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The Potential Role of Objective Activity Monitoring in Off-Site Follow-Ups Post-Bariatric Surgery

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Abstract

Title: The Potential Role of Objective Activity Monitoring in Off-Site Follow-Ups Post-Bariatric Surgery.

Background: Weight gain and attendance at follow-up visits after bariatric surgery are of great concern for the multidisciplinary care team. Geography and schedules make attending follow-up visits increasingly difficult as time after surgery goes on. Recently, inexpensive commercially available activity monitors have become more common place, making information concerning physical activity and sedentary behaviours deliverable online, allowing for important patient lifestyle information to be transmitted to the multidisciplinary care team. The purpose of this study was to determine if off-site objectively monitored physical activity and sedentary time can describe health measures such as total body fat, abdominal adipose tissue (AAT), and weight maintenance long-term post-bariatric surgery.

Methods and findings: 59 individuals who had undergone bariatric surgery wore an ActivPAL for seven consecutive days, monitoring physical activity and sedentary time and underwent one DXA scan to determine body composition. Linear regression shows that (moderate-to-vigorous physical activity (MVPA) explained 18.8% of variance in body fat (p=0.019) and 11.3% of the variance in AAT (p=0.033).

Conclusions: Objective monitoring could offer beneficial information concerning patients' health at post-surgical follow-up visits.

Keywords: Bariatric; Physical activity; Objective monitoring; Sedentary; Follow-up

Introduction

The most effective treatment for individuals living with obesity and associated co-morbidities is bariatric surgery [1]. Results from combined restrictive and mal-absorptive procedures such as roux-en-y gastric bypass (RYGB) demonstrate excellent immediate weight loss with reductions in body fat mass and visceral adipose tissue (VAT) [1,2]. Reductions in fat mass and VAT play an important role in decreasing the risk of cardiovascular disease and type-2-diabetes [1]. However, bariatric surgery alone may not mitigate the aforementioned co-morbidities associated with obesity over the long-term as varying amounts of weight regain are commonly observed post-surgery [3].

Immediately following bariatric surgery, it is crucial to adopt a more physically active lifestyle and limit sedentary time to maintain weight loss over the long-term while simultaneously sustaining improvements in co-morbidities [4]. Increased physical activity with reductions in sedentary time also improve body composition following RYGB compared to those who remain inactive [4]. Importantly, there is a dose response relationship between sedentarism and VAT which contributes to an increased risk of morbidity and mortality [5]. Self-reported measures of physical activity and sedentary time are often inaccurate in individuals living with obesity [6]. Thus, objective measures of physical activity and sedentary time may be helpful for the post-surgical multidisciplinary care team (MDCT) as to provide a more accurate description of patients' lifestyle habits [6].

To maintain optimal health in the long-term post-surgery, it is recommended that patients return to meet with their surgeon at yearly follow-up visits where patients can be weighed and have other diagnostic tests performed. For some patients, attending yearly follow-up visits post-surgery can be difficult due to a multitude of factors. Distance from domicile to hospital/ bariatric clinic, lack of reliable transportation, time constraints, and family responsibilities can all contribute to difficulty attending follow-up visits. Failure to attend follow-up visits can limit the diagnostic information available to the MDCT which limits personalized care for the patient, reducing the probability of post-surgical success.

Recently, inexpensive commercially available activity monitors have become more common place, making information concerning physical activity and sedentary behaviours deliverable online, allowing for important patient lifestyle information to be transmitted to the MDCT. Along with video conferencing applications, these monitors may help to promote successful off-site follow-up meetings in the near future.

As technology progresses and off-site follow-up visits become more commonplace, it is important to understand how off-site objective monitoring of physical activity and sedentary time relates to health measures such as body composition, fat distribution (VAT), and weight maintenance in the long-term post-RYGB before relying on this information as a predictor of post-surgical health. Henceforth, the purpose of this study was to determine whether objectively monitored physical activity and/or sedentary time can describe total body fat, fat distribution (VAT and abdominal adipose tissue (AAT)), and weight maintenance long-term post-RYGB.

Materials and Methods

Fifty-nine participants, aged 35-74 years at time of assessment, who had previously undergone RYGB (5-16 years prior) were recruited for this study. The nature, purpose, and risks of the investigation were described to participants and written informed consent was obtained prior to the start of assessment. The Medical Ethics Institutional Review Board of the university approved this study. Detailed information concerning participant recruitment has been previously published [7]. Each participant underwent one post-surgical assessment. Height was measured to the nearest centimeter using a Seca-216 stadiometer and weight was assessed to the nearest tenth kilogram using a Seca-635 bariatric scale (Seca, Hamburg, Germany). All participants wore lightweight, indoor clothing, without footwear and underwent one full body dual x-ray absorptiometry (DXA) scan (GE Healthcare), to determine body fat, VAT, and AAT. Further details regarding the application of the DXA have been previously published [8].

