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Short Communication

Speed of eating and 3-year BMI change: a nationwide prospective study of mid-age women

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Abstract
Objective: To conduct the first nationwide population survey to examine the associations between changes in speed of eating and weight gain over 3 years. The study also explored whether faster eating at baseline was related to healthy-weight women becoming overweight after 3 years.
Design: Longitudinal. At baseline, participants were randomly selected from a nationally representative sampling frame to participate in a prospective study. Women completed self-administered baseline questionnaires on demographic and health measures. Self-reported speed of eating, smoking status, physical activity, menopause status, and height and weight were collected at baseline and again 3 years later.
Setting: Nationwide study, New Zealand.
Subjects: Women (*n* 1601) aged 40–50 years were recruited at baseline from New Zealand electoral rolls.
Results: There was no evidence of associations between 3-year BMI adjusting for baseline BMI and either baseline speed of eating (slower and faster; $P=0{\cdot}524$) or change in speed of eating (consistently faster eating, consistently slower eating, slower eating at baseline but not at 3 years, faster eating at baseline but not at 3 years; $P=0{\cdot}845$). Of the 488 women with healthy BMI (18·5 to <25·0 kg/m^2) at baseline, seventy-seven (15·8 %) became overweight (BMI ≥ 25·0 kg/m^2) after 3 years. Compared with those who were slower eaters at baseline, faster eating at baseline did not increase the risk of becoming overweight 3 years later ($P=0{\cdot}958$) nor did change in speed of eating ($P=0{\cdot}236$).
Conclusions: Results suggest that once women have reached mid-life, faster eating does not predict further weight gain.

Keywords
Speed of eating
Mid-age women
Longitudinal study

Longitudinal studies have revealed that US and Australian mid-age women (42–55 years) gain on average between 0·2 and 1 kg per year[1–3]. The prevention of weight gain in premenopausal women has been identified as an important health goal[4], since abdominal adiposity and cardiovascular risk increase markedly following menopause[5,6].

Faster self-reported rates of eating have been shown in cross-sectional studies to be associated with excess body weight[7–10], independent of self-reported energy intake[9,10]. Results from our baseline survey of mid-age women[7] showed that after adjusting for demographic, health and behavioural variables, every one-category increase in self-reported speed of eating ('very slow', relatively slow', 'medium', 'relatively fast', 'very fast') was associated with a 2·8 % increase in BMI. Cross-sectional studies have also demonstrated positive associations between faster eating rate and CVD risk factors[11] and insulin resistance[12].

Few longitudinal studies have examined the relationship between weight gain and speed of eating[13–16]. A retrospective longitudinal study of 529 male workers in Japan demonstrated that only among the 20–29 year age group, compared with the combined group of slow and medium-speed eaters, the fast-eating group had a higher average 8-year weight gain (1·9 kg *v.* 0·7 kg)[14]. A 7-year prospective study of 438 male fire service personnel

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showed that those who at baseline reported faster eating rates at the fire station (compared with other locations) gained 1·4 kg more over 7 years than those who reported at baseline that their eating rate did not differ by location[13]. Recently, a 3-year prospective study of 1396 healthy-weight first-year university students showed that among females and males, those who ate quickly at baseline were three times more likely to become overweight compared with those who ate slowly at baseline[16]. Among healthy-weight children (aged 9–10 years), girls who reported eating quickly at baseline and 3 years later had significantly greater gains in BMI, waist circumference, percentage body fat and waist-to-height ratio, compared with those who were not eating quickly at baseline and at 3-year follow-up[15].

Given the potential benefits of slower eating, the present study aimed to examine in mid-life women: (i) the associations between changes in speed of eating and weight gain over 3 years; and (ii) whether faster eating at baseline was related to healthy-weight women becoming overweight after 3 years.

