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Association of waist circumference with outcomes in an acute general surgical unit

T Ryan

P Gosal

A Seal
The University of Notre Dame Australia, alexa.seal@nd.edu.au

J McGirr
The University of Notre Dame Australia, joe.mcgirr@nd.edu.au

N Williams

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Authors:

- **Thomas Ryan [B.Phty, MBBS(hons)] [1]**
- **Dr Preet Gosal (B.Med) [2]**
- **Dr Alexa Seal [BSc (hons), PhD] [1]**
- **Assoc. Prof Joe McGirr (MBBS, FRACMA) [1]**
- **Dr Nicholas Williams (MBBS, FRACS) [1,2]**

1 The University of Notre Dame Australia, School of Medicine Sydney, Wagga Wagga Clinical School.

2 Wagga Wagga Rural Referral Hospital, NSW Australia.

Corresponding Author:

- **Thomas Ryan**
- **Email: tom-ryan@hotmail.com**
- **Post: The University of Notre Dame Australia, PO Box 5050, Wagga Wagga, NSW Australia, 2650**
- **Ph: 0431746020**

Abstract

Introduction: Obesity prevalence is increasing in Australia, particularly in non-metropolitan areas. The effect of obesity on acute surgical outcomes is not known.

Aim: To record waist circumference (WC) (surrogate for obesity) amongst Acute Surgical Unit (ASU) patients in a NSW regional hospital, and compare outcome measures [length of stay (LOS), unplanned return to theatre, readmission rates, ICU admission and mortality].

Methodology: Retrospective cohort study of four months of consecutive ASU admissions, excluding age <16, pregnancy, out-of-area transfer and incomplete data.

Patients were classified according to World Health Organisation WC definitions as high-risk or non high-risk (increased-risk and no-risk).

Results: Of 695 admissions, 512 met the inclusion criteria [47.1% female, average age 52.8y (SD22.3)], with 85.1% (p<0.001) of females and 69.4% (p=0.166) of males having an increased or high-risk WC. This compares to rates amongst inner regional populations of 71.0% (female) and 66.4% (male).

LOS was longer for high-risk patients (5.0 v 3.7 days, p=0.002). However, the mean age of high-risk patients was greater (56.6y vs 46.9y, p=0.001) and LOS was longer for those aged ≥60 (p<0.001). After controlling for age, high-risk WC was not associated with any outcome measure, except amongst ICU admissions, where high-risk patients stayed longer (15.5 vs 6.8 days, p<0.001).

Conclusion: Increased and high-risk WC was overrepresented amongst female ASU patients. High-risk WC was associated with a significantly greater LOS in patients admitted to ICU. High-risk WC was not associated with other outcomes independent of age. WC is useful for quantifying obesity in the inpatient setting.

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Introduction

In 2015 there were 11.2million (63.4%) overweight or obese people in Australia, of whom 4.9 million (27.9%) were obese[1]. This has increased from 56.3% in 1995[1] and is comparable to similar countries[2]. Rates are higher in regional areas (69.2%) when compared to adults in major cities (61.1%)[1].

Obesity is associated with many co-morbidities, notably cardiovascular disease, type two diabetes mellitus (T2DM), certain cancers and all-cause mortality[3-7]. The financial impact of obesity to Australia is projected to be $87.7 billion through direct and indirect costs over the next decade if current trends continue[8].

Obesity is common amongst surgical patients with reported rates approaching 70%[9,10]. It is therefore important to determine the impact of obesity on surgical outcomes. The association of obesity with length of stay (LOS) is uncertain. When general surgical conditions are analysed together, obesity, as measured using body mass index (BMI) is not associated with an increased LOS[10] but when individual conditions, such as biliary disease, are analysed separately a clear relationship between obesity and increasing LOS has been reported[11].

There is also an association between obesity and major post-operative complications in general surgical patients undergoing surgery for malignancy[9,12]. Obesity has also been associated with increased rates of wound infection and breakdown[9,10,13].

Few studies have examined the association of obesity with outcomes in acute surgical patients. The limited research in this area uses BMI as the means of quantifying obesity, with no reported studies using waist circumference (WC). Difficulties with moving acutely unwell patients and the inherent time pressures within an acute surgical unit (ASU) make BMI difficult to reliably collect. WC best predicts morbidity and all-cause mortality when compared to other anthropometric measures[14] and may be a more appropriate measure in the acute setting.

