

# Associations between obesity and overweight and fall risk, health status and quality of life in older people

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The prevalence of overweight and obesity in adults continues to increase in many countries across the world. It is estimated that around 65 million adults aged 20 years and over in the United States (US) and 11 million adults in the United Kingdom (UK) will be obese (Body Mass Index [BMI]  $\geq 30$ ) by 2030.<sup>1</sup> In Australia, it is projected that the number of obese Australians will rise, with 4.6 million to 6.9 million individuals (18.3% and 27.6% of the population, respectively) projected to be obese by 2025.<sup>2</sup>

Overweight and obesity is particularly prevalent in older people in high-income countries. Currently, in the US, 69% of individuals aged 60 years and older are identified as overweight or obese (BMI  $\geq 25$ ) and 31% as obese.<sup>3</sup> In Australia, 71% of those aged 65–74 years, 60% of those aged 75 to 84 years, and 42% of those aged 85 years and older are considered to be overweight or obese.<sup>4</sup> With population ageing, the number of overweight and obese older people is expected to increase markedly.<sup>3,5,6</sup>

Excessive body weight can introduce or exacerbate chronic health conditions such as diabetes, cardiovascular disease, hypertension and arthritis,<sup>3,6</sup> and can also contribute to a reduction in the ability to easily perform activities of daily living, such as walking up stairs.<sup>6</sup> As many of these conditions are associated with reduced peripheral sensation, weakness and instability, it could be expected that excessive body weight would be associated with falls in older people.<sup>7</sup> However, the seminal prospective fall risk cohort studies

## Abstract

**Objectives:** To determine whether overweight and obese individuals have higher reported fall and fall injury risk than individuals of healthy weight, and to examine the influence of BMI on health, quality of life and lifestyle characteristics of fallers.

**Methods:** A representative sample of community-based individuals aged 65 years and older in New South Wales was surveyed regarding their history of falls, height, weight, lifestyle and general health within a 12-month period.

**Results:** Obese individuals had a 31% higher risk of having fallen, but no higher risk of a fall-related injury compared to healthy-weight individuals. Obese fallers also had a 57% higher risk of believing nothing could be done to prevent falls; a 41% higher risk of using four or more medications; a 30% higher risk of experiencing moderate or extreme pain or discomfort; were 26% less likely have walked for two or more hours in the last week; and were less likely to think they were doing enough physical activity.

**Conclusions:** Older obese individuals have an increased risk of falls and obese fallers have a higher prevalence of pain and inactivity than fallers of a healthy weight.

**Implications:** A decrease in sedentary lifestyle and regular weight-bearing exercise may reduce fall risk in older obese individuals.

**Key words:** accidental falls, aged, lifestyle, obesity

in the 1980s and 1990s either reported that increased weight was not associated with falls in older people<sup>8–10</sup> or did not report associations between excessive weight and falls at all.<sup>11,12</sup> More recent studies have also reported inconsistent findings: one documented an increased prevalence of falls in middle and older-aged obese individuals (mean age younger than 60 years);<sup>13</sup> one found a higher risk of falls for obese individuals aged 65 years and older;<sup>14</sup> a third found no clear evidence of the influence of obesity on falls.<sup>15</sup> The lack of significant findings may result from limited power to detect a relatively weak but important fall-risk factor. Large population studies may be

required to uncover the association between excessive weight and falls.

There are no published studies examining whether overweight or obese individuals are more likely to be injured as a result of a fall than individuals of a healthy weight, nor has there been an examination of the influence of health-related quality of life and lifestyle characteristics on fallers by BMI status in a representative population-based sample. Such information may be useful in identifying high-risk fall groups that could be targeted for prevention efforts at the population level. In this paper, responses from the New South Wales (NSW) Falls Prevention Baseline Survey were examined to determine

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whether overweight and obese individuals have higher reported falls and are more at risk of injury than healthy-weight individuals, and to examine the influence of BMI status on health, quality of life and lifestyle characteristics of fallers.

