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ORIGINAL CONTRIBUTIONS

Health-Related Quality of Life 5 Years After Roux-en-Y Gastric Bypass in Young (18–25 Years) Versus Older (≥ 26 Years) Adults: a Scandinavian Obesity Surgery Registry Study

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Abstract

Background To compare changes in health-related quality of life (HRQoL) in young (18–25 years) versus older (≥ 26 years) adults up to 5 years after Roux-en-Y gastric bypass (RYGB).

Methods Data on Short Form-36 (SF-36) and obesity-related problems scale (OP) at baseline and 1, 2, and 5 years after RYGB were extracted from the Scandinavian Obesity Surgery Registry. Within-group changes and the effect of age group on 5-year changes in SF-36 and OP were analyzed. Effects sizes (ESs) were calculated.

Results A total of 2542 young and 12,425 older adults were included at baseline, and 138 young (20.7% of those eligible) and 1021 older (31.8%) adults were followed-up 5 years post-RYGB. At this time, average to large improvements (ES ≥ 0.5) were observed in physical functioning, physical component score and OP in young adults, and in physical functioning, role physical, general health, physical component score, and OP in older adults (all, $p \leq 0.001$). Both age groups displayed negligible to weak (ES < 0.5) or no improvements in mental HRQoL (all, $p < 0.55$). Older adults displayed greater 5-year improvements than their young counterparts in role physical, general health, vitality, social functioning, physical component score, and obesity-related problems scale (all, $p < 0.05$).

Conclusions Both young and older adults displayed improvements in OP and physical HRQoL 5 years post-RYGB compared to baseline, while mental HRQoL did not improve to the same extent. Greater HRQoL-improvements could be expected in older patients why future research on HRQoL post-RYGB should stratify data on age groups.

Keywords HRQoL · RYGB · Young adult

Introduction

Obesity (body mass index [BMI] ≥ 30 kg/m^2) is associated with poor general and weight-related quality of life (HRQoL), most notably in pre-bariatric surgery populations as compared to non-bariatric surgery or non-treatment seekers [1–4], and HRQoL is increasingly acknowledged as an important outcome after bariatric surgery besides weight loss and remission of co-morbidities [5]. While adults and adolescents display long-term improvements, particularly physical dimensions, of HRQoL after bariatric surgery, including control group comparisons with and without obesity [3, 5–8], less is known about post-surgical HRQoL in young adults (here defined as 18–25 years according to the Stockholm health care organization). Young adults are particularly vulnerable to both weight gain and mental health issues [9, 10]. More information regarding age-related changes in HRQoL are therefore warranted as suggested in a recent review by Kolotkin et al. [3].

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Young adulthood is not characterized by a definite age range but by the transition from adolescence to mature adulthood, differentiated by identity building and becoming economically and socially independent [11]. Young adults are vulnerable to weight gain due to factors such as exposures to junk food marketing, while also experiencing high attrition rates and poor weight loss outcomes once enrolled in standard obesity care programs [9, 12–15]. While obesity-related physical co-morbidities are still not common in this age group [16], psychological issues and poor HRQoL are frequently encountered in young adults compared to their adolescent and normal-weight counterparts [17, 18].

While poor HRQoL is a main incentive for seeking bariatric surgery among young adults [19–21], recent research reports that patients in this age group are continuously challenged with mental and emotional hardships after bariatric surgery [22, 23]. However, previous studies on HRQoL after RYGB did not report in detail on young adults' scores [22]. Given the specific traits of young adulthood, together with shifting HRQoL throughout the life course, generalizations from other age groups onto young adults may be misleading.

Therefore, the aim of this study was to compare within- and between-group changes in HRQoL in young (18–25 years) versus older (≥ 26 years) adults up to 5 years after Roux-en-Y gastric bypass (RYGB) by using data from the Scandinavian Obesity Surgery Registry (SOReg) [24, 25].

Methods

Participants

All data were retrieved from SOReg, a quality and research registry [24, 25]. SOReg is financed by the Swedish Association of Local Authorities and the National Board of Health and Welfare [24]. Since the start in 2007, SOReg covers up to 97% of all bariatric procedures in Sweden, and 96.7–98.6% of data were correctly registered according to regular audits [26].

All patients aged 18–25 years (the definition of young adults in the Stockholm health care organization) who had undergone primary RYGB and were registered in SOReg were frequency matched for BMI, gender, and year of surgery to those aged ≥ 26 years. Patients without baseline HRQoL-data were thereafter excluded. Data extraction was performed on February 8, 2016 and the last data entry was made on September 15, 2015 (see flowchart, Fig. 1).

