laparotomy was rarely done in both groups, and no differences were found in hospital stay. Looking at perioperative outcome, bariatric surgery seems to be as safe in patients up to at least 70 years of age as in nonelderly patients.

Elderly patients who receive bariatric surgery do not have an increased mortality risk. Since laparoscopy has become the main surgical approach in bariatric surgery, the perioperative mortality is low, about .1% [12]. In elderly patients, mortality rates of .01% [13] and .4% [14] have been reported after bariatric surgery. In this study, the short-term mortality rate was .2% in elderly patients and .1% in nonelderly patients (P = .086), a finding that is comparable with previously mentioned studies. Thus, also in elderly patients, the short-term mortality rate is low and comparable with that in the general bariatric population.

With regard to severe short-term complications, elderly patients are at higher risk. A systematic review concerning older adults undergoing abdominal elective surgery showed that 24.7% of elderly patients experienced a short-term complication [16]. Regarding bariatric surgery, several studies have shown no difference in short-term complication rate between elderly and nonelderly patients [2,14,17]. However, a recently published review showed significantly more short-term complications in older patients, with an odds ratio of 1.88 [3]. In this study, severe short-term complications were significantly more prevalent in elderly compared with nonelderly patients (4.5% versus 2.2%, respectively; OR = 1.707; 95% CI, 1.218–2.392). This

Table 5
Midterm complications (>30 days to ≤2 years)

Complication	Total (n = 35,535)	Nonelderly (n = 34,975)	Elderly (n = 560)	P value
Complication >30 d to ≤2 yr*, n (%)	1,660 (4.7)	1,648 (4.7)	12 (2.1)	.004
Severe complication >30 d to ≤2 yr*, n (%)	1,318 (3.7)	1,309 (3.7)	9 (1.6)	.008
Mortality >30 d to ≤2 yr,* n (%)	24 (.1)	22 (.1)	2 (.4)	.054
Clavien–Dindo classification,* n (%)				
Grade 0 (no complication)	33,875 (95.3)	33,327 (95.3)	548 (97.9)	
Grade I	259 (.7)	257 (.7)	2 (.4)	
Grade II	75 (.2)	74 (.2)	1 (.2)	
Grade IIIa	82 (.2)	81 (.2)	1 (.2)	
Grade IIIb	1203 (3.4)	1198 (3.4)	5 (.9)	
Grade IVa	7 (0)	6 (0)	1 (.0)	
Grade IVb	2 (0)	2 (0)	0 (0)	
Grade V	24 (.1)	22 (.1)	2 (.4)	
Unknown	8 (0)	8 (0)	0 (0)	
Readmissions >30 d to ≤2 yr,* n (%)	964 (2.7)	957 (2.7)	7 (1.6)	.032
Therapeutic intervention >30 d to ≤2 yr,* n (%)	897 (2.5)	891 (2.5)	6 (1.1)	.027

* Only the most severe complication has been registered for each patient. Follow-up rates: 34,975 (71.8%) nonelderly versus 560 (66.8%) elderly (P = .002).

Table 6
Types of midterm complications reported

Complication	Total	Nonelderly	Elderly
Hepatobiliary	543	543	0
Gallstones	528	528	0
Liver failure	2	2	0
Gastric	423	418	5
Motility disorder	152	149	3
Marginal ulcer	73	73	0
Gastric ulcer	71	70	1
Anastomotic stenosis	60	60	0
Delayed gastric emptying	5	5	0
Metabolic*	298	295	3
Esophageal	56	51	5
Motility disorder	11	10	1
Dilatation	5	5	0
Gastroesophageal reflux disease	0	0	0
Gastric band–related	12	12	0
Motility disorder	0	0	0
Band erosion	3	3	0
Pouch dilatation/band slippage	2	2	0
Port/band infection	1	1	0
Other	1222	1220	2
Internal herniation	692	692	0
Intestinal obstruction	60	59	1
Incisional hernia	55	55	0
Intolerance of bariatric procedure	46	46	0
No type of complication registered	192	192	0

Analyses are performed on complication level, so in case a patient experienced more than 1 complication, all complications are scored/included. The total number of complications in each subgroup may not be equal to the sum of the specific complications within the subgroup due to missing reporting of the specific type of complication.

* Metabolic complication (e.g., dumping syndrome, vitamin deficiency, secondary hyperparathyroidism, peripheral neuropathy, electrolyte disorders).

short-term complication rate of 4.5% in elderly patients is comparable with the complication rate (major adverse events) of 4.3% reported by Dorman et al. [14], who showed no difference between elderly and nonelderly patients. Moreover, the overall short-term complication rate (6.9% in elderly patients) is lower than previously reported complication rates of 8.9% [17] and 14.7% [2]. An explanation might be a difference in type of study: national registry study versus retrospective single-center study versus review. Another explanation might be the selection of relatively healthy elderly patients for elective bariatric surgery, while studies that focus on acute abdominal surgery include all elderly patients. Bariatric surgery should be considered in elderly patients on an individual basis, in which the indication should be balanced against the risk of (severe) complications. Interesting aims for future research in the elderly are long-term complications up to 5 years, efficacy, quality of life, and cost-effectiveness.