## Methods

### Sampling design

The NSW Falls Prevention Baseline Survey was undertaken in 2009 by the NSW Ministry of Health.<sup>16</sup> A representative sample of 5,681 older people (at least 65 years of age) living in the community, with a private telephone, was surveyed across NSW regarding participants' falls experience, knowledge and perception of falls, participation and awareness of physical activity and health status. The full details of the development of the survey and the methods used are described in full elsewhere<sup>16</sup> and summarised below.

A two-stage sampling process was used, with the sample stratified by each of the former eight NSW Area Health Services (AHS). Within each AHS, households were randomly selected using a computer-generated list of telephone numbers. A single respondent was randomly selected from each household for a computer-assisted telephone interview (CATI). Proxy respondents were chosen for 361 participants who were unable to answer on their own behalf due to various conditions, such as hearing impairments, poor health, dementia or cognitive impairment.<sup>16</sup>

Interviews were conducted between March and July 2009. Households selected for a telephone interview with postal addresses in the electronic phone book were sent a letter describing the aims and methods of the survey two weeks prior to the initial attempts at telephone contact. Interviews were conducted by trained Health Survey Program CATI interviewers and by interviewers from McNair Ingenuity Research Ltd. Up to seven call backs were made to establish initial contact with a household and up to five call backs were made to contact a selected respondent. Almost all respondents (96.0%) were interviewed in English.<sup>16</sup> The survey response rate was 60.8%.<sup>16</sup>

### The survey instrument

During each interview, information obtained from all respondents included demographic information on age, gender, weight, height, health status, doctor-diagnosed physical co-morbidities, physical activity

participation, prescription medication use, alcohol consumption and smoking status. Information on fall history, knowledge and perception of fall risk was also obtained. Respondents were asked if they had suffered a fall in the last 12 months (i.e. accidentally lost their balance, tripped or slipped and found themselves on the floor or ground), how many times they had fallen, how many of the falls resulted in injury, how many resulted in going to hospital, and how many resulted in being admitted to hospital. Questions were field-tested prior to use. Identification of risk alcohol drinking was defined as individuals who drank more than two standard drinks on any day.<sup>17</sup> BMI identification included: healthy weight (18.5–24.9), overweight (25–29.9) and obese (30 or higher). Ethics approval was obtained from the NSW Health Population and Health Services Research Ethics Committee (2008/12/114; HREC/08/CIPHS/55).

### Data analysis

Analysis was performed using SAS version 9.3.<sup>18</sup> The SURVEYFREQ procedure was used to calculate prevalence estimates and 95% confidence intervals (95% CIs). Univariate regression was conducted using the GENMOD procedure using generalised estimating equations (GEE), a Poisson error distribution and log link function to generate relative risks and confidence intervals for the associations between BMI and fall experience, health status, quality of life and lifestyle characteristics. Records with missing data values were excluded from each analysis.

The data were stratified by AHS and a sampling weight was applied to adjust for the probability of selection (i.e. due to the varying number of people living in each household, the number of residential telephone connections for the household, and the varying sampling fraction in each AHS) for differing non-response rates among males and females and different age groups, allowing calculation of prevalence estimates for the NSW population. Significant main effects ( $p \leq 0.05$ ) were included in a multivariate model using a backward, stepwise elimination approach and QIC goodness of fit scores were assessed. The final models were based on QIC scores and variable relevance. The dependent variable was BMI and, for healthy weight versus overweight fallers, the independent variables included in the final model were: age group, diabetes, osteoporosis and strength activities

on two or more occasions in the previous week. For healthy weight versus obese fallers, the independent variables included in the final model were: age group, the belief that nothing could be done to prevent falls, diabetes, osteoporosis, blood pressure, four or more medications, moderate/extreme pain or discomfort, walked more than two hours in the previous week and a belief they were doing enough physical activity.

## Results

Obesity was associated with a 31% higher risk (RR 1.31, 95%CI 1.14–1.50) of having fallen in the previous 12 months and a 32% higher risk (RR 1.32, 95%CI 1.08–1.60) of having fallen multiple times compared to individuals with a healthy weight. There were no significant differences between males and females by BMI status for fallers and non-fallers. For all three BMI groups, the risk of an individual having a fall increased as individuals aged, compared to the fall risk of 65–74 year olds, except for individuals aged 75–84 years in the overweight group (Table 1).