Methods

Study design and participants

A cohort of 1601 women, aged 40–50 years and randomly selected from the nationwide general and Māori electoral rolls (all New Zealand residents eligible to vote), was recruited in May 2009 to participate in a prospective study. The baseline sample was reasonably representative of mid-age New Zealand women in terms of socio-economic status (as measured by the New Zealand Socioeconomic Index Score, NZSEI) and ethnicity[7,17]. Survey procedures for both baseline and 3-year surveys were similar and have been previously described[7,17]. A total of sixty-four respondents were excluded from analysis because they did not meet inclusion criteria (i.e. they were pregnant or breast-feeding, outside the age range or, in one case, male), there was reason to doubt the reliability of the answers (e.g. geometric patterns were made by circling answers, the respondent simultaneously answered opposite ends of a scale, the questionnaire was answered on behalf of someone else or the respondent indicated a poor understanding of English) or the potential responder was deceased. Of the 1318 women who were eligible to participate in the 3-year follow-up, 77·8 % (*n* 1025) responded in May 2012. Ten women reported having had bariatric surgery prior to the 3-year follow-up and were excluded, leaving 1015 participants for analyses.

Participants were informed that completing the questionnaires would imply informed consent.

Questionnaires

Women provided information on self-reported speed of eating, physical activity, menopause status, smoking status, and height and weight, both at baseline and 3 years. Demographic and health information was collected at baseline. Questionnaires are described in detail elsewhere[7,17].

The speed of eating question was slightly modified from the original question 'How fast is your rate of eating?'[10] to 'How would you describe your usual rate of eating?' As in the study by Sasaki *et al.*[10], participants were asked to choose one response from 'very slow', 'relatively slow', 'medium', 'relatively fast' or 'very fast'. The original question by Sasaki *et al.*[10] has been shown to have good repeatability over a 1-year period[8]. This measure of self-reported speed of eating has shown a good level of agreement ($\kappa = 0{\cdot}7$) with speed of eating measured in the laboratory[18].

Women were classified as experiencing a 'change in menopause status' (premenopausal at baseline to perimenopausal at 3 years, or premenopausal at baseline to postmenopausal at 3 years) or 'no change in menopause status' (premenopausal at baseline and 3 years, or postmenopausal at baseline to peri-/postmenopausal at 3 years). In each survey, participants were classified as smoker or non-smoker. Their transition from baseline to 3 years was modelled into three categories: (i) 'smoking ceased' (smoker to non-smoker); (ii) 'smoking initiated' (non-smoker to smoker); and (iii) 'smoking status remained unchanged' (either remained non-smoker or remained smoker).

Self-reported physical activity levels were categorised into two categories: 'underactive' (answered 'yes' to either 'I rarely or never do any physical activity' or 'I do some light activity every week') and 'active' (answered 'yes' to 'I do at least 30 min of moderate physical activity five or more days per week' or 'yes' to 'I do at least 20 min of vigorous physical activity on three or more days per week'). Using information at baseline and follow-up, four categories of change in physical activity level were modelled: (i) 'remained active'; (ii) 'becoming active'; (iii) 'remained underactive'; and (iv) 'becoming underactive'.

Participants' height and body weight were used to compute BMI as [weight (kg)]/[height (m)]^2. Healthy BMI was defined as at least 18·5 but less than 25·0 kg/m^2.

Statistical analysis

As relatively few women reported eating 'very slow' (*n* 26 and 25 at baseline and 3 years, respectively) or 'very fast' (*n* 64 and 48 at baseline and 3 years, respectively), women were classified into two categories as follows: (i) 'slower' eaters (combining 'very slow', 'relatively slow' and 'medium'); and (ii) 'faster' eaters (combining 'relatively fast' and 'very fast'). This is consistent with previous studies[8,16]. For participants who completed both baseline and 3-year surveys, distributions of continuous variables were compared between the two speeds of eating categories using *t* tests and categorical variables were compared using χ^2 tests. Linear weighted κ statistics were used to determine the degree of concordance between self-reported speed of

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Table 1 Characteristics of New Zealand female participants by baseline and 3-year self-reported speed of eating, May 2009–May 2012

