INCREASING CALCIUM INTAKE IN YOUNG WOMEN THROUGH GAIN-FRAMED, TARGETED MESSAGES

BY

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Abstract

The purpose of the present study was to test the effects of message framing and targeted messaging on calcium intake behaviour. Young women who were consuming less than adequate amounts of calcium attended a one-hour seminar, received two pamphlets, one sticker, and one notepad in the mail over the course of one year, all containing information about osteoporosis, bone, and how calcium intake relates to each. Using message framing and targeted messaging as the intervention, participants were randomly assigned to receive the standard care seminar and materials (control), or gain-framed targeted seminar and materials (experimental). Examination of the data revealed that the intervention had significant effects on calcium intake behaviour, and minimal effects on the health belief model (HBM) constructs. No relation was found between HBM constructs and calcium intake. Specifically, using an intent-to-treat repeated measures ANOVA, participants in the experimental condition significantly increased their calcium intake more than those in the control condition over the course of the study ($p < .01$). All HBM constructs changed over time in both conditions ($ps < .05$) except for perceived severity ($p = .89$). Self-efficacy was the only construct to improve significantly more in the experimental condition versus control ($p < .01$). The HBM predicted calcium intake only during week 25 ($p < .01$). These findings suggest that it is possible to increase young women's calcium intake consumption through gain-framed, targeted messages. Findings also have important implications for how existing osteoporosis-preventive materials can be improved.

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LITERATURE REVIEW

Osteoporosis is a debilitating disease affecting 1.4 million Canadians (Osteoporosis Society of Canada [OSC], 2001). Women in particular are at an increased risk of developing osteoporosis, with one in every four women over the age of 50 suffering from this disease (OSC, 2001). Osteoporosis is characterized by low bone mass, and those afflicted are at high risk for hip, vertebral, and wrist fractures (Murray & O'Brien, 1995). More specifically, a 50-year-old woman has a 40% chance of experiencing a fracture due to low bone mass during her remaining lifetime (Melton, Chrischilles, Cooper, Lane, & Riggs, 1992).

This statistic is especially disturbing when one considers the costs associated with fracturing a hip. An osteoporotic-related hip fracture leads to death in 20% of all cases and long-term disability in 50% of the cases (Cummings, Kelsey, Nevitt, & O'Dowd, 1985). In addition, osteoporosis is associated with decreased quality of life due to disfigurement, decreased self-esteem, mobility, and independence (Coelho, Silva, Maia, Prata, & Barros, 1999; Gold, 1996). The costs of osteoporosis also impact our public health care system. An estimated $1.3 billion was spent in 1993 on treating osteoporosis and related fractures in Canada alone (Goeree et al., 1996). With the proportion of older adults in our population continuing to rise, osteoporosis-related fracture treatment costs for the year 2018 are expected to reach $32.5 billion (National Institute of Health [NIH] Consensus Statement, 2000, 2001). Considering the severity and costs associated with this disease, it is imperative to create effective strategies to prevent osteoporosis.

Calcium Intake: A Modifiable Risk Factor for Osteoporosis

The highest bone mineral content achieved, known as peak bone mass, determines adult bone mineral density and subsequent risk for developing osteoporosis (Hansen, Overgaard, Riis, & Christiansen, 1991; Khan et al., 2001). Since little bone mineral can be added to the female skeleton after the age of 20 (Heaney, 1995; Miller & Maropis, 1998; Uusi-Rasi, Sievänen, Pasanen, Oja, & Vuori, 2002), it is crucial to gear preventive interventions towards women who have not yet reached this age. Although peak bone mass is strongly influenced by genetics (Rubin, et al., 1999; Ulrich, Georgiou, Sno-Harter, & Gillis, 1996), consuming adequate calcium is one important modifiable factor for attaining optimal peak bone mass (Ho et al., 1997; Uusi-Rasi et al., 2002). Indeed, several studies have confirmed the beneficial effect dietary calcium intake has on bone mass (Krall, Parry, Lichter, & Dawson-Hughes, 1995; Merrilees et al., 2000; Teegarden et al., 1998; Teegarden, Lyle, Proulx, Johnston, & Weaver, 1999).

