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ASSOCIATION BETWEEN OBESITY AND DEPRESSION IN MIDDLE-AGED WOMEN

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Abstract

Objective—Evaluate the association between obesity and depression among middle-aged women.

Methods—4641 female health plan enrollees aged 40–65 completed a structured telephone interview including self-reported height and weight, the Patient Health Questionnaire (PHQ) assessment of depression, a brief measure of rate was 62%.

Results—Prevalence of moderate or severe depression increased from 6.5% among those with body mass index (BMI) under 25 to 25.9% among those with BMI over 35. Prevalence of obesity increased from 25.4% among those with no depressive symptoms to 57.8% among those with moderate to severe depression. Independent of obesity, depression was associated with significant reductions in frequency of moderate (4.6 vs. 5.4 times per week) or vigorous (2.8 vs. 3.7 times per week) physical activity. Depression was associated with significantly higher daily caloric intake (1831 vs. 1543) among those with BMI over 30.

Conclusions—Among middle-aged women, depression is strongly and consistently associated with obesity, lower physical activity, and (among the obese) higher caloric intake. Public health approaches to reducing the burden of obesity or depression must consider the strong association between these two common conditions.

Obesity is a major public health concern. Among US adults, prevalence of obesity (defined as a Body Mass Index or BMI of 30 or more) increased from approximately 23% in 1990 to 31% in 2000¹. Similar increases were seen for men and women, across all age groups, and across all racial/ethnic groups.^{1,2} More recent data indicate no improvement in this trend between 2000 and 2002². Adverse consequences of obesity, such as diabetes and cardiovascular disease, are predicted to cause an unprecedented decline in life expectancy in the United States³.

Beginning in the 1970s, numerous epidemiologic studies have examined the association between obesity and depression or other psychiatric disorders. Early research in the UK^{4,5} suggested a negative association between obesity and symptoms of depression or anxiety. Subsequent studies had variable results, with some^{6,7} finding no significant association

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between obesity and depression, some finding a positive association limited to women⁸⁻¹² finding stronger associations in women than men, and some^{11 13 14} finding associations limited to severe obesity. While the majority of recent US and Canadian studies^{11 14-17} suggest a moderate association between obesity and depression, some studies in Europe and Asia find no association¹⁸ or an inverse relationship^{19 20}.

Methodologic differences may account for some of the variability in previous research regarding obesity and depression. Previous studies have used varying measures of depression, including depression screening questions¹², symptom scales^{8 9 16}, and structured diagnostic interviews¹⁰⁻¹². The relationship between obesity and depression may be either confounded or moderated by sociodemographic characteristics such as race or socioeconomic status^{12 21}. Most previous studies have not examined potential mechanisms or mediators of this relationship, such as body dissatisfaction or differences in caloric intake and physical activity.

The present paper uses data from a large sample of middle-aged women enrolled in a prepaid health plan to: 1) Assess the association between various levels of obesity and various levels of depression severity; 2) Examine potential confounders of the association including tobacco use and use of antidepressant medications; 3) Evaluate how the association between obesity and depression varies as a function of age, race, marital status, and educational attainment; and 4) Examine differences in body satisfaction, dietary intake and physical activity level that might help to explain any association.

METHODS

Data used in this paper were obtained through a population-based survey of middle-aged women enrolled in Group Health Cooperative, a group-model prepaid health plan serving approximately 500,000 members in Washington and northern Idaho. Most Group Health members are enrolled via employer-purchased contracts, but approximately 20,000 are enrolled via risk-sharing contracts with Medicare and another 20,000 via risk-sharing contracts with Medicaid or other subsidized low-income programs. The Group Health enrollment is demographically similar to the area population²². Study participants were recruited from eight Group Health primary care clinics selected for higher rates of minority enrollment. All study procedures were approved by the Group Health Institutional Review Board.

All women aged 40 and older enrolled in Group Health are invited to complete periodic breast cancer risk questionnaires including self-reported height and weight²³. In order to over-sample women expected to have higher BMI, data from this breast cancer screening program were used to stratify the population of women aged 40 to 65 into three groups. Women who last reported a BMI of 30 or more were sampled at 100%, women who last reported a BMI less than 30 were sampled at 12%, and women who did not complete a screening questionnaire in the last five years were sampled at 25%. This stratified sampling procedure was intended to increase the efficiency of the survey and to permit correction for differences in response rates. All analyses incorporated sampling weights (see below) so that results accurately reflect the entire population of women aged 40 to 65.