Preexisting obesity-related co-morbidities and age are considered to negatively impact the short-term complication rate. Among others, age, co-morbidities, frailty, American Society of Anesthesiologists score, and emergency surgery have been reported previously as risk factors [16,18–21]. Focusing on bariatric surgery, in a national sample of patients undergoing bariatric surgery in the United States, age and male sex were independent risk factors for mortality after bariatric surgery [22]. Our study identified female sex ($P = .033$), age ($P < .001$), preoperative BMI ($P = .005$), hypertension ($P < .001$), and OSA ($P = .004$) as independent risk factors associated with a severe short-term complication. Furthermore, this study found that SG was associated with more severe short-term complications than gastric bypass ($P < .001$), which does not comply with the existing literature [23–26]. In the SG group, potentially more complex patients are included because the sleeve resection is an escape procedure when a gastric bypass is technically not possible. During the eligibility screening process of elderly patients for bariatric surgery, known risk factors should be considered, and more research should be performed to determine the best procedure.

General postoperative complications tend to occur more frequently in elderly patients. Khorgami et al. [27] described 3.4% major adverse cardiovascular events in a retrospective cohort study including >100,000 adult patients after bariatric surgery. A multicenter prospective database study regarding pulmonary complications after bariatric surgery showed a 30-day morbidity rate of 6.4%, with pneumonia and respiratory failure accounting for 18.7% [28]. In our study, a general complication was scored in 22 elderly patients (2.6%) and 665 nonelderly patients (1.4%) ($P = .002$). After correction for baseline variables, only a trend toward significance was seen ($P = .061$). The pulmonary complication rate was 22.7% versus 23.9% and the cardiac complication rate 22.7% versus 9.8% in elderly versus nonelderly patients, respectively. When an elderly patient undergoes bariatric surgery, awareness and prevention (applying, among others, enhanced recovery after surgery) of general postoperative complications should be pursued. Prehabilitation, a process of improving the physical, nutritional, medical, and mental conditions of a patient prior to a surgical procedure, has increasingly shown to be beneficial regarding reducing postoperative complications in various other types of surgery. It also may contribute to a reduction in postoperative complications in elderly patients undergoing bariatric surgery. However, more research is needed to support this hypothesis.

Bariatric surgery in elderly patients is safe regarding midterm complications up to 2 years after surgery. The literature so far has focused on efficacy in the mid/long term rather than safety [29,30]. This study showed that the overall midterm complication rate as well as the severe midterm complication rate was higher in nonelderly versus elderly patients (4.7% versus 2.1% and 3.7% versus 1.6%, respectively). Of note, significantly more nonelderly patients had a follow-up visit, and the number of complications in elderly

Table 7
Sensitivity analyses

	Univariate		Multivariate	
	Odds ratio (CI)	*P* value	Odds ratio (CI)	*P* value
Age (continuous)	1.015 (1.011–1.018)	<.001	1.009 (1.005–1.013)	<.001
Elderly versus nonelderly	1.393 (1.064–1.825)	.016	1.154 (.878–1.517)	.305
Severe short-term complication*				
Age (continuous)	1.025 (1.019–1.031)	<.001	1.021 (1.015–1.027)	<.001
Elderly versus nonelderly	2.190 (1.591–3.014)	<.001	1.707 (1.218–2.392)	.002
Age groups, yr				
25–35 compared with <25	1.323 (.923–1.898)	.128	1.349 (.940–1.936)	.104
35–45 compared with <25	1.601 (1.133–2.260)	.008	1.614 (1.139–2.286)	.007
45–55 compared with <25	2.149 (1.538–3.003)	<.001	2.032 (1.442–2.863)	<.001
55–65 compared with <25	2.381 (1.687–3.359)	<.001	2.119 (1.147–3.037)	<.001
65–75 compared with <25	3.873 (2.454–6.113)	<.001	3.300 (2.056–5.298)	<.001
Midterm complication†				
Age (continuous)	.985 (.981–.989)	<.001	.981 (.977–.985)	<.001
Elderly versus nonelderly	.356 (.200–.631)	<.001	.424 (.253–.710)	.001
Severe midterm complication*				
Age (continuous)	.984 (.980–.988)	<.001	.982 (.977–.987)	<.001
Elderly versus nonelderly	.331 (.157–.699)	.004	.388 (.192–.782)	.008

CI = confidence interval.

For all analyses, only the most severe complication has been registered for each patient. The independent variables included in each analysis are shown in the corresponding table in Appendix 2, in which "Elderly versus nonelderly" was replaced by "Age (continuous)" or "Age group."

* Including Clavien–Dindo Classification ≥3.

† Including all Clavien–Dindo Classification grades.

patients was low. This could have biased results, and therefore, the results should be interpreted with caution.

The major strength of this study is the national population-based design with almost complete coverage of all patients who had bariatric surgery in the Netherlands between January 2015 and January 2020. However, this study has several limitations. The DATO contains a large set of data points, but some outcomes are not registered and therefore missing, such as operative time and cause of death. Furthermore, the administrative burden is extensive, making errors more likely but also leading to missing follow-up and complications and thus selection bias. Third-party visits to bariatric centers are needed to validate data to correct for this possible bias, but not all errors are covered [9,10].

Conclusion

Bariatric surgery in elderly patients is safe regarding the perioperative outcome, short-term mortality, and complications rate after 30 days and up to 2 years. However, significantly more severe complications ≤30 days were noted for elderly patients. These data add to the growing body of evidence that weight loss surgery is a possible option for elderly patients with severe obesity and that patients should not be denied surgery solely based on their chronological age. Bariatric surgery in elderly patients should be recommended on a case-by-case basis. Future studies with long-term follow-up should aim to determine the long-term complication rate, efficacy, and quality of life.

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Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

Supplementary materials

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