Yet despite the known benefits of calcium intake on bone health, the most recent Canadian dietary survey (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000) reports that the vast majority of women between the ages of 18-34 consume less than the recommended daily intake (RDI) of calcium (Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 1999). In fact, even at the 75th percentile of current calcium intakes, young women (18-34 years) are only consuming 980 mg of calcium per day, considerably lower than the RDI of 1200mg/day for 18-year old females (Optimal Calcium Intake, National Institutes of Health Continuing Medical Education, 1995). Failure to meet the RDI for calcium is not just a Canadian issue – 85% of

American females between the ages of 12-19 also fall short of the RDI (approximately 700-950mg/day; National Institutes of Health [NIH], 1997). Calcium deficiency is obviously a widespread problem for young women in North America. To rectify this nutritional imbalance, we must first understand why this population is not consuming appropriate amounts of calcium.

Why Don't Young Women Consume Enough Calcium?

There is evidence to suggest that calcium intake is related to weight and appearance concerns. According to a cross-sectional survey of young women, concerns with appearance have a somewhat stronger effect on eating habits than do concerns with health (Hayes & Ross, 1987). In young women, appearance concerns are almost always about looking fat (Fabian & Thompson, 1989; Gruber, Pope, Lalonde, & Hudson, 2001). A more recent survey indicated that half of the study sample (293 females between the ages of 14 to 19) was both trying to lose weight and skipping one meal per day, and only consuming 450 milligrams of calcium per day (Ali & Siktberg, 2001). Although it was a cross-sectional study, the strongest predictors of calcium intake were skipping meals, perceived barriers to calcium intake, and trying to lose weight (Ali & Siktberg, 2001). Another study reported that low consumption of calcium in college women was associated with skipping meals and perceiving themselves to be overweight (Ali, 1996). The association between weight-loss attempts and low calcium intake may be explained by young women's perceptions of calcium-rich foods as fattening (Georgiou, Betts, Hoos, & Glenn, 1996; Horwath, Parnell, Wilson, & Russell, 2001; Sobal & Cassidy, 1990). Taken together, these findings suggest that concerns about being overweight are associated with decreased calcium consumption. Unfortunately, one weight-loss strategy used by these women is avoiding calcium-rich foods.

Young female university students may be at a particularly high risk for not consuming adequate amounts of calcium. It is disturbing to note that approximately 80% of Canadian university women are dissatisfied with their bodies, and many are consequently practicing dietary restraint (Page, 1991). Indeed, nutritional adequacy and frequency of meals has been shown to decline with decreased satisfaction with weight (Koszewski & Kuo, 1996). Considering calcium intake declines with increasing weight concerns, the majority of young female university students may not be consuming adequate amounts of calcium. Furthermore, young female university students who are on restrictive diets have been shown to have lower total body bone mineral content than women who are not on restrictive diets. This is of concern because total bone mineral content is the primary predictor of osteoporosis (McLean, Barr, & Prior, 2001).

In addition to deliberately reducing consumption of calcium-rich foods as a weight-loss strategy, female university students may also be at greater risk for calcium deficiency because of lifestyle changes. Most freshman university female students are, for the first time, living on their own and making all of their own food choices (Huang, Hoerr, & Song, 1997; Marietta, Welshimer, & Long Anderson, 1999). During this transition phase of moving away from home, first-year students may also have to adapt to an unfamiliar environment, increased workload, financial restrictions, limited food preparation skills, restricted food storage and cooking facilities, and difficulties with time management

(Betts, Amos, Keim, Peters, & Stewart, 1997; McArthur, Grady, Rosenberg, & Howard, 2000). These new stressors, combined with the convenience of snack foods and the availability of less than nutritious cafeteria foods, may make it particularly challenging to consume adequate amounts of calcium.

Regrettably, it is often in these first years of living independently that lifelong eating patterns are established (Hendricks & Herbold, 1998; Marietta et al., 1999). Therefore, it is particularly important to target calcium interventions to university women at this age, not only to assure adequate calcium consumption during bone accrual years, but also to help them establish a habit of consuming the RDI of calcium. The epidemic proportion of women suffering from osteoporosis has initiated research on osteoporosis prevention. A general overview of the characteristics of this research follows.

General Characteristics of Osteoporosis Prevention Studies

Of the studies that have focused on osteoporosis prevention, the samples have been predominantly female. Considering women are twice as likely to develop osteoporosis, this is to be expected (OSC, 2001). Furthermore, young adolescents to college-aged women are most often studied in prevention-based studies (Ali, 1996; Ali & Siktberg, 2001; Ievers-Landis, et al., 2003; Piseau, Schepp, & Belza, 2002; Sedlak, Doheny, & Jones, 2000; Taggart & Connor, 1995; Wallace, 2002; Wurtele, 1988). Again, this is to be expected in studies attempting to prevent rather than treat osteoporosis.