All sampled participants were mailed an invitation letter including core elements of informed consent (purpose of the study, study procedures, risks, voluntary nature of participation, procedures to protect confidentiality). The letter included a \$5 gift card incentive and a phone number through which potential participants could decline further contact. Those who did not decline were contacted by telephone beginning approximately one week after mailing of the invitation letter. Participants received no additional compensation for completing the survey.

Surveys were conducted by trained interviewers from Group Health's survey research program. Each interviewer received at least 8 hours of general interview training and 4 hours of project-specific training. Certification required satisfactory performance in 2 role-play interviews and 2 observed interviews. Contact protocols required a minimum of 9 contact attempts, including attempts during evening and weekend times.

Each survey began with a detailed consent script repeating all elements of informed consent, and each participant provided documented oral consent prior to participation.

The telephone survey included the following measures:

- Self-reported height, weight, race/ethnicity, marital status, current and past tobacco use, and educational attainment.
- The 9-item Patient Health Questionnaire or PHQ - This self-report measure of depression symptoms examines the nine American Psychiatric Association DSM-IV²⁴ criteria for diagnosis of major depressive episode. Validation studies in the general population²⁵ as well as in general medical outpatients^{26,27} and medical inpatients²⁸ have shown excellent agreement between the self-report PHQ and a clinician structured interview. To assess diagnosis of current major depression, each item was scored as positive if endorsed as "More than half the time" or "Nearly all the time". A diagnosis of major depression required a positive response to one of the two core symptoms (depressed mood or loss of interest) and a total of five positive symptoms. In addition, a dimensional score was calculated as the total of all 9 items (possible range 0 to 27). A score of 10 or more on this scale represents a moderate level of depressive symptoms²⁷.
- A 13-item measure of physical activity developed by Jacobs²⁹ assessing frequency (number of times each week) that respondents typically engaged in specific moderate physical activities (e.g. walking, bowling, household work) or vigorous physical activities (e.g. jogging, lap swimming, aerobic exercise classes) over the last year.
- An abbreviated 12-month food frequency questionnaire based on the questionnaire originally developed by Block for the National Cancer Institute^{30,31}. The abbreviated questionnaire included 39 items found to account for over 90% of the variance in estimated caloric intake measured by the full questionnaire³². The full questionnaire and the abbreviated version would both be expected to underestimate actual caloric intake, but both should accurately assess group differences in intake.
- Body dissatisfaction was assessed using a single item ("I feel satisfied with the shape of my body") with responses ranging from 0 ("Always") to 5 ("Never").

A sample of 250 women reporting BMI of 30 or more were invited to in-person assessment to assess eligibility for a treatment study. At this assessment, height was measured by stadiometer and weight was measured by triple-beam balance. Comparison of self-reported height and weight with directly measured height and weight found that weight was under-reported by an average of 1.35 kg and height was under-reported by an average of .002 meters. In this validation subsample, Pearson's correlations between measured and self-reported heights and weights were $r=0.95$ and $r=0.98$, respectively³³.

All analyses incorporate sampling weights³⁴ to account for the stratified sampling procedure described above and for differential response rates across sampling strata (see below). All data analyses were conducted using SAS/STAT® software, Version 9.1. The Taylor series expansion approximation was used to adjust confidence intervals and significance tests for design effects (potential over-estimation of statistical significance due to the stratified sampling design). Specific SAS procedures used included SURVEYFREQ for calculation of

proportions, SURVEYREG for linear regression models, and SURVEYLOGISTIC for logistic regression models.

RESULTS

Of 8000 potential participants who were mailed invitation letters, 442 were found to be ineligible (had since died, moved away, or disenrolled from the health plan). Of the remaining 7558 eligible women, 865 could not be reached by telephone and 2033 declined to participate, leaving 4660 participants (62% of those eligible). Nineteen participants had missing data on one or more key variables, so 4641 were included in analyses presented here. Participation varied significantly across sampling strata (63% among those who reported BMI of 30 or more on the breast cancer screening questionnaire vs. 59% among those reporting BMI less than 30 vs. 34% among those declining to participate in breast cancer screening, $X^2=344$, $df=2$, $p<.001$). As discussed above, all analyses incorporated sampling weights to correct for differential response across strata.