Outcomes

The primary aim was to compare 5-year changes in HRQoL after RYGB in young (18–25 years) versus older (≥ 26 years) adults as compared to baseline. The secondary aim was to compare within-group levels of HRQoL throughout the study period in young and older adults, respectively.

HRQoL was assessed by the global Short Form-36 version 1.0 (SF-36) [27] and the disease-specific obesity-related problems scale (OP) [28]. SF-36 measures eight patient-reported domains of functional health during the last 4 weeks by 36 items. SF-36 was validated for the general Swedish population and was frequently used to study HRQoL post-RYGB [5, 27]. Scoring ranges from 0 to 100 points. A score of 100 indicates optimal HRQoL. The eight domains may be summarized into two summary scores; the physical and the mental component score (PCS and MCS, respectively). The summary scores are standardized to a mean of 50 indicating average health compared to the general population. Cronbach's alpha for the present sample was 0.85–0.91, indicating good to excellent internal consistency.

OP was developed and validated in the Swedish Obese Subject and the Xendos studies to assess obesity-related psychosocial functioning in eight daily activities such as buying clothes and eating out [28]. The summary score measures 0–100 points and is categorized into mild (< 40), moderate (40–59), and severe (≥ 60) impairment.

Covariates Used in the Regression Analysis

Co-morbidities were registered at baseline and defined as current pharmacological treatment for diabetes type 2, hypertension, dyslipidemia, depression, and/or usage of continuous positive airway pressure treatment for sleep apnea. Weight loss was defined as percentage total weight loss 5 years post-RYGB as compared to baseline (before any preoperative weight loss). Any RYGB-related adverse event reported at the 5-year follow-up was registered as an adverse event; see Hedenbro et al. for details [25]. Surgical access was categorized into laparoscopic, open, or converted surgery.

Data Collection

Registry data were prospectively collected on physical appointments, by telephone or e-mail, and were collected at baseline and at 1, 2, and 5 years after RYGB [25].

Statistical Analysis

For between-group comparisons of baseline characteristics and HRQoL-data, chi-square test, independent samples *t* test and Mann Whitney *U* test were used when appropriate. For within-group comparisons of HRQoL between time points, the paired samples sign test was used.