With respect to study design, the majority of osteoporosis-related preventive studies have assessed correlates of calcium intake through cross-sectional surveys (Ali, 1996; Ali & Bennet, 1992; Ali & Siktberg, 2001; Ali & Twibell, 1995; Blalock, et al., 1996; Carlsson & Johnson, 2004; Ievers-Landis, et al., 2003; Taggart & Connor, 1995; Turner, Hunt, Kendrick, & Eddy, 1999; Wallace, 2002). Variables measured have ranged from body dissatisfaction (Ali, 1996) to knowledge about osteoporosis (Carlsson & Johnson, 2004; Ievers-Landis et al., 2003), but have primarily focused on the constructs of the health belief model (Rosenstock, 1974 [HBM]; Ali & Bennet, 1992; Ali & Siktberg, 2001; Taggart & Connor, 1995; Wallace, 2002). A description of the HBM, and results from cross-sectional studies that have measured constructs of the HBM, will be discussed in the following section.

The Health Belief Model: What is it and Why is it Used So Frequently?

The HBM model was first designed to help researchers understand why Americans were not making use of free Tuberculosis screening programs. Rosenstock (1974) hypothesized that individuals choose whether they will take action concerning a health condition based on perceived threat of the disease (operationalized by perceived severity and perceived susceptibility of the negative health outcome), as well as perceived effectiveness (perceived benefits) and perceived negative consequences (perceived barriers) of performing actions to reduce the threat of the illness. The HBM was therefore derived to explain and predict health actions performed (e.g., getting screened for Tuberculosis) in order to avoid a negative health consequence (e.g., Tuberculosis).

Because this model was designed for prediction of protective/preventive health behaviours, it is one of the most frequently used models in prevention studies (Janz &

Becker, 1984). A meta-analysis of the effectiveness of the HBM to predict preventive behaviours concluded that it is one of the best, if not the best, predictive models of preventive health behaviours (Janz & Becker, 1984, pg. 41). The model's predictive ability improved substantially with the addition of self-efficacy. Self-efficacy, borrowed from social cognitive theory (Bandura, 1986), was added to the HBM in 1988 (Rosenstock, Strecher, & Becker, 1988). In the context of predicting whether one performs a preventive health action, self-efficacy can be defined as confidence in one's ability to perform the specific health action required.

The five constructs of the HBM - self-efficacy, perceived severity, susceptibility, benefits, and barriers - have each been reported to be correlated with calcium intake (Ali, 1996; Ali & Twibell, 1995; Carlsson & Johnson, 2004; Ievers-Landis et al., 2003; Taggart & Connor, 1995). As a result of the significant relationships found in cross-sectional studies between cognitions assessed by the HBM and calcium intake, several researchers have suggested using the HBM as the framework for osteoporosis prevention interventions. For example, Carlsson and Johnson (2004) recommended developing interventions to change perceived susceptibility to osteoporosis. Developing interventions that increase self-efficacy has also been recommended due to the high correlation between self-efficacy for consuming calcium-rich foods and calcium intake (Ievers-Landis et al., 2003). To explain more of the variance in calcium intake, Ievers-Landis and colleagues (2003) also suggested targeting perceived benefits and barriers. Although there are far more cross-sectional studies than intervention studies in the osteoporosis prevention literature, most of these interventions have incorporated constructs of the HBM. An overview of these intervention studies follows.

Educational Interventions Using the Health Belief Model

To date, literally all osteoporosis preventive studies have used educational interventions of some sort (Blalock et al., 2002; Jamal et al., 1999; Piseau et al., 2002; Smith Klohn & Rogers, 1991). Indeed, the National Institute of Health's (NIH) consensus statement on osteoporosis strongly recommended that researchers determine the most effective method to *educate* health professionals and the public about how to prevent osteoporosis (NIH, 2000, 2001). The recommendation to use education as a way to target changes in calcium intake is based on the assumption that women at risk for osteoporosis are not aware of the relationship between calcium intake and osteoporosis, but this has yet to be empirically proven.

Why use educational interventions?