	Speed of eating at baseline						Speed of eating at 3-year follow-up					
		Slower* (*n* 669; 66·0 %)		Faster* (*n* 345; 34·0 %)				Slower* (*n* 650; 64·0 %)		Faster* (*n* 365; 35·9 %)		
Baseline characteristics	*N*	*n*	%	*n*	%	*P* value	*N*	*n*	%	*n*	%	*P* value
Prioritised ethnicity†	1012					0·214§	1015					0·090§
European and others		551	82·6	297	86·1			519	79·8	310	84·9	
Māori		71	10·7	28	8·1			72	11·1	35	9·6	
Pacific People		18	2·7	4	1·2			21	3·2	4	1·1	
Asian		27	4·1	16	4·6			38	5·9	16	4·4	
Missing data		2		0				0		0		
Socio-economic status (NZSEI)	1012					0·132§	1015					0·005§
10–29 (lowest)		97	14·5	35	10·2			93	4·3	28	7·7	
30–59		430	64·5	230	66·7			424	65·2	247	67·7	
60–90 (highest)		140	21·0	80	23·2			133	20·5	90	24·7	
Missing data		2		0				0		0		
Smoking status	1000					<0·001§	927					<0·00§
Current smoker		130	19·8	35	10·2			106	30·4	22	6·0	
Non-smoker		528	80·2	307	89·9			543	83·7	342	94·0	
Missing data		11		3				1		1		
Physical activity	1004					0·328§	1009					0·122§
Underactive		194	29·3	110	32·3			211	32·7	102	28·0	
Active		469	70·7	231	67·7			434	67·3	262	72·0	
Missing data		6		9				5		1		
Menopause status	997					0·681§	1006					0·235§
Premenopause		512	78·1	270	79·2			162	25·2	109	30·0	
Perimenopause		–	–	–	–			257	40·0	132	36·4	
Postmenopause		144	22·0	71	20·8			224	34·8	122	33·6	
Missing data		13		4				7		2		
Thyroid condition	1014					0·208§	1015					0·204§
Thyroid problems		42	6·3	29	8·4			13	2·0	12	3·3	
Without thyroid problem		627	93·7	316	91·6			637	98·0	353	96·7	
BMI classification	993					<0·001§	998					<0·001§
<18·5 kg/m^2		11	1·7	2	0·6			9	1·4	4	1·1	
18·5 to <25·0 kg/m^2		357	54·5	143	42·3			331	51·8	136	37·9	
25·0 to <30·0 kg/m^2		175	26·7	105	31·1			174	27·2	125	34·8	
≥30·0 kg/m^2		112	17·1	88	26·0			125	19·6	94	26·2	
Missing data		14		7				11		6		
		Mean	SD	Mean	SD			Mean	SD	Mean	SD	
Age (years)	1008	45·5	3·2	45·6	3·2	0·385‖	1009	45·5	3·2	45·6	3·2	0·564‖
Weight (kg)‡	994	68·0	1·2	73·0	1·2	<0·001‖	1000	69·1	1·2	73·4	1·2	<0·001‖
BMI (kg/m^2)‡	993	25·1	1·2	26·6	1·2	<0·001‖	998	25·4	1·2	26·9	1·2	<0·001‖

NZSEI, New Zealand Socioeconomic Index Score.
Percentages may not add up to 100 % due to rounding.
*Values are expressed as *n* and %; percentages may not add to 100 % due to rounding.
†Multiple ethnicities could be reported and were prioritised as follows: Māori, Pacific People, Asian, Other and New Zealand Europeans. 'Other' and 'New Zealand European' were combined to form one category of classification due to small numbers in the 'Other' category.
‡Values are expressed as geometric mean and geometric SD.
§Differences in categorical variables by self-reported speed of eating assessed using χ^2 tests.
‖Differences in continuous variables by self-reported speed of eating assessed using *t* tests.

eating at baseline and 3 years later using all five levels listed above.

Partially adjusted and adjusted multiple linear regression models were used to examine the associations between 3-year BMI adjusting for baseline BMI and baseline speed of eating categories ('slower' and 'faster') as well as the four change in speed of eating categories ('consistently faster eating', 'consistently slower eating', 'slower eating at baseline but not at 3 years' and 'faster eating at baseline but not at 3 years').

Among a sub-sample of women whose baseline BMI was categorised as healthy, logistic regression models were used to examine the association between baseline speed of eating and BMI category change ('remained healthy weight at 3 years' and 'had become overweight/obese at 3 years'), as well as between the four change in speed of eating categories and BMI category change. Where the Wald test for a categorical variable was statistically significant, *post hoc* pairwise comparisons between the levels of that variable were performed.

The adjusted linear regression model and the logistic regression model controlled for baseline BMI, age, NZSEI score, thyroid condition, ethnicity, change in physical activity, change in smoking status and change in menopause status.

Residuals of linear regression models were assessed for normality and homogeneity of variances. Variance inflation factors were used to check for excessive collinearity in all adjusted linear models. The Homer–Lemeshow goodness-of-fit tests were examined for all logistic regression models. Two-sided P values less than 0·05 were deemed statistically significant. Statistical analyses were conducted using the Stata statistical software package version 12·1 (2012).