### Fall injury and perceptions of fall risk

Overweight or obese individuals were not at a higher risk of experiencing a fall injury of any severity compared to individuals of a healthy weight. Of those who fell, fear of falling, restriction in activities due to fear of falling, or a belief in the importance of being active as a way to reduce falls risk did not differ significantly across BMI groups. However, obese individuals had a 57% higher risk of believing that nothing could be done to prevent older people falling when compared to individuals of a healthy weight (Table 2).

There was a marginally insignificant result for obese individuals who report a perceived higher risk of falling compared to individuals of a healthy weight. When asked why they felt at risk of falling, obese individuals were significantly more likely to have poor co-ordination and/or body instability or dizziness than individuals of a healthy weight (RR 1.60, 95%CI 1.21–2.12). Conversely, obese individuals were 40% less likely than individuals of a healthy weight to associate physical activity or fitness with their perceived risk of falling.

### Health status of fallers

Compared to fallers of a healthy weight, obese fallers were more likely to have diabetes (RR 2.06, 95%CI 1.49–2.85), heart

disease/angina (RR 1.29, 95%CI 1.02-1.64), and high blood pressure (RR 1.34, 95%CI 1.16-1.55). They were also more likely to be taking four or more prescribed medications compared to individuals of a healthy weight (RR 1.41, 95%CI 1.23-1.62). Overweight (RR 0.55, 95%CI 0.41-0.74) and obese (RR 0.74, 95%CI 0.55-0.99) fallers were less likely to report having a diagnosis of osteoporosis when compared to healthy weighted fallers (Table 3).

**Quality of life and lifestyle characteristics of fallers**

Obese fallers were 31% more likely to report suffering moderate or extreme pain or discomfort than fallers of a healthy weight. There were no differences in smoking status or risk alcohol drinking by BMI status. However, overweight fallers were significantly less likely to be undertaking strength-based activities on two or more occasions in the

past week compared to healthy-weight fallers (RR 0.60, 95%CI 0.38-0.93). There was a significant association between a more sedentary lifestyle and increasing BMI in that obese fallers were 1.9 times more likely to sit for more than eight hours per day on weekdays and were 1.3 times more likely to experience walking problems than fallers of a healthy weight. Compared to fallers of a healthy weight, obese fallers were 26% less likely to walk for more than two hours in the last week and both overweight (RR 0.88, 95%CI 0.79-1.00) and obese (RR 0.63, 95%CI 0.53-0.75) fallers were less likely to think they were doing enough physical activity (Table 4).

**Multivariate results**

The multivariate model did not add considerably to the interpretation of the main results of the study (Table 5). The main effects of the comparison between healthy weight and obese fallers largely remained significant,

but their effects were possibly dampened by the inclusion of likely related factors of opposing directions within the single model. For example, obese fallers were less likely than fallers of a healthy weight to have walked two or more hours in the past week, but were more likely to report experiencing moderate or extreme pain or discomfort.

**Discussion**

This study examined the influence of obesity and overweight on fall risk and factors influencing fall risk in obese and overweight individuals compared to those of a healthy weight. It demonstrates an association between increasing BMI and risk of falls, but fails to show a significant association between increasing BMI and fall-related injury. This is consistent with previous research that has suggested a link between known risk factors for falls and BMI<sup>13,19</sup> but no link with injury.<sup>20</sup>

**Table 1: Gender and age group overall and by fall status in the last 12 months, NSW Falls Prevention Baseline Survey, 2009.**

	Healthy weight					Overweight					Obese				
	% total	% fell	RR	95%CI	p-value	% total	% fell	RR	95%CI	p-value	% total	% fell	RR	95%CI	p-value
<b>Gender</b>															
Male	42.5	39.4	1			54.8	51.9	1			44.0	44.1	1		
Female	57.5	60.6	1.10	0.99-1.22	0.09	45.2	48.1	1.13	0.94-1.34	0.2	56.0	55.9	1.13	0.94-1.34	0.2
<b>Age group</b>															
65-74	46.8	39.4	1			60.2	54.7	1			65.6	58.0	1		
75-84	39.4	42.0	1.26	1.04-1.54	0.02	32.2	34.4	1.18	0.97-1.43	0.10	29.9	35.1	1.33	1.07-1.65	0.01
85+	13.8	18.6	1.60	1.26-2.04	0.0001	7.6	10.9	1.58	1.19-2.08	0.001	4.4	6.9	1.77	1.20-2.61	0.004