Educational interventions, as compared to individual or group counselling, are ideal for several reasons. First, the cost of disseminating information through printed materials and audio-visual devices such as videos is much cheaper than one-on-one or group counselling, and yet just as effective at increasing knowledge (Sedlak et al., 2000) and changing calcium intake (Cox, White, & Gaylord, 2003). Second, educational interventions are typically not labour-intensive. In contrast, interventions that rely on credible practitioners (e.g., nurses, doctors, primary researcher) to council participants are very labour-intense, and thus are not realistic in most communities. Third, as opposed to

counselling or group interventions, educational interventions can reach many people simultaneously. This is particularly advantageous considering the vast majority of young women who are not consuming adequate amounts of calcium who would benefit from interventions. A further advantage of using an educational intervention to increase calcium intake is that it can be tailored to the tenets of the HBM. It seems logical that learning about the susceptibility and severity of osteoporosis, as well as the benefits and barriers associated with consuming calcium-rich foods would influence consumption of the recommended amount of calcium. The many benefits of educational interventions have made it the preferred choice of intervention for many research studies.

Review of Effects of Osteoporosis and Calcium Education Interventions on HBM Constructs and Calcium Intake.

Examination of past research limitations and failures helps researchers to design and implement more effective preventive interventions in the future. It has been suggested that preventive interventions be evaluated by assessing the prospective change in OP-preventive intentions and behaviours, with an emphasis on longitudinal change (Turner et al., 2003). Although some osteoporosis interventions have focused on both calcium intake and physical activity, this paper will only review the calcium intake findings of studies.

In a study assessing the effectiveness of educational essays on perceived severity and intentions to increase calcium intake, female college students between the ages of 16 and 25 were randomized to treatment control, nontreatment control, or one of six experimental conditions (Smith Klohn & Rogers, 1991). Participants in the treatment control condition read a general essay on osteoporosis prevention. In the experimental conditions, this general essay was manipulated to emphasize certain aspects of osteoporosis: very/not at all disfiguring (hi/low visibility), fast/slow onset of symptoms (hi/low rate of onset), or late/early onset of disease in life (hi/low onset). Participants in the very disfiguring condition had the greatest increase in perceived severity and intentions to consume adequate amounts of calcium. The effects of the general or experimental essays on other constructs of the HBM and actual calcium intake behaviour were not tested.

Educational essays were also used in a similarly designed study (Wurtele, 1988). Female college students between the ages of 17 and 26 read either a general osteoporosis prevention essay (control), hi/low vulnerability essay (general essay plus messages about susceptibility to osteoporosis), or hi/low response efficacy essay (general essay plus messages about effectiveness of consuming calcium on bones). As expected, perceived susceptibility increased in participants who read the essay with messages of high vulnerability, while response efficacy increased in those that read the essay with messages of high response efficacy. Self-efficacy to perform osteoporosis preventive behaviours and severity were only measured at baseline, and perceived benefits and barriers were not measured at all, so it is unknown whether the information in the essays lead to changes in these other HBM cognitions. However, both intentions and calcium intake behaviour were assessed in this study; participants in the high vulnerability

condition had significant increases in intention and calcium intake as compared to participants who read only the general informational essay. The validity of the calcium intake measures used in this study are questionable, however. Participants were simply asked whether their intake of calcium-rich foods increased, decreased, or did not change, and whether they had started to take calcium supplements on a daily basis. Such a general measure does not accurately quantify changes in behaviour.

Taken together, these educational essay study results suggest that including more than just general osteoporosis information in written materials may lead to changes in cognitions captured in the HBM and improved calcium intake. But, because neither Smith Klohn and Rogers (1991) nor Wurtele (1988) assessed all HBM constructs or used a sensitive measure of calcium intake, we cannot conclude relationships exist between educational interventions, HBM and behaviour. Future research in this area should ensure that all constructs of the HBM are tested, and that the outcome behaviour (calcium intake) is monitored using accurate, sensitive measures.

Now that studies using HBM constructs as outcome variables have been examined, research that has tested the HBM as a mediator for calcium intake behaviour will be reviewed. Only one study was identified that addressed the possibility of HBM variables mediating the effects of an educational intervention on actual calcium intake behaviour. In a recent study assessing the impact of osteoporosis educational materials, Piaseu, Schepp, and Belza (2002) reported that all HBM variables combined, mediated the relationship between knowledge and calcium intake in Thai female college students (age was 17-21 years). While the researchers made a logical case for why increased knowledge about how to prevent OP may increase one's self-efficacy to perform the appropriate preventive behaviours and change the constructs of the original HBM, there are major limitations to the statistical analyses used to conclude these "causal," mediated associations.