Weighted prevalence of current major depressive episode by strict diagnostic criteria was 5.1%, and an additional 7.7% had PHQ scores of 10 or greater (a conventional threshold for moderate symptoms of depression). Weighted prevalence of obesity was 33.4%, with 17.7% having BMI between 30 and 35 and an additional 15.7% having BMI of 35 or greater (the customary threshold for severe or morbid obesity). These rates are consistent with expectations for prevalence of depression³⁵ and obesity² in a sample of middle-aged women.

Figure 1 displays the prevalence of depression according to BMI. Whether depression was defined by current major depressive episode or by PHQ score of 10 or more, prevalence of depression was progressively higher as BMI increased from normal to morbidly obese. Compared to those with BMI less than 25, the relative odds of having a PHQ score of 10 or more were 3.83 (95% CI 1.89 to 7.76) for those with BMI between 25 and 30, 4.40 (95% CI 2.21 to 8.78) for those with BMI between 30 and 35, and 4.95 (95% CI 3.47 to 7.05) for those with BMI of 35 or more. Compared to those with BMI less than 25, relative odds of satisfying criteria for current major depressive episode were 1.92 (95% CI 1.26 to 2.92) for those with BMI between 25 and 30, 2.92 (95% CI 1.98 to 4.29) for those with BMI between 30 and 35, and 5.72 (95% CI 3.02 to 10.85) for those with BMI of 35 or more. Figure 2 displays prevalence of obesity according to depression status. Compared to those with PHQ score less than 5, relative odds of obesity were 2.26 (95% CI 1.86 to 2.73) for those with PHQ score of 5 to 9, 3.38 (95% CI 2.50 to 4.57) for those with PHQ score of 10 to 15, and 4.02 (95% CI 2.63 to 6.15) for those with PHQ score of 15 or more. All subsequent analyses considered dichotomous measures of obesity (BMI less than 30 vs. 30 or more) and depression (PHQ score less than 10 vs. 10 or more). Using these dichotomous thresholds yielded an odds ratio of 2.82 (95% CI 2.20 to 3.62) for the association between obesity and depression.

Diagnostic criteria for depression such as fatigue or appetite change could be confounded with physical effects of obesity. Consequently, additional analyses examined the association between obesity and specific depression criteria less likely to be directly determined by physical consequences of obesity. Using a threshold of BMI greater than or equal to 30, odds ratios for association between obesity and individual depression criteria were 1.94 (95% CI 1.42 to 2.66) for depressed mood, 2.39 (95% CI 1.81 to 3.17) for loss of interest in activities, 2.65 (95% CI 1.96 to 3.57) for feelings of guilt or worthlessness, and 1.48 (95% CI 0.68 to 3.68) for suicidal ideation.

The top portion of Table 1 compares demographic characteristics, tobacco use, and antidepressant use for groups defined by both obesity and depression status. Obesity was associated with African American race, single marital status, lower educational attainment and

more frequent use of antidepressant medication. Depression was associated with single marital status, lower educational attainment, higher rates of current tobacco use, and more frequent use of antidepressant medication. Adjustment for age and race had no meaningful effect on the association between obesity and depression (adjusted odds ratio = 2.84, 95% CI 2.21 to 3.65). Further adjustment for educational attainment, marital status, smoking status, and antidepressant use yielded an odds ratio of 2.37 (95% CI 1.81 to 3.10).

Additional analyses examined whether the association between depression and obesity varied according to age, race, marital status, and educational attainment. We observed no statistically significant interaction across any of those demographic classifications ($p \geq .23$ for all comparisons).