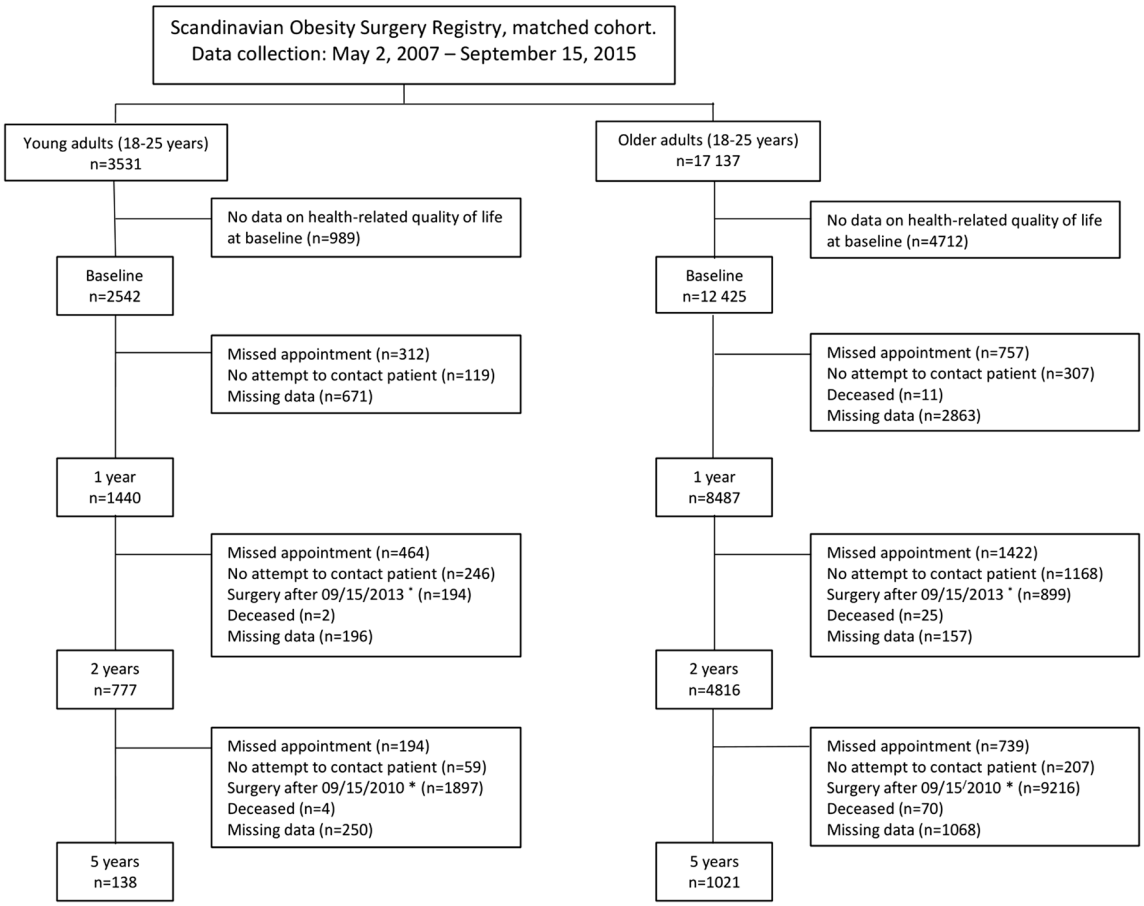

Fig. 1 Study flow chart. Numbers of young (18–25 years) and older (≥ 26 years) adults, matched for body mass index at baseline, gender and year of surgery, at baseline, and 1 year, 2 years, and 5 years after Roux-en-Y gastric bypass. Abbreviations: n = numbers. *Not eligible for 2 and 5 years follow-up respectively

The effect of age group on HRQoL change (at 5 years post-RYGB compared to baseline) was analyzed in a uni- and multivariate regression analysis. Covariates with a p value < 0.10 in a full multivariate regression analysis were included in the final adjusted analyses (HRQoL at baseline, co-morbidities at baseline [yes/no], weight loss at 5 years, adverse events [yes/no], and surgical access [laparoscopic/open]). A sensitivity analysis was performed by imputing missing data with last observation- and baseline-carried forward data.

The clinical relevance of the differences/changes in HRQoL was measured by effect size, Cohen's d (average $\text{score}_{\text{group1}}$ − average $\text{score}_{\text{group2}}$/pooled standard deviation) [29]. Effect size was categorized into negligible (< 0.2), weak (0.2–0.5), average (0.5–0.8), and large changes (> 0.8).

For missing data analyses, differences between patients with versus without HRQoL-data at baseline, and differences between patients with versus without HRQoL-data at 5 years were analyzed by the chi-square test, independent samples t test and Mann Whitney U test when appropriate. All analyses were performed in SPSS version 22.0. A p value of < 0.05 was considered to be statistically significant.

Results

Baseline Characteristics

A total of 2542 young (mean age 22.2 years, SD 2.2; mean-BMI 43.6, SD 5.4; 72.0% of original cohort) and 12,425 older (mean age 42.6 years, SD 9.6; mean-BMI 43.4, SD 5.0; 72.5% of original cohort) adults were included (Fig. 1). Patients with HRQoL data at baseline differed from those without in terms of fewer smokers (13.4 versus 15.0%), more depression (15.8 versus 14.5%) and more open procedures (3.9 vs 2.8%, all, $p < 0.047$).

Of eligible patients, 20.7% ($n = 138$) of the young and 31.8% ($n = 1021$) of the older adults were followed-up 5 years after RYGB (Fig. 1). Table 1 displays baseline characteristics in young and older adults respectively, grouped on all the patients who were included at baseline and on those with HRQoL data 5 years post-RYGB. Statistically significant differences in baseline characteristics between patients with versus those without missing data at the 5-year follow-up are reported in Table 1. Percentage weight loss at 5 years was 32.3% in young and 27.6% in older adults ($p < 0.001$).

Table 1 Baseline descriptive characteristics of $n = 2542$ young (18–25 years) and $n = 12,425$ older (26–74 years) adult Roux-en-Y gastric bypass patients included at baseline (baseline cohort), and $n = 138$ young (18–25 years) and $n = 1021$ older (26–74 years) adult Roux-en-Y gastric bypass patients who were eligible and included in follow-up 5 years after surgery (5-year cohort)