This study aimed to quantify rates of increased-risk and high-risk WC [according to World Health Organisation (WHO) definitions] amongst ASU patients and analyse any association with

surgical outcomes, in a non-elective setting in regional NSW, Australia. Our hypothesis was that high-risk WC would be associated with an increased LOS and a higher rate of adverse outcome measures.

Method

A retrospective cohort study was undertaken using the ASU database located at Wagga Wagga Rural Referral Hospital (WWRRH), the major acute care provider in the Murrumbidgee Local Health District (MLHD). Data from patients admitted between the 1st February to 1st June, 2016 were extracted and de-identified by the ASU data officer.

Based on previous studies, it was estimated that 450 patients were required to detect an effect size of 0.28 in LOS (primary outcome measure), with an alpha level of 0.05 and beta of 80%[11,15,16]. With approximately 150 admissions per month, four months of data were interrogated.

Data examined included patient age, gender, WC, T2DM status, known active malignancy, discharge diagnosis and procedure category. Outcome measures collected included LOS, unplanned return to theatre, admission to the ICU, readmission to WWRRH or the ASU within 28 days of discharge and mortality during admission or within 28 days of discharge. Exclusion criteria included patients aged <16, pregnancy, patients transferred to an out of area facility or incomplete data.

WC was measured using the WHO surveillance manual technique[17], and was completed by nursing/medical staff and students attached to the unit. Measurements were performed standing, or supine when required for patient safety and comfort.

The WHO defines patients with a WC >80cm for females and >94cm for males to be at "increased-risk" of all-cause mortality and metabolic disease[14,17-19]. When WC exceeds 88cm for females and 102cm for males they are considered "high-risk". For analysis, patients were grouped into two categories. Those who were deemed at no-risk or an increased-risk, according to WC, were grouped together under the term non high-risk and compared with the high-risk group. It should be

noted however, that for comparison with data available from the Australian Bureau of Statistics, the high-risk and increased-risk groups were combined.

Statistical analysis was performed using SPSS 23 statistical software (IBM, New York, NY, USA). Differences in categorical variables were analysed using Pearson's chi-square, or Fisher's exact test for small numbers. For continuous variables t-tests were used for comparison of group means. WC and LOS were analysed as continuous variables using Pearson's correlation. A binomial test was used to compare known population rates of obesity with the study cohort.

Ethical approval was granted by The University of Notre Dame Australia and Greater Western Human Research Ethics Committees with Site Specific Authority from the MLHD.

Results

There were 695 admissions during the study period with 183 patients excluded (Fig 1). Of the 512 patients included, 241 (47.1%) were female, with a mean age of all participants of 52.8 years (SD=22.3) (Table 1).

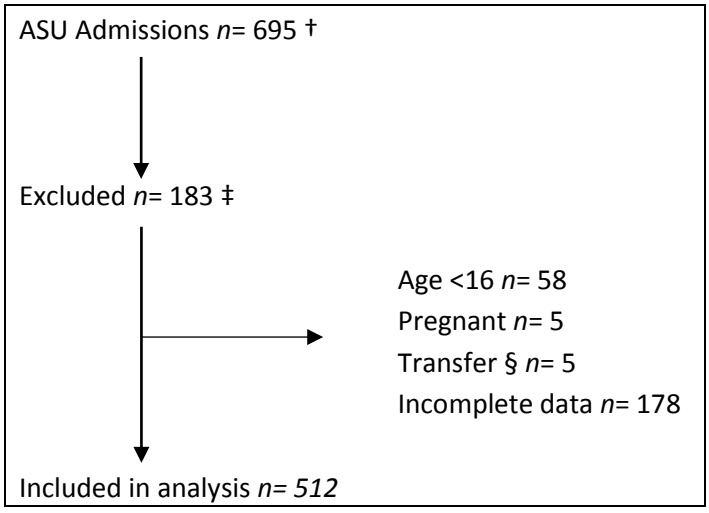

Figure 1: Flow diagram for acute surgical unit (ASU) patients.