Results

The geometric mean BMI of women was 25·7 (SD 1·2) kg/m^2 at baseline and 25·8 (SD 1·2) kg/m^2 at 3 years, with a mean 3-year weight gain of 0·9 (SD 6·1) kg. Baseline characteristics of participants according to baseline and 3-year self-reported speed of categories are presented in Table 1. At baseline and 3 years, self-reported 'faster' eaters were significantly heavier than 'slower' eaters ($P<0·001$ for weight, BMI and BMI category). Slower eaters were more likely to be smokers at both baseline and follow-up (both $P<0·001$). Other variables did not appear to be associated with speed of eating apart from socio-economic status (NZSEI) at follow-up, where faster eaters appeared to have higher NZSEI scores ($P=0·005$). Of the 488 healthy-weight women at baseline (BMI at least 18·5 but less than 25·0 kg/m^2), seventy-seven (15·8 %) became overweight (BMI ≥ 25·0 kg/m^2) after 3 years.

Table 2 describes the distribution of participants according to self-reported speed of eating at baseline and

Table 2 Distribution of New Zealand female participants according to self-reported speed of eating at baseline and at 3-year follow-up, May 2009–May 2012

	Speed of eating (3-year follow-up)											
	Very slow		Relatively slow		Medium		Relatively fast		Very fast		Total	
Speed of eating (baseline)	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*
Very slow	58·8	10	35·3	6	5·9	1	0·0	0	0·0	0	100·0	17
Relatively slow	9·0	13	62·1	90	27·6	40	1·4	2	0·0	0	100·1	145
Medium	0·4	2	8·1	41	75·7	384	15·8	80	0·0	0	100·0	507
Fast	0·0	0	1·3	4	19·1	58	72·0	218	7·6	23	100·0	303
Very fast	0·0	0	0·0	0	2·4	1	38·1	16	59·5	25	100·0	42
Total	2·5	25	13·9	141	47·7	484	31·2	316	4·7	48	100·0	1014

Percentages may not add up to 100 % due to rounding.

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Table 3 Associations between each of baseline speed of eating and change in speed of eating, and each of BMI change over 3 years and BMI category change (remained healthy weight or had become overweight/obese at 3 years for baseline healthy BMI women), among New Zealand female participants, May 2009–May 2012

	Adjusted linear regression model*			Adjusted logistic regression model*		
Variable	*n*	% Increase/decrease in BMI over 3 years	*P* value	*n*	OR ratio for being overweight over 3 years	*P* value
Speed of eating (baseline)	864		0·524	436		0·958
Slower		Reference category			Reference category	
Faster		– 0·10 – 0·40, 0·21			1·08 – 0·52, 1·99	
Change in speed of eating (baseline to 3 years)	864		0·845	436		0·236
Consistently slower eating		Reference category			Reference category	
Consistently faster eating		0·09 – 0·24, 0·43			0·78 0·38, 1·59	
Slower eating at baseline but not 3 years		– 0·05 – 0·62, 0·53			0·66 0·18, 2·43	
Faster eating at baseline but not 3 years		– 0·13 –0·75, 0·49			0·16 0·03, 0·94	

NZSEI, New Zealand Socioeconomic Index Score.
*Adjusted for baseline BMI, age, NZSEI score, thyroid condition, ethnicity, change in physical activity, change in smoking status and change in menopause status.

3 years. Seventy-two per cent (*n* 727) of women were classified in the same category at both time points. Of the respondents, 14 % (*n* 149) increased speed of eating by one category and 0·3 % (*n* 3) increased by two categories from baseline to 3-year follow-up. Thirteen per cent (*n* 128) of women decreased their speed of eating by one category and 0·7 % (*n* 7) decreased their speed of eating by two categories from baseline to 3-year follow-up. The agreement between self-reported speed of eating at baseline and 3 years (five levels) was 92·7 % with a κ statistic of 0·7.

Table 3 depicts the associations between each of baseline speed of eating and change in speed of eating, and each of BMI change over 3 years and BMI category change (remained healthy weight or had become overweight/obese at 3 years for baseline healthy BMI women). None of these associations were statistically significant (all $P \geq 0{\cdot}1$).