Variable	Baseline cohort			5-year cohort		
	Young adult	Older adult	*p* value	Young adult	Older adult	*p* value
Age, year (SD)	22.2 (2.2)	42.6 (9.6)	< 0.001	22.4 (2.1)	43.8 (9.9)*	< 0.001
Female, % (*n*)[a]	82.1 (2087)	81.9 (10,177)	0.84	81.9 (113)	85.4 (872)*	0.31
Year of surgery, % (*n*) [a]			.85			0.033
Height, cm (SD)	169.7 (8.4)	168.0 (8.5)	< 0.001	169.4 (8.2)	167.5 (8.5)*	0.012
Body weight, kg (SD)	126.0 (20.9)	122.8 (19.4)	< 0.001	127.7 (19.4)	122.7 (19.2)	0.004
Body mass index, kg/m^2 (SD)[a]	43.6 (5.4)	43.4 (5.0)	0.034	44.4 (5.3)	43.6 (5.2)	0.093
30.0–34.9 kg/m^2	2.7 (69)	2.4 (300)		2.2 (3)	2.6 (27)	
35.0–39.9 kg/m^2	23.2 (591)	23.8 (2962)		15.9 (22)	24.7 (252)	
40.0–44.9 kg/m^2	39.3 (1000)	40.2 (5001)		39.9 (55)	37.2 (380)	
45.0–49.9 kg/m^2	23.3 (593)	23.5 (2926)		29.0 (40)	23.6 (241)	
≥ 50.0 kg/m^2	11.4 (289)	9.9 (1236)		13.0 (18)	11.9 (121)	
Waist circumference, cm (SD)	125.7 (14.2)	127.4 (13.2)	< 0.001	127.6 (14.8)	127.6 (12.9)	0.96
Diastolic blood pressure, mm Hg (SD)[b]	77.8 (9.3)	83.6 (10.3)	< 0.001	79.6 (11.8)	84.5 (8.5)	0.066
Systolic blood pressure, mm Hg (SD)[b]	127.9 (13.7)	136.4 (16.8)	< 0.001	127.5 (10.4)	137.5 (18.0)	0.061
Co-morbidities, % (*n*)[c]						
Any disorder	23.1 (587)	53.0 (6585)	< 0.001	18.8 (26)	45.2 (462)*	< 0.001
Diabetes mellitus type 2	2.7 (69)	13.8 (1713)	< 0.001	2.2 (3)	15.7 (160)	< 0.001
Hypertension	2.0 (51)	26.5 (3289)	< 0.001	2.2 (3)	27.5 (281)	< 0.001
Dyslipidemia	1.2 (32)	10.0 (1237)	< 0.001	0.7 (1)	9.8 (100)	< 0.001
Sleep apnea	1.5 (37)	10.1 (1251)	< 0.001	1.4 (2)	8.2 (84)	0.002
Depression	9.6 (243)	15.8 (1947)	< 0.001	10.9 (15)	13.6 (139)	0.42
Current smoking, % (*n*)[b]	26.8 (476)	13.4 (1160)	< 0.001	50.0 (7)	13.8 (17)	< 0.001
Surgical access			< 0.001			0.015
Laparoscopic	96.1 (11,945)	98.0 (2491)		94.2 (130)*	85.7 (875)*	
Open	3.1 (379)	1.7 (42)		5.8 (8)*	11.8 (120)*	
Converted	0.8 (101)	0.4 (9)		0.0 (0)*	2.5 (26)*	

SD standard deviation, *n* number

[*] Statistically significant difference ($p < 0.05$) in baseline values for patients with missing versus non-missing data at the 5-year follow-up

[a] Matching variable

[b] Non-mandatory variable; $n_{baseline}$: young adults = 1650–1777, older adults = 8172–8654; $n_{5\text{-years}}$: young adults = 12–14, older adults = 123–127

[c] Patients on regular pharmacological treatment for any comorbidity included in the registry or continuous positive airway pressure for sleep apnea

Health-Related Quality of Life

Table 2 displays SF-36 and OP including effect sizes of differences between age groups, and Fig. 2 displays effect sizes in young and older adults respectively throughout the observation period. A total of 70.8% ($n = 1793$) of young and 63.5% ($n = 7874$) of the older adults were categorized as having severely impaired psychosocial functioning at baseline ($p < 0.001$). Young adults displayed average to large improvements (effect size ≥ 0.5) in physical functioning, PCS, and OP 5 years after RYGB. Likewise, older adults displayed average to large improvements in physical functioning, role physical, general health, PCS, and OP 5 years post-RYGB (all, $p \leq 0.001$). For mental domains of SF-36, negligible, weak, or no 5-year changes were observed in both age categories (all, $p < 0.55$).

In an analysis of the effect of age group on 5-year changes in HRQoL, older adults displayed larger improvements in physical role, general health, vitality, social functioning, PCS, and OP than their younger counterparts (all, adjusted $p \leq 0.037$, Table 3). The sensitivity analyses with imputed data did not materially alter these findings (data not shown).