First, the predictors and outcome variables used in their regressions were all measured concurrently. In order for a variable to truly predict the outcome variable, measurements must be made prospectively (Baron & Kenny, 1986). Second, according to Baron and Kenny (1986), the predictor variable (i.e., knowledge) must significantly predict the outcome variable (i.e., calcium intake). Pisaeu et al. failed to report a significant beta weight for the regression of calcium intake on knowledge. Finally, a close analysis of the proposed mediation of calcium intake by HBM, showed that the HBM constructs did not directly predict calcium intake, another criterion needed to support true mediation (Baron & Kenny, 1986). With respect to measurement tools, a three-day food record was used to assess calcium intake. Unfortunately, the researchers did not report any data on calcium intake at either pre or post intervention, thus we are not aware if the educational intervention led to any changes in dietary behaviour at all. Nevertheless, although this Thai study may have statistical flaws, the finding that the HBM was not a significant predictor of behaviour is noteworthy. The researchers suggested that the HBM was a poor predictor of osteoporosis preventive behaviour because the attitudes and beliefs of Thai women may be different from the attitudes and beliefs of people for whom the HBM was designed for (i.e., Americans). It is also possible that the intervention slide presentation and pamphlet were based on the benefits

and barriers of consuming dairy products – items that Thai women do not consume. In sum, the only study that has assessed the HBM as a mediator for calcium intake behaviour was flawed with statistical, intervention, and measurement shortcomings.

The last type of osteoporosis preventive intervention studies to be examined are ones that focus specifically on calcium intake as the outcome variable. To examine whether intervention intensity impacts the effectiveness of an osteoporosis education program in changing calcium intake, Sedlak, Doheny, and Jones (2000) designed and tested the effects of three different programs - intense, intermediate, and brief - all with the same general osteoporosis prevention information derived from the National Osteoporosis Foundation (NOF). The researchers' rationale for the different study conditions was that public education programs are generic and do not account for individual differences in terms of readiness to learn, thus compromising the programs' impact. Participants in the "intense" program attended one educational session per week for three weeks and completed food and exercise diaries, those in the "intermediate" program attended one 3-hour educational session, and those in the "brief" program attended one 45-minute education session. The outcome variables assessed were osteoporosis knowledge, health beliefs (assessed all HBM constructs but self-efficacy), and calcium intake (via self-report of how much milk and yoghurt were consumed). While all participants increased their knowledge about osteoporosis, no group reported increased calcium consumption. Of the HBM constructs measured, only perceived benefits of calcium increased, and only for those in the intermediate program.

Serious methodological flaws in Sedlak et al.'s study included a lack of a control group, and failure to randomize participants to the experimental condition. College-aged women comprised the intense program (no age range given), a community group of women between the ages of 22-83 comprised the intermediate program, and those in the brief program were nurses between the ages of 35 and 45. Because of these flaws, it is impossible to conclude whether calcium intake behaviour did not change because the education was ineffective, or because the intervention intensity was inappropriate for a particular population (e.g., college-aged women may have responded more favourably to the succinct 45-minute lecture with no "homework" than three sessions spanned over 3 weeks). It is also possible that there were in fact changes in calcium intake, just not through milk or yoghurt consumption. To our knowledge, the above four studies are the only osteoporosis-preventive intervention studies that were conducted and evaluated using the HBM as a framework. With respect to the criteria set out to examine interventions, the above studies failed to report valid, prospective changes in calcium intake behaviour.

The biggest drawback of educational interventions is that, unfortunately, simply giving individuals knowledge about the appropriate health preventive behaviour(s) to perform does not ensure they will change their behaviour (Ali & Bennett, 1992; Taggart & Connor, 1995; Taubes, 1996; Waller et al., 2002). Indeed, it has been stated that "Knowledge alone is not enough to effect behaviour change" (Piaseu et al., 2002, p. 373). There are, however, other educational interventional studies that we can learn from that have not used the HBM as a framework. As will be apparent in the following section, these studies produced changes in calcium intake behaviour without the use of a theory

(i.e., were atheoretical). The following section reviews these atheoretical educational interventions that have used risk factor appraisals.