Physical activity (steps and time spent in moderate-to-vigorous physical activity (MVPA)) and sedentary time were monitored objectively using an ActivPAL3 (PAL Technologies Ltd., Glasgow, UK) tri-axial accelerometer. The ActivPAL3 was placed in a latex sleeve to prevent sweat from penetrating the connection port and attached to the mid-thigh using a clear Tegaderm adhesive patch. A wear-time journal was used for the duration of the wear-period to differentiate between day sedentary time, sleeping time, and non-wear time [7].

Accelerometer data was extracted using ActivPAL Software v17.18.1 and saved in 15s epochs for each 7-day wear-period. A valid day was ≥ 12 hours of waking wear-time, and a valid wear-period was 4-6 days (≥ 1-weekend day) [9]. ActivPAL3 data and wear-time journal information were entered into a MATLAB computer program which isolated the wear-time from the 24 hrs/day recordings.

Stepwise regression, controlling for age, sex, and time since surgery, was used to determine the predictability of objective physical activity and sedentary time on the abovementioned body composition variables. Statistical tests were considered significant if $p \leq .05$ and were performed using v22 of IBM's SPSS statistical software.

Results

Detailed characteristics concerning participants anthropometric, weight and activity characteristics are shown in Table 1. 59.3% (22 female; 13 male) were categorized as obese (BMI >30 kg/m^2). Participants living with obesity had significantly higher AAT (4.64 *vs* 2.58 kg), VAT (1.83 *vs* 0.64 kg), total body fat mass (47.8 *vs* 30.2 kg), lean mass (56.1 *vs* 42.9 kg), and fat % (45.4 *vs* 41.0 %) (Table 1). Moreover, participants classified as obese spent significantly more time in sedentary behaviours than non-obese (10.2 *vs* 8.95 hrs/day), but there were no differences in MVPA or steps (Table 1). Men had significantly more AAT, VAT, total body fat and lean mass; however there was no difference in fat percentage between sexes (Table 2). There were no significant differences in MVPA, sedentary time, or steps between sexes (Table 2).

Table 1: Participant Characteristics by Obesity.

	Non-Obese (≤ 30 kg/m^2; n=24)	Obese (>30 kg/m^2; n=35)	Total (n=59)
Age			
Pre-Surgical Age (years)	39.7 ± 8.48	42.2 ± 9.73	41.2 ± 9.25
Age at Time of Assessment (years)	50.9 ± 8.64	51.4 ± 9.21	51.2 ± 8.91
Time Since Surgery (years)	11.2 ± 2.90	9.15 ± 2.97*	9.98 ± 3.09
BMI/Weight			
Pre-Surgical BMI (kg/m^2)	44.3 ± 7.22	58.7 ± 13.2**	52.9 ± 13.2

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Nadir BMI (kg/m^2)	22.0 ± 3.21	34.2 ± 7.87**	29.3 ± 8.77
BMI at Time of Assessment (kg/m^2)	26.0 ± 3.55	40.5 ± 8.81**	34.6 ± 10.1
Delta BMI (kg/m^2)	18.2 ± 5.83	18.2 ± 7.36	18.2 ± 6.73
Excess Weight Loss (%)	104.4 ± 46.2	54.8 ± 14.5**	74.8 ± 39.2
Weight Regain (%)	18.6 ± 10.1	25.9 ± 15.1*	22.9 ± 13.7
Body Composition			
Abdominal Adipose Tissue (kg)	2.58 ± 1.09	4.64 ± 1.06**	3.85 ± 2.01
Visceral Adipose Tissue (kg)	0.64 ± 0.42	1.83 ± 1.10**	1.35 ± 1.06
Total Body Fat (kg)	30.2 ± 6.88	47.8 ± 15.4**	40.6 ± 15.3
Total Body Fat %	41.0 ± 5.08	45.4 ± 7.48*	43.6 ± 6.92
Total Body Lean (kg)	42.9 ± 5.32	56.1 ± 9.75**	50.7 ± 10.5
Activity			
MVPA (minutes)	29.9 ± 17.3	27.3 ± 22.1	28.3 ± 20.2
Sedentary time (hours)	8.95 ± 2.71	10.2 ± 2.15*	9.71 ± 2.45
Steps	6414 ± 2731	6229 ± 2876	6304 ± 2795
*p ≤ 0.05 different from non-obese, **p ≤ 0.001 different from non-obese			

Table 2: Participant Characteristics by Sex.

