approximately twice the loss of waist circumference, waist-to-hip circumference ratio, and abdominal adipose tissue volume (subcutaneous and visceral). Participants in the severely energy-restricted intervention were also 3 times less likely to discontinue the trial compared with those in the moderately energy-restricted intervention. This is possibly because the large and rapid weight loss associated with severe energy restriction has been shown to be encouraging and because the total meal replacement diet used to achieve it is simple and convenient.[47] These striking findings were offset by an approximately 2.5-fold greater loss of total hip BMD with severe energy restriction compared with moderate energy restriction, a difference not accounted for by the greater weight loss.

In this trial, the participants in the moderate group experienced approximately 1.3% reduction in total hip BMD after 12 months, similar to the annual rate of BMD loss at the hip in the early postmenopausal years (approximately 1.0%-1.4%).[48] However, after the 12-month severe intervention, total hip BMD loss (approximately 3.3%) was 2.4 to 3.3 times higher than these annual BMD losses. Interestingly, the decrease in BMD continued over the whole 12 months of the severe intervention, even though weight loss had plateaued by 6 months. This occurred despite a dietary protein prescription of 1 g/kg of actual body weight per day in both groups[31,49] and despite the fact that the total meal replacement products used in this trial contained more than the Australian recommended dietary intake for vitamin D and calcium for women aged 51 to 70 years.[33] This loss of BMD may have been exacerbated because of the population selected for this trial (women with obesity who were ≥5 years postmenopausal). For example, in a study where men and women with obesity were prescribed a total meal replacement diet until they reached 15% weight reduction in 3 to 6 months, all participant groups exhibited significant decreases in body weight at 2 years, and both groups showed loss of BMD over 2 years, but this loss was statistically significant only among women.[50] This suggests that women may have a greater propensity to lose BMD following weight loss. Research also suggests that BMD loss may be exacerbated in postmenopausal women (as in this trial) compared with women who are still in the perimenopausal transition.[48]

The consequences of accelerated BMD loss with a severely energy-restricted dietary obesity treatment are clinically concerning, especially if BMD loss continues beyond the 12-month intervention, because it has been linked to an increased risk of osteoporosis and fragility fracture.[51,52] However, this bone loss must be considered in light of the beneficial effects of substantial weight loss on other health outcomes and health care costs. For example, although a 3% to 5% loss of initial weight has generally been accepted as being clinically significant,[11,53] recent research shows that greater weight losses, ie, of 7.7%, 10%, 15%, or 20%, dose-dependently improve health outcomes.[54-57] In addition, if treated effectively, the costs of obesity-related health complications would be significantly reduced.[2] Thus, implementing effective obesity treatments is essential to reducing obesity-related comorbidities and the associated costs. Thus, while the current trial should not discourage the use of total meal replacement diets as a treatment for obesity in postmenopausal women, further investigation is needed to determine the long-term consequences of the associated BMD loss on health outcomes such as osteoporotic fractures and to determine how BMD losses could be prevented in this population during and after these diets.

Strengths and Limitations

Strengths of this study include the 12-month randomized clinical trial design and the criterion-standard techniques used for the assessment of body composition, notably our primary outcome of lean mass. Another strength is that data variability was reduced by analysis of all data by a single researcher (ie, S.M. for DXA, A.L.W.-T. for MRI, and S.E.K. for MRS). There are, however, some limitations that must be noted, 1 of which is the technical limitation of DXA, which can only measure 2 tissue types at any time (eg, bone and soft tissue). Thus, being a 2-compartment model for the determination of body composition, a possible confounder is that the DXA analysis assumes a constant hydration of lean soft tissue, which is not always true, as hydration varies with age, sex, and disease. To help control for this, all participants were measured after an overnight fast (≥8 hours)