The bottom portion of Table 1 compares self-reported physical activity, estimated caloric intake, and body dissatisfaction for groups defined by both obesity and depression status. Highest levels of physical activity by both measures were seen in those who were neither obese nor depressed, and lowest levels were seen among those who were both obese and depressed. Table 2 displays the independent effects of both obesity and depression on measures of physical activity. After accounting for the effect of obesity, depression was associated with significant reductions in frequency of moderate and vigorous physical activity. For both types of exercise, the adjusted differences associated with depression was approximately half as large as the adjusted differences associated with obesity. The pattern was similar for body dissatisfaction: lowest scores in those who were neither obese nor depressed and highest (most dissatisfied) scores in those who were both obese and depressed. As shown in the bottom of Table 2, depression was independently associated with body dissatisfaction after accounting for the association with obesity. The magnitude of the association between body dissatisfaction and depression was approximately half as large as that between body dissatisfaction and obesity.

As shown in the bottom row of Table 1, the relationship between depression and caloric intake appeared to differ between obese and non-obese respondents. Among the non-obese, depression was not associated with higher caloric intake. Among the obese, depression was associated with nearly 20% higher caloric intake. This appearance of effect modification was confirmed by a linear regression model predicting caloric intake as a function of obesity, depression, and the interaction of the two ($p < .001$). Subgroup analyses found no significant association between caloric intake and depression in those with BMI less than 30 ($p = .59$) and a highly significant relationship in those with BMI of 30 or more ($p < .001$).

DISCUSSION

In this sample of middle-aged women, we observe a strong and consistent relationship between obesity and depression. Prevalence of depression (whether defined by diagnostic criteria or severity of symptoms) was more than twice as great among women with BMI of 30 or more compared to those with BMI less than 30, and this strong association was seen across different age groups, racial and ethnic groups, and levels of educational attainment. Furthermore, we observed a step-wise increase in both directions: increasing severity of depressive symptoms was strongly associated with higher risk of obesity, and increasing body mass index was strongly associated with higher risk of depressive disorder. We do not find that the association between obesity and depression was limited to more severe obesity. This association was only minimally affected by accounting for potential confounders such as educational attainment, marital status, tobacco use, and antidepressant drug use. The association could not be attributed to selective effects of obesity on somatic symptoms of depression.

The association between obesity and depression in this sample is considerably stronger than that seen in previous US¹⁰⁻¹² and Canadian¹⁶ surveys where odds ratios ranged from

approximately 1.4 to 1.8 among women. We must consider whether any differences in study design or method might account for the much stronger association seen in this sample.

First, our survey may have focused on the demographic groups in which the obesity-depression association is strongest. While we did not find that the association between obesity and depression varied across demographic groups, previous research suggests that this relationship may vary by age, socioeconomic status, or ethnicity. Community survey data from the 1950s suggest a stronger association between obesity and depression among those with higher socioeconomic status²¹. A more recent US survey¹² found a stronger association in those under age 65 compared to older respondents. In another US population survey¹², depression and obesity were more strongly associated in non-Hispanic whites and those with higher educational attainment. International studies^{19,20} suggest that the association observed in predominantly Caucasian samples in the US and Canada may not extend to other racial or ethnic groups. Our sample was relatively homogeneous, and it may have included primarily those for whom the relationship between obesity and depression appears to be the strongest: middle-aged women who were predominantly middle-class and Caucasian.

Second, only 62% of those potentially eligible participated in the survey. Our results might over-estimate the association between obesity and depression if women with both conditions were more likely to participate than those with either alone. We did observe a slightly higher response rate among those who previously reported a higher BMI, but all analyses were weighted to correct for this potential bias.

Third, depression was assessed by non-clinicians using a structured research interview rather than by a full clinical assessment. Inaccurate measurement of depression, however, would generally lead to a conservative bias (underestimating the association between depression and obesity). We would not expect an imperfect measure of depression to differentially overestimate depression in those with higher body mass index. Compared to the gold standard of a clinician assessment, the validity of the PHQ^{26,27} is as good or better than alternative measures used in previous studies^{8-11,16}. In addition, our finding of a strong association between depression and obesity did not depend on whether the PHQ was analyzed as a diagnostic assessment or a measure of symptom severity.

Fourth, height and weight were assessed by self-report. Previous methodologic research suggests that self-reported height and weight are highly correlated with direct physical measurements³⁶⁻³⁸, but self-report tends to consistently under-estimate weight and over-estimate height³⁷. In a sample of participants in this study, weight was under-reported by less than 1.5kg on average, and correlation between self-reported and measured weight was 0.98*. In addition, we would not expect that a general tendency to under-report weight would affect the association between obesity and depression. Previous studies demonstrating an association between obesity and depression have included both self-report^{10,12} and physical measurements^{9,11,16} of height and weight.