Discussion

We found no evidence of an association between changes in speed of eating and weight gain, nor between faster eating at baseline and healthy-weight women becoming overweight after 3 years. Speed of eating was stable over 3 years. These results were consistent with a recent retrospective longitudinal study among males reporting that, among the 40–49 and 50–59 year age groups, there was no evidence of an association between self-reported speed of eating (measured at follow-up) and weight gain over 8 years[14]. Results from an earlier study by Sasaki *et al.*[10] among adult men and women suggested that fast eating may be acquired in childhood and maintained up to and during adulthood. It is possible that faster eating may be more strongly associated with weight gain earlier in life[15,16] than during mid-life. In studies where faster eating has been linked with weight gain, excess energy intake in faster eaters presents a possible mechanism[12]. The lack of association with weight gain in the present study may reflect that, in women of this age group, faster eating might not necessarily be associated with an increased energy intake. Faster eating may be a consequence of stress or a lack of time available for consuming meals. Further research is needed to explore contributors to weight gain in mid-life.

Despite findings suggesting that modifying speed of eating may be more beneficial for weight management early in life than in mid-life, recent cross-sectional studies among mid-aged men and women have shown that faster eating was associated with cardiovascular risk factors[11] and insulin resistance[12] after controlling for BMI. If proved to be causal, interventions to reduce speed of eating might be of value even during mid-life for preventing the development of CVD and diabetes mellitus. Around mid-age, there is evidence of increasing body fatness[19] and worsening lipid profiles[20] in women, with metabolic syndrome accounting for almost half of coronary events in postmenopausal women[21]. Factors that help to reduce cardiovascular risk and insulin resistance during this life stage may therefore be particularly valuable.

The current study presents evidence of a high degree of stability over 3 years in self-reported speed of eating among mid-age women. This may partly explain why a 1991 study found that although women's eating speed decreased following an intervention intended to promote slower eating, relapse to faster eating was common[22].

The main strengths of the present study are the nationally representative sampling frame (New Zealand electoral rolls include 97 % of adults aged 40–49 years)[23], good baseline response rate (66 %)[7] and 3-year retention rate (79 %), and longitudinal design. A limitation is the reliance on self-reported height and weight. However, studies conducted in New Zealand[24] and overseas[25,26] have shown that among mid-aged women, the mean

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differences between self-reported and measured height and weight were small[24–26] and stable over time[26]. Nevertheless, there exists the possibility of under-reporting of body weight by obese women with faster eating[25]. A recent analysis of data from the US National Health and Nutrition Examination Survey, however, revealed that between 1988–1994 and 2005–2008, under-reporting of weight declined among obese adults leading to an improvement in the accuracy of BMI classifications based on self-reported height and weight[27]. This may reflect changing social norms and greater acceptance of higher BMI values as 'normal'. Another limitation of the study was that we did not control for total energy intake, which has been previously shown to have a strong positive correlation with speed of eating[8,9].

Conclusions

Although mid-age women who eat fast are significantly heavier than slower eaters, our longitudinal results suggest that once women reach mid-age, eating rate may not significantly influence further weight change. Interventions promoting slower eating for weight management may be more effective in earlier life. However, since faster eating during mid-life has been associated with insulin resistance and cardiometabolic risk factors, independent of weight, intervention studies are required to elucidate the impact of slower eating on health outcomes.