Table 2 Short Form-36 and Obesity Problems Scale at baseline and 1, 2, and 5 years after Roux-en-Y gastric bypass in young (18–25 years) versus older (26–74 years) adults and corresponding effect sizes for differences *between* age groups

Variable, mean (SD)	Young adult	Older adult	*p* value[a]	Effect size[a]
Physical functioning, baseline	64.7 (20.7)	58.5 (22.6)	< 0.001	0.15
1 year	93.0 (14.3)**	88.4 (18.0)**	< 0.001	0.28
2 years	91.8 (14.5)**	87.7 (19.1)**	< 0.001	0.24
5 years	87.1 (17.2)**	81.5 (22.9)**	0.027	0.28
Role physical, baseline	59.1 (37.5)	55.3 (39.6)	< 0.001	0.10
1 year	90.7 (23.9)**	86.6 (29.6)**	< 0.001	0.15
2 years	85.7 (30.0)**	84.0 (32.3)**	0.835	0.05
5 years	74.2 (38.8)*	75.7 (37.7)**	0.647	0.04
Bodily pain, baseline	61.0 (27.4)	52.6 (27.5)	< 0.001	0.63
1 year	80.8 (24.5)**	74.1 (28.0)**	< 0.001	0.25
2 years	75.3 (28.1)**	72.0 (29.2)**	0.006	0.12
5 years	68.1 (34.0)*	63.0 (31.5)**	0.071	0.16
General health, baseline	52.2 (22.3)	54.7 (22.2)	< 0.001	0.11
1 year	77.7 (19.0)**	79.3 (20.3)**	< 0.001	0.08
2 years	73.1 (22.3)*	76.1 (22.2)**	< 0.001	0.13
5 years	61.7 (25.8)**	66.5 (25.2)**	0.039	0.19
Vitality, baseline	42.9 (21.8)	44.3 (23.4)	< 0.001	0.06
1 year	64.6 (21.7)**	67.9 (23.6)**	< 0.001	0.15
2 years	57.8 (24.8)**	63.1 (25.4)**	< 0.001	0.21
5 years	48.1 (27.3)	52.1 (27.2)**	0.118	0.15
Social functioning, baseline	67.5 (27.7)	70.9 (27.8)	< 0.001	0.12
1 year	86.4 (21.1)**	87.4 (21.5)**	< 0.001	0.05
2 years	81.6 (24.1)**	84.7 (23.6)**	0.001	0.13
5 years	73.9 (29.1)	77.3 (27.5)**	0.203	0.12
Role emotional, baseline	63.6 (40.4)	71.8 (38.5)	< 0.001	0.21
1 year	81.8 (33.8)**	85.5 (31.3)**	< 0.001	0.11
2 years	77.6 (36.4)**	82.2 (34.3)**	0.001	0.13
5 years	70.6 (41.1)	73.8 (39.8)	0.426	0.08
Mental health, baseline	62.7 (20.6)	69.2 (20.5)	< 0.001	0.32
1 year	75.9 (19.7)**	79.8 (19.9)**	< 0.001	0.20
2 years	71.1 (22.1)**	76.7 (21,7)**	< 0.001	0.26
5 years	68.2 (22.8)*	69.8 (23.9)	0.285	0.07
Physical component score, baseline	40.7 (10.0)**	36.8 (10.9)	< 0.001	0.37
1 year	53.4 (7.1)**	50.7 (9.3)**	< 0.001	0.33
2 years	52.2 (8.3)**	50.2 (9.8)**	< 0.001	0.22
5 years	47.1 (11.3)**	45.3 (12.4)**	0.171	0.15
Mental component score, baseline	40.7 (12.6)	45.4 (12.5)	< 0.001	0.37
1 year	46.0 (12.1)**	49.0 (12.0)**	< 0.001	0.25
2 years	43.5 (13.1)**	47.2 (13.0)**	< 0.001	0.28
5 years	40.9 (14.0)	43.5 (14.4)**	0.008	0.18
Obesity problems scale, *median (IQR)*, baseline	75.0 (33.3)	70.8 (35.7)	< 0.001	0.20
1 year	20.8 (33.4)**	12.5 (29.2)**	< 0.001	0.34
2 years	29.2 (45.9)**	12.5 (33.3)**	< 0.001	0.45
5 years	39.6 (45.8)**	20.8 (45.8)**	< 0.001	0.40