**Table 2: Comparison of fall injury and perceptions of falls of fallers by body mass index, NSW Falls Prevention Baseline Survey, 2009.**

Fall injury and fall perception	Healthy weight		Overweight				Obese			
	% yes	RR	% yes	RR	95%CI	p-value	% yes	RR	95%CI	p-value
<b>Fall experience</b>										
Fall in the last 12 months	23.0	1	24.9	1.08	0.96-1.23	0.2	30.1	1.31	1.14-1.50	<0.0001
Multiple falls in the last 12 months	34.2	1	39.1	1.15	0.95-1.38	0.2	45.0	1.32	1.08-1.60	0.006
<b>Fall injury</b>										
Fall-related injury	65.4	1	68.5	1.05	0.95-1.16	0.3	63.9	0.98	0.87-1.10	0.8
Falls requiring visit to hospital	19.5	1	20.3	1.04	0.78-1.39	0.8	15.6	0.80	0.57-1.13	0.2
Falls requiring hospital admission	10.4	1	8.7	0.84	0.54-1.31	0.4	11.0	1.06	0.67-1.66	0.8
Falls requiring medical treatment	20.4	1	22.2	1.08	0.82-1.42	0.6	24.2	1.17	0.87-1.57	0.3
<b>Fall perception</b>										
Fear of falling	40.4	1	38.9	0.95	0.79-1.14	0.6	47.6	1.16	0.96-1.39	0.1
Limited activities due to fear of falling	49.4	1	48.1	1.00	0.78-1.27	1.0	49.7	1.01	0.79-1.30	0.9
Agrees nothing can be done to prevent older people falling	19.1	1	25.3	1.26	0.96-1.64	0.09	31.5	1.57	1.19-2.05	0.001
Agrees being active reduces the risk of falling	65.5	1	65.4	0.95	0.87-1.04	0.3	68.7	1.03	0.94-1.13	0.5
Perceived risk of falling is high	9.5	1	9.9	1.03	0.65-1.62	0.9	14.5	1.51	0.97-2.36	0.07
<b>Why feel at risk of falling:</b>										
Poor coordination and/or body unstable/dizziness	18.1	1	23.7	1.31	0.99-1.73	0.06	28.9	1.60	1.21-2.12	0.001
Physically active/fit/good balance	20.6	1	21.0	1.02	0.78-1.34	0.9	12.3	0.60	0.41-0.87	0.007

While there were no significant differences in fear of falling by BMI status for fallers, about two in five individuals in each BMI group indicated that they had a fear of falling. Older individuals can develop a fear of falling, especially after having a fall, which can result in a decrease in their level of physical activity in an attempt to prevent further falls.<sup>21,22</sup>

Obese individuals who had fallen were more likely to indicate that they thought that nothing could be done to prevent older people falling. This fatalistic view that nothing can be done to prevent a fall may be influenced by obese individuals' reduced levels of physical functionality, activity and their physical instability;<sup>13,23</sup> all factors perceived to increase the fall risk among obese individuals in the current study. The fact that falls among older individuals are preventable is a key message for future population health-based fall injury prevention campaigns to convey.

In the current study, there was a higher risk among obese fallers of certain physical comorbidities commonly associated with weight gain, including diabetes, heart

disease and high blood pressure, and also of prescription of multiple medications – all factors that have been previously associated with an increased fall risk or risk of multiple falls.<sup>24,25</sup> Review of the health status of non-fallers from the baseline survey by BMI status indicated that the same physical comorbidities were an issue for both overweight and obese individuals compared to individuals of a healthy weight, with several additional comorbidities being significantly more likely for overweight (i.e. arthritis, heart disease/angina, cataracts) and obese (i.e. arthritis) non-fallers compared to healthy weighted individuals.