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References

1. Lee IM, Djousse L, Sesso HD *et al.* (2010) Physical activity and weight gain prevention. *JAMA* **303**, 1173–1179.
2. Brown WJ, Williams L, Ford JH *et al.* (2005) Identifying the energy gap: magnitude and determinants of 5-year weight gain in midage women. *Obes Res* **13**, 1431–1441.
3. Sternfeld B, Wang H, Quesenberry CP Jr *et al.* (2004) Physical activity and changes in weight and waist circumference in midlife women: findings from the Study of Women's Health Across the Nation. *Am J Epidemiol* **160**, 912–922.
4. Kremers S, Reubsaet A, Martens M *et al.* (2010) Systematic prevention of overweight and obesity in adults: a qualitative and quantitative literature analysis. *Obes Rev* **11**, 371–379.
5. Franklin RM, Ploutz-Snyder L & Kanaley JA (2009) Longitudinal changes in abdominal fat distribution with menopause. *Metabolism* **58**, 311–315.
6. Rosano GMC, Vitale C, Marazzi G *et al.* (2007) Menopause and cardiovascular disease: the evidence. *Climacteric* **10**, Suppl. 1, 19–24.
7. Leong SL, Madden C, Gray A *et al.* (2011) Faster self-reported speed of eating is related to higher body mass index in a nationwide survey of middle-aged women. *J Am Diet Assoc* **8**, 1192–1197.
8. Maruyama K, Sato S, Ohira T *et al.* (2008) The joint impact on being overweight of self reported behaviours of eating quickly and eating until full: cross sectional survey. *BMJ* **337**, a2002.
9. Otsuka R, Tamakoshi K, Yatsuya H *et al.* (2006) Eating fast leads to obesity: findings based on self-administered questionnaires among middle-aged Japanese men and women. *J Epidemiol* **16**, 117–124.
10. Sasaki S, Katagiri A, Tsuji T *et al.* (2003) Self-reported rate of eating correlates with body mass index in 18-y-old Japanese women. *Int J Obes Relat Metab Disord* **27**, 1405–1410.
11. Lee KS, Kim DH, Jang JS *et al.* (2013) Eating rate is associated with cardiometabolic risk factors in Korean adults. *Nutr Metab Cardiovasc Dis* **23**, 635–641.
12. Otsuka R, Tamakoshi K, Yatsuya H *et al.* (2008) Eating fast leads to insulin resistance: findings in middle-aged Japanese men and women. *Prev Med* **46**, 154–159.
13. Gerace TA & George VA (1996) Predictors of weight increases over 7 years in fire fighters and paramedics. *Prev Med* **25**, 593–600.
14. Tanihara S, Imatoh T, Miyazaki M *et al.* (2011) Retrospective longitudinal study on the relationship between 8-year weight change and current eating speed. *Appetite* **57**, 179–183.
15. Ochiai H, Shirasawa T, Ohtsu T *et al.* (2013) The impact of eating quickly on anthropometric variables among schoolgirls: a prospective cohort study in Japan. *Eur J Public Health* **24**, 691–695.
16. Yamane M, Ekuni D, Mizutani S *et al.* (2014) Relationships between eating quickly and weight gain in Japanese university students: a longitudinal study. *Obesity (Silver Spring)* **22**, 2262–2266.
17. Madden CEL, Leong SL, Gray A *et al.* (2012) Eating in response to hunger and satiety signals is related to BMI in a nationwide sample of 1601 mid-age New Zealand women. *Public Health Nutr* **15**, 2272–2279.
18. Petty AJ, Melanson KJ & Greene GW (2013) Self-reported eating rate aligns with laboratory measured eating rate but not with free-living meals. *Appetite* **63**, 36–41.
19. Sowers M, Zheng H, Tomey K *et al.* (2007) Changes in body composition in women over six years at midlife: ovarian and chronological aging. *J Clin Endocrinol Metab* **92**, 895–901.
20. Matthews KA, Crawford SL, Chae CU *et al.* (2009) Are changes in cardiovascular disease risk factors in midlife women due to chronological aging or to the menopausal transition? *J Am Coll Cardiol* **54**, 2366–2373.
21. Kaaja RJ (2008) Metabolic syndrome and the menopause. *Menopause Int* **14**, 21–25.

22. Spiegel TA, Wadden TA & Foster GD (1991) Objective measurement of eating rate during behavioral treatment of obesity. *Behav Ther* **22**, 61–67.
23. Elections New Zealand (2010) Enrolment statistics. http://www.elections.org.nz/enrolment/statstics.html (accessed October 2013).
24. Sharples H, Crutchley PW, García JA *et al.* (2012) Agreement between measured and self-reported height, weight and BMI in predominantly European middle-aged New Zealanders: findings from a nationwide 1989 survey. *N Z Med J* **125**, 1362.
25. Stommel M & Schoenborn CA (2009) Accuracy and usefulness of BMI measures based on self-reported weight and height: findings from the NHANES and NHIS 2001–2006. *BMC Public Health* **9**, 421.
26. Dahl AK, Hassing LB, Fransson EI *et al.* (2010) Agreement between self-reported and measured height, weight and body mass index in old age – a longitudinal study with 20 years of follow up. *Age Ageing* **39**, 445–451.
27. Stommel M & Osier N (2012) Temporal changes in bias of body mass index scores based on self-reported height and weight. *Int J Obes (Lond)* **37**, 461–467.

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