Fifth, our analyses do not consider the possible influence of previous depressive episodes on weight, physical activity, or diet. Over 20% of women with BMI $\geq$ 30 and PHQ $<$ 10 reported current or recent use of antidepressants, suggesting a significant rate of prior depression. Misclassification of depression, however, would be expected to blunt or obscure the association between depression and obesity.

Sixth, some physical or somatic criteria for diagnosis of depression, such as fatigue or disturbances in appetite, could be confounded with manifestations of obesity. We find, however, that obesity is strongly related to psychological symptoms such as depressed mood, feelings of guilt, or suicidal ideation. A similar concern has been raised regarding biased

assessment of depression in chronic medical illness^{39,40}. Psychometric analyses, however, have not found evidence for such bias⁴¹.

Previous research suggests several mechanisms for an association between obesity and depression. Various potential mechanisms have been described⁴²⁻⁴⁴. Some mechanisms propose that depression causes or contributes to obesity. Common symptoms of depression include increased appetite^{45,46} and reduced physical activity⁴⁷. Reduced motivation or self-efficacy associated with depression may interfere with initiating or maintaining exercise programs or diet change. Depression may increase risk of weight gain through its effect on binge eating^{48,49}, especially among women^{50,51}. Medications used to manage mood or anxiety disorders may also lead to weight gain⁵². Alternatively, some proposed mechanisms suggest that obesity causes or contributes to depression. The stigma attached to obesity (especially for women) may contribute to depression⁵³, and this stigma may vary by race/ethnicity or socioeconomic status⁵⁴⁻⁵⁷. Activity limitations or due to obesity or obesity-related chronic illnesses may increase risk of depression through distressing physical symptoms or decreased involvement in rewarding or pleasurable activities¹⁵. Finally, depression and obesity may be linked through some common cause or third factor, either environmental (e.g. childhood abuse⁵⁸) or biological.

We examine three potential mediators of the relationship between obesity and depression: physical activity, caloric intake, and body satisfaction.

In this sample, depression was independently associated with decreased physical activity after accounting for the association between physical activity and obesity. This observation is, of course, consistent with causal mechanisms in either direction: depression causing obesity or obesity causing depression. In the former scenario, depression may lead to decreased physical activity and subsequently to weight gain. In the latter scenario, decreased physical activity associated with obesity might contribute to depressed mood. In either case, however, our data suggest that physical activity level is a potential mediator of this relationship.

Depression was strongly associated with increased caloric intake among the obese, but we observed no association among those with BMI less than 30. This may reflect population subgroups experiencing different effects of depression on appetite or weight. Depression may be associated with either increased or decreased appetite. Increased appetite associated with depression tends to be consistent across episodes^{45,46} (although this is not a universal finding⁵⁹). Again, our findings suggest that increased caloric intake is a potential mediator of the relationship between obesity and depression.

Body dissatisfaction was also associated with depression after accounting for the relationship between body satisfaction and BMI. This finding is consistent with the hypothesis that obesity contributes to depression by way of stigmatization and reduced self-esteem¹³.

This cross-sectional study cannot, of course, clearly establish either the direction of the causal relationship between obesity and depression or the mechanism of that relationship. Our findings do, however, suggest that the relationship probably involves multiple mechanisms including decreased physical activity, increased caloric intake, and negative body image.

To illustrate the public health importance of the relationship between obesity and depression, we can examine the population attributable fraction, the proportion of any disease attributable to its association with a particular risk factor. By this measure, we estimate that 33% of the risk of depression in this population could be attributable to its association with obesity or that 9% of the risk of obesity could be attributable to its association with depression. These calculations do not, of course, demonstrate a causal relationship. They simply illustrate the significance of a strong association between two common health conditions. As alternative

indicators of public health importance, we point out the extremely high rates of comorbidity at the extremes of depression and obesity. Those with BMI of 35 or more (a conventional threshold for morbid obesity) had a 26% prevalence of clinically significant depressive symptoms. Those with PHQ scores of 15 or more (indicating more severe depression) had a 58% prevalence of obesity.