Increasing age and an increasing weight are associated with the presence of chronic health conditions.<sup>3</sup> Similarly, the presence of certain physical comorbidities, such as arthritis or lung disease, can also lead to weight gain. In order to reduce fall risk among obese fallers, tailored fall prevention initiatives could be of benefit, such as strength and balance training, home safety assessments and eyesight checks.<sup>26</sup> In addition, mechanisms to decrease medication

load among older individuals need to be considered and, where possible, medication reviews promoted.<sup>24</sup>

Obese fallers were more likely to report being in moderate or extreme pain or discomfort, to remain sedentary for more than eight hours on a weekday, to walk less and to have problems walking. Other studies have also found that obese individuals have lower quality of life measures, including bodily pain, and reduced activities of daily living, such as walking.<sup>13,27</sup> In the current study, both overweight and obese fallers did not think that they were doing enough physical activity. To improve physical functioning and reduce fall risk among this group, weight reduction, increasing levels of physical activity, particularly balance, strength and resistance training, may be options to consider.<sup>28,29</sup>

The lower risk of reported osteoporosis among both overweight and obese fallers, as found in the current study, has been previously acknowledged.<sup>27</sup> While there was a higher risk of obese individuals falling compared to individuals of a healthy weight,

**Table 3: Comparison of health status of fallers by body mass index, NSW Falls Prevention Baseline Survey, 2009.**

Health status	Healthy weight		Overweight				Obese			
	% yes	RR	% yes	RR	95%CI	p-value	% yes	RR	95%CI	p-value
<b>Physical comorbidities and symptoms</b>										
Diabetes	13.6	1	21.1	1.55	1.12-2.15	0.008	28.1	2.06	1.49-2.85	<0.0001
Arthritis (all types)	57.5	1	59.0	1.03	0.91-1.16	0.7	61.8	1.08	0.94-1.23	0.3
Osteoporosis	25.4	1	14.0	0.55	0.41-0.74	<0.0001	18.7	0.74	0.55-0.99	0.05
Heart disease/angina	26.3	1	28.3	1.08	0.85-1.36	0.5	34.0	1.29	1.02-1.64	0.04
High blood pressure	46.9	1	55.6	1.19	1.03-1.36	0.02	62.7	1.34	1.16-1.55	<0.0001
Stroke	12.4	1	8.0	0.65	0.43-0.99	0.04	11.2	0.90	0.58-1.40	0.6
Cataracts	47.3	1	42.7	0.90	0.77-1.06	0.2	44.8	0.95	0.80-1.13	0.5
<b>Medication</b>	46.9	1	49.6	1.06	0.92-1.23	0.4	66.3	1.41	1.23-1.62	<0.0001
Four or more prescription medications										

**Table 4: Comparison of quality of life and lifestyle characteristics of fallers by body mass index, NSW Falls Prevention Baseline Survey, 2009.**

	Healthy weight		Overweight				Obese			
	% yes	RR	% yes	RR	95%CI	p-value	% yes	RR	95%CI	p-value
<b>Quality of life</b>										
Self-rated health status as excellent, very good or good	69.6	1	73.3	1.05	0.96-1.15	0.3	64.7	0.94	0.84-1.05	0.3
Moderate or extreme pain or discomfort	57.2	1	62.1	1.08	0.96-1.22	0.2	74.0	1.31	1.17-1.46	<0.0001
<b>Lifestyle</b>										
Current smoker	7.5	1	5.2	0.69	0.40-1.18	0.2	4.0	0.53	0.24-1.15	0.1
Risk alcohol drinking	11.3	1	11.8	1.04	0.70-1.55	0.8	12.2	1.07	0.68-1.69	0.8
Did strength activities on 2 or more occasions in the last week	11.1	1	6.6	0.60	0.38-0.93	0.02	7.6	0.69	0.42-1.13	0.1
Usually sat more than 8 hours per day on weekdays	8.1	1	11.4	1.42	0.86-2.35	0.2	15.1	1.87	1.15-3.05	0.01
Walked more than 2 hours in the last week	50.2	1	48.2	0.96	0.83-1.12	0.6	37.0	0.74	0.60-0.90	0.003
Some problems walking	35.9	1	37.3	1.04	0.86-1.25	0.7	48.0	1.34	1.11-1.61	0.002
Thinks they are doing enough physical activity	63.2	1	55.9	0.88	0.79-1.00	0.04	39.8	0.63	0.53-0.75	<0.0001