† Admissions from 1st February to 1st June 2016. ‡ Some patients met more than one exclusion criteria. § Transferred to out of area facility for treatment

The overall rate of increased-risk and high-risk WC in the study cohort was 76.8% (393 patients), with 61.5% (315 patients) high-risk, 15.2% (78 patients) increased-risk and 23.2% (119 patients) at no-risk. The rate of increased-risk and high-risk WC amongst female patients was 85.1% and 69.4% in males. This compares to figures for the Australian population for females (65.4%, p<0.001) and males (58.8%, p<0.001); and to inner regional populations for females (71%, p<0.001) and males (66.4%, p=0.166)[1].

Table 1 Patient baseline characteristics and procedure status

	Total	Non obese	Obese †	*p*-value
Total patients	512	197(38.5)	315(61.5)	
Sex [n(%)]				
Female	241(47.1)	68(34.5)	173(54.9)	<0.001
Male	271(52.9)	129(65.5)	142(45.1)	
Age [mean (SD)]				
Mean age	52.8(22.26)	46.86(23.86)	56.56(20.37)	<0.001
Female	52.44(22.54)			
Male	53.16(22.05)			
Age <60 [n(%)]	293(57.2)	132(67.0)	161(51.1)	
Age ≥60 [n(%)]	219(42.8)	65(33.0)	154(48.9)	<0.001
Overweight and obese ‡ [n(%)]	393(76.8)			
Female	205(85.1)			
Male	188(69.4)			<0.001
Malignancy [n(%)]	29(5.7)	11(5.6)	18(5.7)	0.950
Diabetes status [n(%)]				
Nil diabetes	434(84.8)	187(95.0)	247(78.4)	
Diabetes	78(15.2)	10(5.0)	68(21.6)	<0.001
Procedure status [n(%)]				
Nil procedure	203(39.6)	74(37.6)	129(41.0)	
Underwent procedure	309(60.4)	123(62.4)	186(59.0)	0.446

† "High risk" waist circumference (WC), ‡ According to WC risk status [17]. SD, standard deviation.

The most common diagnosis was hepatobiliary disease (17% of all patients). Patients in the high-risk group had higher rates of hepatobiliary, pancreatic and diverticular disease (p<0.040). Patients in the non high-risk group had higher rates of appendicitis, non-specific abdominal pain, perianal disease and trauma (p<0.041).

High-risk patients had a longer average LOS (5.0 vs 3.7 days, *p*=0.002) when compared to the non high-risk patients (Table 2). A significantly longer average LOS was also found amongst patients who were aged ≥60 years and those with a known malignancy (Table 3). When all patients were divided into groups aged <60 and ≥60, there was no significant association between high-risk WC and LOS. When LOS and WC were analysed as continuous variables a significant correlation was found (Pearson's correlation =0.122, *p*=0.006), however once age was controlled for, no difference was found (partial correlation =0.071, *p*=0.106). For patients admitted to the ICU there was a significant association between high-risk WC and total LOS. High-risk patients had a mean LOS of 15.5 vs 6.8 days (*p*=0.001) in the non high-risk, and this was independent of age.

Table 2 Outcomes according to obesity status

	Non obese	Obese †	*p*-value
Outcome	*n*=197	*n*=315	
Mean LOS (SD)	3.66(2.95)	4.95(6.36)	0.002
Admitted to ICU [n(%)]	12(6.1)	35(11.1)	0.056
Unplanned return to theatre [n(%)]	4(2.0)	12(3.8)	0.260
Readmit WWRRH 28 days [n(%)]	17(8.6)	27(8.6)	0.982
Readmit ASU 28 days [n(%)]	13(6.6)	18(5.7)	0.683
Mortality ‡ [n(%)]	0	6(1.9)	0.087
Any adverse outcome measure § [n(%)]	30(15.2)	65(20.6)	0.126

† "High risk" waist circumference 17. ‡ Mortality during admission or within 28 days of discharge. § Unplanned return to theatre, ICU admission, readmission to hospital within 28 days of discharge and mortality during admission or within 28 days of discharge. LOS, length of stay in days; SD, standard deviation; ICU, intensive care unit; WWRRH, Wagga Wagga Rural Referral Hospital; ASU, acute surgical unit.