	Male (n=15)	Female (n=44)
Age		
Pre-Surgical Age (years)	41.1 ± 10.1	41.3 ± 9.08
Age at Time of Assessment (years)	51.8 ± 9.75	51.0 ± 8.72
Time Since Surgery (years)	10.7 ± 3.26	9.72 ± 3.02
BMI/Weight		
Pre-Surgical BMI (kg/m^2)	61.2 ± 15.0	50.0 ± 11.4*
Nadir BMI (kg/m^2)	35.0 ± 8.74	27.3 ± 7.97*
BMI at Time of Assessment (kg/m^2)	42.4 ± 10.3	31.9 ± 8.66**
Delta BMI (kg/m^2)	18.7 ± 6.62	18.0 ± 6.83
Excess Weight Loss (%)	54.9 ± 14.7	81.6 ± 42.6*
Weight Regain (%)	28.2 ± 12.6	21.2 ± 13.7
Body Composition		
Abdominal Adipose Tissue (kg)	5.57 ± 2.06	3.20 ± 1.58**
Visceral Adipose Tissue (kg)	2.42 ± 1.21	0.98 ± 0.71**
Total Body Fat (kg)	47.8 ± 18.5	38.2 ± 13.4*
Total Body Fat %	42.3 ± 7.18	44.1 ± 6.86
Total Body Lean (kg)	62.4 ±10.3	46.7 ± 7.04**
Activity		
MVPA (minutes)	20.9 ± 16.4	30.8 ± 20.9
Sedentary time (hours)	10.2 ± 2.19	9.53 ± 2.53
Steps	5837 ± 2959	6464 ± 2755
*p ≤ 0.05 different from male, **p ≤ 0.001 different from male		

Linear regression analysis demonstrates that MVPA explained 18.8% of the variance in body fat (F(1, 27)=6.26, p=0.019; body fat=-0.434 (MVPA)). Moreover, MPVA significantly explained 11.3% of the variance in AAT (F(1, 26)=5.061, p=0.033; AAT=-0.346 (MVPA)). There was no relationship between physical activity/sedentary time and weight maintenance.

Conclusion

This study found that objectively monitored MVPA helps to explain total body fat and AAT in bariatric patients long-term post-surgery. Objective monitoring could be a beneficial addition to follow-ups that members of the MDCT may consider, to help assess patients' health. A parallel can be drawn with the management of type-2-diabetes, where sharing self-monitored blood glucose measurements with physicians has resulted in consistent doctor-patient interaction resulting in better management of their condition [10]. As more commercial activity monitors are validated against research-grade devices (ActivPAL), they could soon be employed in this context and be used to log activity levels of patients over time. This information could provide the MDCT with longitudinal data, offering a more encompassing view of their patients' physical activity as compared to a cross-sectional time frame (e.g. one week prior to or after follow-up appointments).

The main strength of our study was the use of an iDXA scanner and ActivPAL tri-axial accelerometer, since they are both valid and reliable methods of assessing body composition; activity levels and sedentary time, respectively, in a clinical setting.

A limitation of this study was that we examined the relationship between physical activity/sedentary time and body composition in individuals who had undergone RYGB exclusively. As this is a long-term investigation, we recruited individuals who had undergone RYGB to test our hypothesis in the most extreme cases. However, we do recognize that this limits the generalizability of our findings as individuals who undergo other weight loss procedures such as sleeve gastrectomy or adjustable gastric banding may react differently post-surgery. We acknowledge that there is limited pre-surgical data available for comparison, however the purpose of this investigation was to examine this relationship long-term post-RYGB, a time frame which is underserved in research with regards to objective monitoring. To obtain participants ranging from 5-to-17 years post-surgery we recruited post-surgically only which limited this study to a cross-sectional analysis rather than a longitudinal one. Considering the findings of this study, in future research longitudinal data will be important to understand how these relationships respond pre-, and in the short-term post-surgery.

In summary, the multi-disciplinary team caring for bariatric patients should consider the use of objective physical activity monitors as an assessment tool during follow-up appointments and may consider encouraging their patients to use commercially available monitors on a daily basis. Although direct measures of body composition will provide more detailed information on their patients' health statuses, the cost of purchasing, maintaining, and running such devices is beyond the reach of many bariatric clinics. Moreover, the cost and time associated with travelling to in-person follow-ups may reduce the likelihood of patients attending yearly post-surgical visits. Relying on wearable activity monitors allows for regular follow-ups to occur, either through video messaging, email, or through reports sent by the patient's general practitioner. The information obtained from objective monitoring could allow members of the MDCT to quickly and feasibly gain insight into their patient's health status, and could use this information to help inform immediate intervention strategies, thereby potentially reducing the extent of weight regain in patients post-RYGB.

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