Review of Effects of Risk Factor Appraisal, Educational Interventions on Calcium Intake

Educational interventions have also been combined with other types of motivating tools, such as risk-factor screening assessments. In one study, a sample of 80 premenopausal women (mean age was 21 years) underwent bone density testing at baseline, 3, and 6 months (Peterson, Klesges, Kaufman, Cooper, & Vukadinovich, 2000). Those assigned to the experimental condition also attended three educational sessions and received a 3-month supply of calcium supplements at each follow-up assessment. In addition to the general information taught about osteoporosis in the educational sessions, participants were given suggestions of low-fat and nondairy calcium-rich foods, a small bottle of calcium supplements, and one-on-one counselling whereby the health educator counted the number of supplements left in the participant's bottle and brainstormed how to overcome any barriers the participant had with regard to taking the supplements. Each participant was informed of both conditions' protocol at the beginning of the study, as well as the study's purpose; thus, participants knew whether they were assigned to the experimental or control condition.

There was a 34% dropout rate, with dropouts having a significantly lower baseline calcium intake than those who completed the study. Of the women who completed the study, both conditions significantly increased their dietary calcium intake. Participants in the experimental condition increased their amount of supplemental calcium intake significantly more than those in the control condition. While this study managed to increase the amount of calcium consumed in a sample of women, it is difficult to generalize these results to the general population. Unlike typical life conditions, those in the experimental condition were given free supplements and were carefully monitored (i.e., individual attention was given to count the number of pills the participant had left). Improvements in the control condition were probably due (at least in part) to the Hawthorne effect; the impact of knowing the study purpose, having bone scans every 3 months, and reporting one's calcium intake, likely impacted what the women ate. Unfortunately, closely monitoring diets on an individual level and providing free bone scans and calcium supplements is too costly of an intervention to implement at a public health level. The long-term impact of the intervention is also questionable considering the work by Lee, Leung, Leung, and Cheng (1996), who found that after free supplementation ceased in an experimental condition of adolescent girls, the statistically significant improvement in calcium intake *and* bone density dropped back to the levels found in a control condition.

Jamal and colleagues (1999) also found that providing bone scans plus osteoporosis information lead to increases in self-reported calcium intake. Specifically, 669 premenopausal women (mean age was 28 years) received an educational package that included pamphlets from the Osteoporosis Society of Canada (OSC) about the RDI of calcium, risk factors, prevention and treatments for osteoporosis, and they were mailed the results of their bone scan. The researchers made note that one-on-one attention was

provided to review and tailor the educational package to each participant, such that information met "individual needs" (p. 2144).

One year later, participants were more likely to use a calcium supplement and drink at least one glass of milk per day than they were at baseline. This statistically significant result must be interpreted with caution, however, as there was no control condition, and the measurement of calcium intake was very general (i.e., brief food frequency questionnaire). Similar to Peterson et al.s' study, it is impossible to determine whether it was the bone scan, the individualized attention, or the educational materials that resulted in self-reported improvements in calcium intake. Again, providing free bone density tests for all young women is currently not a realistic intervention in Canada.

The most recent osteoporosis intervention also included bone density testing (Turner, Wallace, Hunt, & Gray, 2003). Middle-aged women (mean age was 49.5 years) who volunteered to be part of an osteoporosis prevention program underwent four educational classes, a bone density scan, and an individual consultation (no details were provided on what this entailed). In addition to the general osteoporosis information provided in the education classes, participants were taught how to select low-fat dairy products and were given specific information about the calorie, fat, and calcium contents of dairy products, a sample grocery list, and calcium-rich recipes. Results suggested that the intervention was successful; more participants reported consuming one or more servings of milk, yoghurt, and cheese per day after the intervention than at baseline.

Although promising, Turner and colleagues' (2003) findings are limited to within-group changes, as no control group was used. This design also makes it impossible to partition out the effects of having a bone scan, attending educational classes, and having an individual consultation. In addition, the sample used was highly biased, as participants were self-motivated enough to join an osteoporosis preventive program. Finally, because the measurement of calcium intake did not assess milligrams of calcium consumed per day, we do not know if the changes reported are clinically significant (i.e., did they increase their intake to meet the RDI for calcium?). The researchers advised future interventions be designed to assess actual change in calcium for at least one year, and to have a control group.