obese individuals did not experience a higher risk of fall-related injury, including fractures. As such, obese individuals may be less likely to undergo more detailed assessment of bone health, including DEXA scanning, and therefore less likely to be diagnosed with osteoporosis. It is also possible that reduced injury among obese individuals is related to adipose tissue protecting bone, rather than better bone quality. Osteoporosis has been associated with increased body fat in individuals<sup>28</sup>, yet when the mechanical loading effect of body weight on bone mass is adjusted for, Zhao et al<sup>29</sup> found a negative association between bone mass and body fat mass.

The self-reported lifestyle factors of smoking and drinking behaviours were similar for each BMI group. It is possible that heavy smokers and high-risk drinkers were more likely to have early deaths and not reach older age, indicating a survival bias effect for these two lifestyle risk factors.<sup>9</sup>

Limitations of the current study include its self-reported nature and the possibility of recall bias associated with respondents reporting injury events over a 12-month period, compared to other methods, such as diaries or telephone calls.<sup>30</sup> Cognitive decline associated with age can also undermine the validity of self-reported survey responses.<sup>31</sup> However, to minimise the impact of these factors, survey items were pre-tested, interviewers were trained and proxy respondents were used, where necessary. There were no physiological measurements, mobility examinations or functional assessments conducted to verify the conditions reported, nor was information on fracture history obtained. Examination of fall risk in underweight individuals was not possible due to the relatively small sample size (n=44) with BMI <18.5. It is also possible that there is a degree of survival bias, with some obese older individuals more likely to have died at an earlier age than healthy weighted individuals.<sup>3</sup>

## Conclusions

This study has shown that obese individuals aged 65 years and older were at a higher risk of falling, but did not have a higher risk of being injured as a result of the fall compared to individuals of a healthy weight. Further research should explore the possible impact of mediating factors on fall risk for obese individuals. Involvement in limited physical

**Table 5: Multivariable model of characteristics of fallers by body mass index, NSW Falls Prevention Baseline Survey, 2009.**

	Overweight <sup>1</sup>			Obese <sup>1</sup>		
	RR	95%CI	p-value	RR	95%CI	p-value
<b>Age group</b>						
65-74	1		<0.0001	1		<0.0001
75-84	0.97	0.93-1.01		0.91	0.84-0.98	
85+	0.92	0.89-0.96		0.81	0.75-0.88	
<b>Fall perception</b>						
Agrees nothing can be done to prevent older people falling	-	-		1.08	1.01-1.15	0.02
<b>Quality of life</b>						
Moderate or extreme pain or discomfort	-	-		1.09	1.03-1.15	0.003
<b>Physical comorbidities and symptoms</b>						
Diabetes	1.07	1.03-1.10	0.0002	1.15	1.06-1.24	0.0004
Osteoporosis	0.95	0.93-0.98	0.001	0.92	0.87-0.97	0.006
Blood pressure	-	-		1.07	1.01-1.13	0.02
<b>Medication</b>						
Four or more prescription medication	-	-		1.08	1.02-1.15	0.01
<b>Lifestyle</b>						
Did strength activities on 2 or more occasions in the last week	0.96	0.92-0.99	0.02	-	-	
Walked more than 2 hours in the last week	-	-		0.93	0.88-0.98	0.009
Thinks they are doing enough physical activity	-	-		0.93	0.88-0.98	0.007

<sup>1</sup> Healthy weight is the reference group.

activity, weight-associated comorbidities and multiple medication use are likely to have an effect on fall risk for obese individuals. A decrease in sedentary lifestyle and regular weight-bearing exercise could assist to reduce fall risk among obese individuals as well as improving overall health status.

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