Overall, 95(18.6%) patients experienced an adverse outcome measure, with no difference between high-risk and non high-risk patients (Table 2). Although ICU admission rates were higher amongst high-risk patients (11.1% vs 6.1%, *p*=0.056), and all six deaths were amongst the high-risk group, these differences were not statistically significant.

Table 3 Variables associated with mean length of stay for all patients, age groups and those admitted to ICU

	Mean LOS (SD)	*p*-value
All patients		
Non obese	3.66(2.95)	
Obese †	4.95(6.36)	0.002
Age <60	3.32(3.45)	
Age ≥60	5.97(6.86)	<0.001
Nil diabetes	4.29(5.43)	
Diabetes	5.37(4.80)	0.101
Female	4.24(5.14)	
Male	4.65(5.53)	0.389
Nil Malignancy	4.26(5.05)	
Malignancy	7.64(8.45)	0.042
	Mean LOS	*p*-value
Age <60		
Non obese	3.01(2.22)	
Obese	3.58(4.9)	0.155
Age ≥60		
Non obese	5.00(3.71)	
Obese	6.38(7.79)	0.078
	Mean LOS	*p*-value
ICU admissions ‡		
Non obese	6.77(3.63)	
Obese	15.52(13.42)	0.001
Age <60	10.58(9.65)	
Age ≥60	14.68(13.39)	0.284

† "high risk" waist circumference (WC) 17. ‡ Analysis of patients admitted to ICU during hospitalisation. LOS, mean length of stay in days; SD, standard deviation; ICU, intensive care unit

Discussion

This was the first study to directly explore the association between WC and surgical outcomes in an acute general surgical unit. For the cohort as a whole, an association between high-risk WC and increased LOS was not observed, independent of age. Nor was an association observed between high-risk WC and any of the other outcome measures. There was however a significant association between high-risk WC and an increased average LOS amongst patients admitted to the

ICU. These patients had a more than two-fold increase in average LOS, substantially increasing the total cost of their admission. Also there appears to be an increased need for ICU (p=0.056) and all-cause mortality (p=0.087) amongst the high-risk group although this was not significant.

Several factors may explain this lack of association. Healthcare staff are increasingly familiar with treating obese patients in public hospitals across Australia. In addition, healthcare facilities are now routinely equipped with purpose-built beds, operating tables, lifting equipment, diagnostic imaging capabilities and surgical tools and training to deal with obese patients. Utilisation of a multidisciplinary approach[13] may also account for the lack of association between obesity and poor outcomes.

Previous large international studies examining the association of obesity on surgical outcomes have looked at selected patient groups only, namely elective patients, female patients[11] or patients with a specific diagnosis. The most recent[9] showed that obesity was not associated with major post-operative complications, unless there was a malignant diagnosis. This study contained 38% non-elective patients. Another study of almost 120 000 patients (only 13.5% non-elective patients) found a survival benefit amongst the overweight and moderately obese patients[10]. Our study, which examined all consecutive patients admitted to the ASU, found that high-risk WC patients may not have worse outcomes in the acute surgical setting, which was consistent with the reported findings with obese patients. With regard to LOS, a large study analysing the association between obesity and gall bladder disease found that obesity was associated with an increased LOS regardless of undergoing surgical intervention or not[11]. This is in direct contrast to Mullen *et al.* (2009), who reported no association between obesity and increased LOS amongst general surgical admissions. Our study found that high-risk WC was not associated with increased LOS, independent of age, unless the patient was admitted to the ICU.

Of greatest concern is the finding that the rates of increased-risk and high-risk WC amongst ASU patients were significantly higher than the already high background rates in the community. Obesity is well known to be associated with higher rates of chronic disease and we have

demonstrated that in an inner regional population, high-risk WC patients may be consuming acute surgical healthcare resources at a disproportionately higher rate. This has obvious implications for planning of healthcare expenditure, placing obesity firmly in the spotlight as a potential area for cost-saving through improved primary prevention strategies, and implementation of proven medical and surgical therapies for treating obesity in the public sector.