Effect size categories: negligible (< 0.2), weak (0.2–0.5), average (0.5–0.8), large (> 0.8), $N_{young\ adults} = 1440$ (1 year), 777 (2 years), 138 (5 years). $N_{older\ adults} = 8487$ (1 year), 4816 (2 years), 1021 (5 years)

**Within-group difference compared to baseline, $p \leq 0.001$; *Within-group difference compared to baseline, $p < 0.05$

[a] Between-group differences

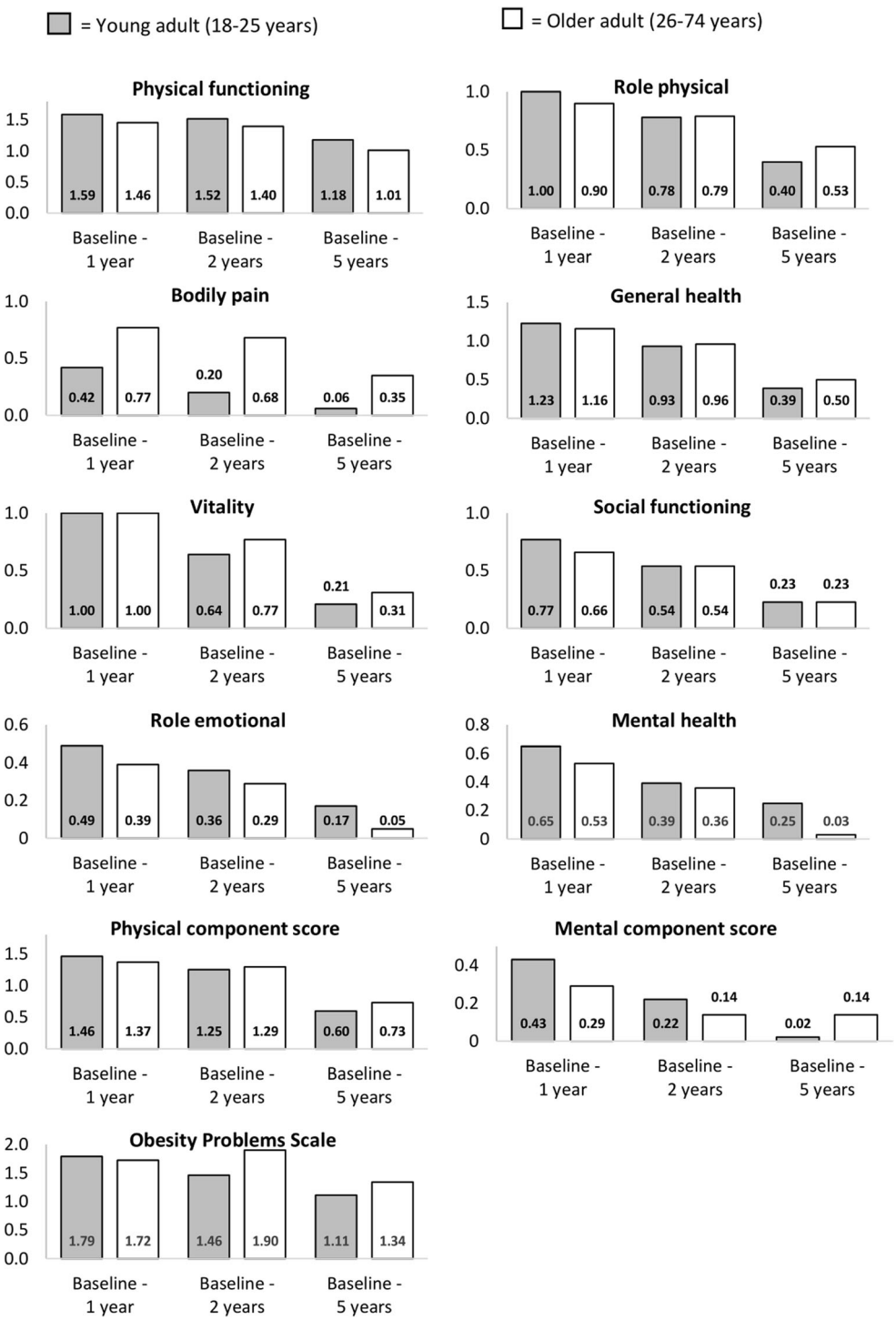

Fig. 2 Effect sizes of components of Short Form-36, and Obesity Problems Scale, in young (18–25 years) and older (26–74 years) adults 1, 2, and 5 years after Roux-en-Y gastric bypass compared to baseline. $N_{young\ adults} = 1440$ (1 year), 777 (2 years), 138 (5 years). $N_{older\ adults} = 8487$ (1 year), 4816 (2 years), 1021 (5 years). Effect size categories: negligible (< 0.2), weak (0.2–0.5), average (0.5–0.8), large (> 0.8)