To date, the osteoporosis educational and risk factor intervention literature has reported improvements in calcium intake, but not without some major methodological flaws and poor external validity. The studies described thus far leave us wondering whether calcium intake could be improved when expensive screening tests (i.e., bone density scans) and labour-intensive one-on-one counselling are not available. A program that effectively increases calcium intake *and* is economical has great potential to improve the health of many women. As stated earlier, the benefits of using an educational intervention are its low cost, ability to reach a large number of people at once, and relatively low labour requirement. Educational interventions may also be designed based on a theory or model, a point often overlooked in many studies, but in fact crucial if we are to understand what motivates individuals to perform preventive behaviours.

In summary, interventions designed to prevent osteoporosis have either been atheoretical or based on the HBM. While the cognitions assessed by the HBM appear to be related to calcium intake behaviour, there is not yet sufficient evidence to ascertain the

precise nature of this relationship (i.e., predictor or mediator). The atheoretical studies have used educational interventions of some kind plus a risk factor appraisal to encourage women to consume more calcium. Unfortunately, it is difficult to interpret and implement results from these studies due to poor experimental design and the lack of a theoretical framework. A research intervention designed without theory tells the scientific community little about the mechanisms behind the process being studied, and cannot provide future directions for research other than to replicate the same protocol in varying populations.

What is currently missing from the osteoporosis prevention literature are innovative ideas on how to change young women's calcium intake behaviour. These new ideas could be captured in theories not previously applied to this domain of research. Two potential approaches that have yet to be used in osteoporosis prevention interventions are message-framing and message targeting. The value of each of these approaches to improving calcium intake in young women will be examined separately in the following sections.

Message Framing

According to prospect theory (Kahneman & Tversky, 1979), the framing of information influences one's choices, preferences, attitudes, and behaviours (Rothman, Salovey, Antone, Keough, & Drake Martin, 1993). Messages or other information provided in educational interventions can be phrased in either a gain- or loss-framed manner. For instance, "Consuming adequate amounts of calcium each day can help prevent osteoporosis" and "Failing to consume adequate amounts of calcium each day can lead to osteoporosis" both relay the same information, but the former emphasizes the *benefits* of performing the behaviour, whereas the latter emphasizes the *costs* of not performing the behaviour. Messages emphasizing the benefits, or potential gains associated with performing a specific behaviour, are considered gain-framed, whereas messages emphasizing the costs of not performing a behaviour are considered loss-framed. The decision to phrase messages in a gain or loss-framed manner depends on the type of behaviour being promoted and specifically, whether it is a high or low risk behaviour.

Health behaviours can be generally categorized as actions that either prevent, detect, or treat illness (Rothman & Salovey, 1997). Preventive behaviours are classified as low risk because they provide a relatively certain, desirable outcome (i.e., wearing sunscreen prevents one from getting skin cancer). When attempting to increase the performance of low-risk behaviours, gain-framed messages are recommended because people are more likely to perform a preventive behaviour when informed about the *benefits* of that behaviour than when told about the *costs of not* performing that behaviour (Tversky & Kahneman, 1981). Therefore, in relation to a health preventive behaviour such as consuming the RDI of calcium, people may be willing to accept the risks of not consuming enough calcium when informed about the costs of a calcium-deficient diet, but they should be more likely to try and attain adequate amounts of calcium when informed about what they stand to gain from doing so. Indeed, empirical evidence has shown that emphasizing the benefits associated with a preventive behaviour is more

effective for changing behaviour than emphasizing what stands to be lost by not performing the low-risk behaviour (Rothman & Salovey, 1997; Rothman et al., 1993). To test the effects of message framing on preventive behaviours, researchers have manipulated information in educational materials. To date, no study has assessed whether phrasing pre-existing educational messages in a gain-framed manner is a plausible way to promote changes in dietary intake. As a result, the following review of gain-framed health interventions will examine the effects of framing on a variety of health preventive behaviours other than dietary behaviours.

Results of Gain-framed Interventions on Health Preventive Behaviours

Two studies were found that assessed the effects of gain-framed messages on exercise as a health-preventive behaviour. In a study attempting to increase intentions to exercise among sedentary college-aged women, Robberson and Rogers (1988) used informational essays on exercise as the means to manipulate messages. Messages were gain- or loss-framed with respect to self-esteem consequences, or gain- or loss-framed with respect to health consequences. Both gain-framed conditions produced significantly stronger intentions to exercise than the loss-framed conditions. The proposed mechanisms for differences between conditions were constructs captured by protection motivation theory, which has similar constructs to the HBM (perceived vulnerability/susceptibility, perceived severity, self-efficacy, and response efficacy). Only perceived severity differed between gain and loss-framed conditions, with those reading the loss-framed health essay perceiving the consequences of not exercising as more severe than those who read the gain-framed health essay.