Whilst most studies examining obesity traditionally use BMI to stratify patients, there are inherent problems with this in the inpatient setting. Bedbound patients would be automatically excluded, and the use of multiple scales in different wards introduces unwarranted variation if the scales are not calibrated. WC, on the other hand, has been validated by the WHO as an inexpensive, reliable and reproducible means of assessing abdominal adiposity, and correlates directly with increased risk of metabolic disease. However, dynamic changes to WC related to pathological processes, such as bowel obstruction, could not be accounted for in this study. Patients who had an acutely distended abdomen had their WC measure deferred until after the underlying cause was treated.

This study adds to the body of evidence regarding the association of excess adiposity with surgical outcomes. It also strengthens the use of WC as a clinical measure to quantify health risk in acute surgical patients, particularly those admitted to intensive care. This study found that increased-risk and high-risk WC was overrepresented amongst ASU patients. High-risk WC was associated with a significantly longer LOS amongst patients admitted to the ICU. No association was demonstrated between high-risk WC and surgical outcomes independent of age.

References

(1) Australian Bureau of Statistics. *National Health Survey: First results*, 2014-15. 2015.

(2) Davies SC. "*Annual report of the chief medical officer, surveillance volume, 2012: On the state of the public's health*". 2014.

(3) Adams KF, Schatzkin A, Harris TB *et al*. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. *N Engl J Med* 2006;**355**(8):763-778.

(4) Whitlock G, Lewington S, Sherliker P *et al*. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *The Lancet* 2009;**373**(9669):1083-1096.

(5) Janssen I, Katzmarzyk PT, Ross R. Waist circumference and not body mass index explains obesity-related health risk. *Am J Clin Nutr* 2004 Mar;**79**(3):379-384.

(6) Lean M, Han T, Seidell J. Impairment of health and quality of life in people with large waist circumference. *The Lancet* 1998;**351**(9106):853-856.

(7) Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. *BMC Public Health* 2009;**9**(1):1.

(8) van Smeerdijk J, Jovic M, Hutchins D, Petere T, Lee J. *Weighing the cost of obesity: A case for action*. 2015. https://www.pwc.com.au/pdf/weighing-the-cost-of-obesity-final.pdf

(9) STARSurg collaborative. Multicentre prospective cohort study of body mass index and postoperative complications following gastrointestinal surgery. *BJS* 2016, **103**:1157-1172.

(10) Mullen JT, Moorman DW, Davenport DL. The obesity paradox: body mass index and outcomes in patients undergoing nonbariatric general surgery. *Ann Surg* 2009 Jul;**250**(1):166-172.

(11) Liu B, Balkwill A, Spencer E, Beral V, Million Women Study Collaborators. Relationship between body mass index and length of hospital stay for gallbladder disease. *J Public Health* (Oxf) 2008 Jun;**30**(2):161-166.

(12) Al-Refaie WB, Parsons HM, Henderson WG *et al*. Body mass index and major cancer surgery outcomes: lack of association or need for alternative measurements of obesity? *Ann Surg Oncol* 2010;**17**(9):2264-2273.

(13) Balentine CJ, Robinson CN, Marshall CR *et al*. Waist circumference predicts increased complications in rectal cancer surgery. *J Gastrointest Surg* 2010;**14**(11):1669-1679.

(14) Pischon T, Boeing H, Hoffmann K *et al*. General and abdominal adiposity and risk of death in Europe. *N Engl J Med* 2008;**359**(20):2105-2120.

(15) Pikarsky A, Saida Y, Yamaguchi T *et al*. Is obesity a high-risk factor for laparoscopic colorectal surgery? *Surg Endosc* 2002;**16**(5):855-858.

(16) Garey CL, Laituri CA, Little DC, Ostlie DJ, Peter SDS. Outcomes of perforated appendicitis in obese and nonobese children. *J Pediatr Surg* 2011;**46**(12):2346-2348.

(17) World Health Organisation. *WHO STEPS surveillance manual*. Geneva: World Health Organisation 2008.

(18) Lee CMY, Huxley RR, Wildman RP, Woodward M. Indices of abdominal obesity are better discriminators of cardiovascular risk factors than BMI: a meta-analysis. *J Clin Epidemiol* 2008;**61**(7):646-653.

(19) Vazquez G, Duval S, Jacobs DR,Jr, Silventoinen K. Comparison of body mass index, waist circumference, and waist/hip ratio in predicting incident diabetes: a meta-analysis. *Epidemiol Rev* 2007;**29**:115-128.