Discussion

By using data from SOReg, changes in HRQoL 5 years after RYGB in young (18–25 years) versus older (26–74 years) adults were compared. Average to large improvements in both groups concerning physical HRQoL and OP were found, while no (young adults) or negligible to weak change(s) (older adults) were observed in mental HRQoL. Young adults displayed smaller 5-year improvements in physical role, general health, vitality, social functioning, PCS, and OP than the older adults.

Previous studies displayed correlations between HRQoL after RYGB primarily with weight loss (positive) and co-morbidities (negative), yet only explaining a minor proportion of post-surgery improvements [30, 31]. Thus, age may be

Table 3 Effect of matching group (1 = young adults) on 5-year change in Short Form-36 and obesity-related problems scale in $n = 138$ young (18–25 years) and $n = 1021$ older (26–74 years) adults

Variable[a]	Unadjusted model beta (95% CI)	*p* value	Adjusted model beta (95% CI)[b]	*p* value
Short Form-36				
Physical functioning	− 2.5 (− 6.9, 1.8)	0.25	− 2.0 (− 5.5, 1.6)	0.29
Role physical	− 9.0 (− 17.7, − 0.44)	0.039	− 7.2 (− 14.0, − 0.49)	0.036
Bodily pain	− 2.2 (− 8.2, 3.8)	0.47	− 2.0 (− 7.4, 3.3)	0.46
General health	0.72 (− 4.3, 5.8)	0.78	− 6.8 (− 11.1, − 2.5)	0.02
Vitality	− 3.8 (− 9.2, 1.7)	0.17	− 6.2 (− 11.0, − 1.4)	0.011
Social functioning	− 5.3 (− 11.5, 0.90)	0.094	− 5.8 (− 10.8, − 0.74)	0.024
Role emotional	0.56 (− 8.3, 9.5)	0.90	4.7 (− 12.0, 2.7)	0.21
Mental health	2.4 (− 2.2, 7.0)	0.30	− 1.3 (− 5.4, 2.8)	0.53
Physical component score	− 2.1 (− 4.3, 0.064)	0.057	− 2.0 (− 4.0, − 0.13)	0.037
Mental component score	0.06 (− 2.9, 3.0)	0.97	− 2.06 (− 4.7, 0.55)	0.12
Obesity-related problems scale	5.3 (− 0.64, 11.3)	0.08	13.6 (8.8, 18.5)	< 0.001

[a] For Short Form-36, a negative coefficient denotes that the 5-year change was smaller in young versus older adults. For obesity-related problems scale, a positive coefficient denotes that the change was smaller in young versus older adults

[b] Adjusted for health-related quality of life component at baseline, comorbidity (yes/no), weight loss at 5 years, adverse events (yes/no) and surgical access (laparoscopic/open)

added to the list of predictors according to the present results. However, conversely to the present findings, King et al. reported on an inverse association between age and 3-year improvements in physical function and bodily pain (both, SF-36 components) after RYGB/gastric banding (adjusted relative risk of 1.05 for clinically meaningful improvement for each 10-year decrease, $p \leq 0.03$) in 18–78-year-olds [32]. Possibly, differences in baseline levels of physical health including for example history of orthopedic surgery between age groups/study may explain the diverging results, since poor function allows for a larger change. Moreover, Nun et al. found no association between age as a linear variable and changes in HRQoL post-bariatric surgery [1], which however may disguise HRQoL differences between age-strata.

Young adults' comparatively small improvements in HRQoL post-RYGB in the present study may be secondary to life events. For example, young adults struggle with unemployment and housing shortages [33, 34], and the prevalence of mental illnesses peak during young adulthood [10], which together may deteriorate mental HRQoL during the follow-up period. Moreover, young adults hypothetically expect higher physical functions after RYGB than their older counterparts, as the younger likely compare themselves to normal-weight youths who generally did not yet develop for example musculoskeletal disorders/symptoms or reductions in sexual functions that may deteriorate HRQoL [4].