CONCLUSIONS

Among middle-aged women, obesity is strongly associated with depression. This association is consistent across demographic groups and is not explained by confounding effects of age, race, marital status, educational attainment, tobacco use, or antidepressant use. Depression is associated with significantly lower physical activity levels and, among the obese, higher caloric intake. Public health approaches to reducing the burden of obesity or depression must consider the strong association between these two common conditions.

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Figure 1.
Prevalence of current depression according to Body Mass Index

Figure 2.
Prevalence of obesity (BMI $\geq$ 30) according to PHQ depression score

Table 1

Demographic and clinical characteristics of survey respondents according to obesity and depression status. Sample size numbers reflect actual number of respondents; all other results incorporate sampling weights.

	BMI < 30, PHQ < 10 (n=1263)	BMI < 30, PHQ ≥ 10 (n=127)	BMI ≥ 30, PHQ < 10 (n=2635)	BMI ≥ 30, PHQ ≥ 10 (n=616)
Mean BMI	24.1 (24.0-24.3)	25.1 (24.4-25.7)	36.2 (35.9-36.6)	37.9 (36.9-38.9)
Mean Age	52.1 (51.7-52.5)	52.3 (51.0-53.7)	52.1 (51.8-52.5)	51.4 (50.6-52.2)
% White	83.6 (81.3-85.9)	81.6 (73.9-89.2)	80.6 (78.3-82.9)	78.2 (73.3-83.1)
% African American	5.0 (3.6-6.3)	5.6 (1.2-10.1)	11.2 (9.3-13.1)	9.3 (6.4-12.2)
% Other Race	11.5 (19.5-13.4)	12.8 (6.2-19.5)	8.2 (6.6-9.7)	12.5 (8.2-16.8)
% Hispanic	2.3 (1.4-3.3)	3.3 (0.0-6.8)	2.7 (1.7-3.6)	2.7 (0.9-4.4)
% Married/Living as Married	71.1 (68.3-73.9)	53.8 (43.7-63.8)	60.2 (57.4-63.0)	53.3 (47.1-59.5)
% College Graduate	67.1 (64.2-70.0)	59.2 (49.4-69.1)	43.7 (40.9-46.6)	34.0 (28.2-39.8)
% Current Smoker	8.7 (7.0-10.4)	13.6 (6.5-20.7)	9.7 (7.8-11.6)	15.7 (11.0-20.4)
% Recent Antidepressant Use	17.0 (14.6-19.4)	31.7 (22.1-41.4)	24.6 (22.2-27.1)	50.8 (44.5-57.0)
Mean Moderate Phys Activity/Wk	6.2 (6.0-6.5)	5.1 (4.3-5.9)	4.6 (4.4-4.8)	4.0 (3.5-4.4)
Mean Vigorous Phys Activity/Wk	4.7 (4.4-4.9)	3.3 (2.6-4.1)	2.7 (2.5-2.8)	2.2 (1.8-2.6)
Mean Est. Caloric Intake/Day	1368 (1342-1395)	1340 (1239-1440)	1543 (1515-1571)	1831 (1748-1914)
Mean Body Dissatisfaction Score	2.21 (2.12-2.29)	3.05 (2.72-3.38)	3.81 (3.75-3.88)	4.40 (4.27-4.53)

Table 2
Results of regression models indicating independent associations of depression and obesity with self-reported physical activity and body satisfaction.

	Adjusted Association with Depression Mean (95% CI)		Adjusted Association with Obesity Mean (95% CI)	
	PHQ < 10	PHQ ≥ 10	BMI < 30	BMI ≥ 30
Moderate Physical Activity per Week	5.4 (5.3 to 5.6)	4.6 (4.1 to 5.0)	5.8 (5.5 to 6.1)	4.2 (4.0 to 4.5)
Vigorous Physical Activity per Week	3.7 (3.5 to 3.8)	2.8 (2.4 to 3.2)	4.2 (3.9 to 4.5)	2.3 (2.1 to 2.5)
Body Dissatisfaction Score	3.00 (2.95 to 3.06)	3.72 (3.55 to 3.88)	2.57 (2.46 to 2.69)	4.14 (4.07 to 4.22)
				Difference
				1.5 (1.3 to 1.8)
				1.9 (1.6 to 2.2)
				1.57 (1.46 to 1.68)