Although the present study was not designed to compare findings with norm data, the present results indicate that at 1 year after surgery, young and older RYGB patients approach Swedish norm levels of PCS (score 53.4, SD 7.1 versus 53.4, SD 6.8, in young adults and 50.7, SD 9.3, versus 51.2, SD 8.5, in older adults) and MCS (score 46.0, SD 12.1, versus 49.8, SD 9.5, in young adults and 49.0, SD 12.0, versus 50.2, SD 10.0, in older adults) [35]. Importantly, particularly MCS deteriorate below norm levels at 2 and 5 years post-surgery in both age groups. Also, a comparison of the 5-year results with data on Swedish adolescents recently diagnosed with cancer (40.9, SD 14.0 in RYGB patients vs 52.8, SD 6.3 in cancer-patients) further illustrate the low self-reported mental HRQoL in young adult post-RYGB patients [36].

Previous high-quality long-term (≥ 5 years) follow-ups of physical HRQoL display clear and clinically meaningful peak improvements 1–2 years after bariatric surgery followed by a gradual decline that stabilized at 5 years, but typically somewhat below population norms [7]. Moreover, the previously reported scores of PCS and OP in adults 5 years post-surgery were comparable to the present results [7]. Meanwhile, previous research on long-term mental HRQoL is inconsistent, displaying both improvements and deteriorations up to 6 years after bariatric surgery [7]. The conflicting results may be secondary to differences in baseline psychiatric co-morbidities between cohorts, which have rarely been accounted for. However, a meta-analysis comparing mental HRQoL data ≥ 5 years after bariatric surgery with non-surgical obese individuals found significant and clinically meaningful improvements in the surgical group, although not as large as for physical HRQoL, highlighting the need for comparison groups in HRQoL research [37].

Young adults with obesity have usually not yet developed obesity-related physical co-morbidities, but struggle with poor HRQoL, particularly mental domains [16]. Such circumstances may interfere with life events that

characterize emancipation in young adulthood including leaving the parental home, entering the work-force and starting higher education [11]. From this perspective, the present poor improvements in mental HRQoL post-RYGB, together with previous correlations between young age and self-harm as well as externally caused death after bariatric surgery [23, 38], are disappointing. The poor outcomes in mental HRQoL might support the bidirectional theories of obesity—mental health issues [39], why RYGB may not necessarily improve underdiagnosed psychiatric diseases, which clearly should be treated primarily according to mental health guidelines. Instead, programs that focus on comorbid mental health issues including stigma, body image, and self-esteem which have shown promising results in non-bariatric surgical settings may be an adjunct in and should be evaluated also after weight loss surgery [40, 41].

The clear improvements in physical domains in young adults are promising and obviously promote increased physical activity, which is a predictor for weight loss after surgery [42, 43]. Improvements in physical role and OP indicate greater abilities to work and perform daily activities, thus facilitating general social participation and should have the potential to support young adults' emancipation into independent adult life [35].

The main shortcomings in the current study include the large drop-out and secondary insufficient matching quality. However, there was no clinically relevant difference in matching variables between age groups after the exclusion of patients without HRQoL data at baseline, and the analysis of baseline and last observation carried forward data did not materially alter the findings, thus showing that the findings were robust. Since inclusion and follow-up rates were higher in the older versus the younger adults, statistical power was higher for the older group, and small clinical differences may thus become statistically significant for the older but not the younger adults. Therefore, results should be interpreted with effect sizes in mind.

The use of registry data limited what variables that could be adjusted for, and known correlates of HRQoL, such as physical activity levels, body image, loss of control of eating, and symptoms of dumping syndrome, were not included [4, 43–45]. Also, the matching design did not allow for an analysis by gender [2]. Nor was there any information on whether some patients were subjects to interventions aiming at improved HRQoL during the follow-up, which then might have distorted the results. Moreover, age-dependent differences in impression management pre-operatively may have skewed the results and could not be accounted for [46].

Strengths included the use of a high-quality bariatric surgery registry, the use of validated global as well as obesity-specific questionnaires, long-term follow-up of real-life data and inclusion of the difficult-to-reach patient group of young adults, who were reported to display high drop-out rates in previous trials [3, 14].

Conclusion

Both young (18–25 years) and older (26–74 years) adults displayed improvements in physical domains of HRQoL 5 years after RYGB, although greater improvements were observed in the older adults, while both age groups displayed poor improvements in mental domains. Future studies of HRQoL after bariatric surgery should stratify data on age in order not to falsely generalize adult results on younger patients. Interventions aiming at improving mental HRQoL in particularly young adult post-RYGB patients are urgently needed.

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Compliance with Ethical Standards

Ethical Approval The study was approved by the Stockholm Regional Ethical Review Board (2012/1217-31/5 and 2017/1887-32).

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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