In a study that actually measured behaviour, cardiac patients who read 10 gain-framed messages attended significantly more exercise sessions than those in the control condition (McCall & Martin Ginis, in press). Although not statistically significant, those in the gain-framed condition attended 12.5% more classes than the controls, while those in the loss-framed condition attended only 4% more classes than the controls. Given the small sample size and underpowered design, the authors suggested that significant differences between conditions would have been found had there been a larger sample. The HBM was the proposed mechanism of influence in this study. Although differences existed between conditions on perceived susceptibility (control condition felt less susceptible than both framed conditions) and perceived barriers (loss-framed perceived more barriers than either control or gain-framed conditions), the model did not mediate differences in exercise behaviour.

Another health preventive behaviour, use of appropriate SPF sunscreen protection, has also been shown to be influenced by gain-framed messages (Rothman et al., 1993, Experiment 2). College students read an educational pamphlet on skin cancer and prevention that contained either gain or loss-framed messages. Women who read the gain-framed pamphlet were significantly more likely to request sunscreen with the appropriate SPF (a measure of intention) than women who read the loss-framed pamphlet. No tests of mediation were performed in this study.

Taken together, these results suggest that framing health preventive information in terms of what can be gained by performing the behaviour increases intentions

(Robberson & Rogers, 1988) and actual performance of that behaviour (McCall & Martin Ginis, in press, Rothman et al., 1993). Still, with no empirical evidence of prospect theory being tested in dietary preventive behaviours, and a large majority of our sample population (young women in university) avoiding the very products we are trying to promote (calcium-rich foods), it is not known if gain-framed messages would be as effective in a dietary osteoporosis preventive intervention as the studies described here. Conversely, ensuring adequate amounts of calcium is consumed each day to avoid illness is very similar as the preventive act of ensuring adequate amounts of physical activity are performed each day to avoid illness. Given how effective gain-framed messages have been on other preventive behaviours such as exercise, a message-framing intervention to increase calcium intake seems promising. Furthermore, if we are to use gain-framed messages in an educational intervention to increase calcium intake in young women, targeting these messages and other general osteoporosis information to the intended audience may capture their attention, thus maximizing the effectiveness of the intervention. This possibility is explored in the next section.

Targeting Messages

Dietetic researchers have sometimes turned to the principles of consumer advertising in order to induce changes in food selections. Point-of-purchase (POP) interventions use marketing schemes that attempt to catch the attention of consumers while they are deciding what foods to buy (Zifferblatt, Wilbur, & Pinsky, 1980). Similar to advertising, POP interventions assume that a customer's choice can be easily persuaded by reminders of what the advertised product has to offer. Using large signs at cafeteria entrances (Buscher, Martin, & Crocker, 2001), labelling specific nutritional information on food products (Davis & Rogers, 1982), giving out collector cards (Zifferblatt et al., 1980), and providing monetary tokens when "healthy" foods are purchased (Cinciripini, 1984), are all POP interventions that have been used to increase the consumption of nutritious foods, and all have been somewhat successful. Unfortunately, the above-mentioned tactics are not realistic options outside of cafeterias, where these studies have taken place. In order to instil long-lasting behavioural change, the individual must not need to be prompted by flashy signs or rewards. Instead, the ideal intervention would change the individual's cognitions so that she is personally motivated to make the right dietary choices irrespective of locale. Yet despite not being very generalizable to daily life, POP intervention studies can teach us valuable information about what types of messages most influence young women.

An explicit demonstration of what young, university students respond to, is seen in Cinciripini's study (1984). In a university cafeteria, the effects of three different 8-week POP interventions were compared: caloric feedback (signs listed caloric content of all foods on daily menu), labelling (food items low in fat and calories but high in nutrients were labelled with a green triangle), and tokens (monetary rebate for every 10 "green triangle" foods purchased). Giving students caloric feedback decreased consumption of regular dairy products without increasing the intake of low-fat dairy. This reduction did not persist once the signs were removed. Labelling foods increased consumption of low-fat dairy in those classified as obese, but this change did not persist once the labelling

intervention ceased, and those classified as thin or normal did not increase their dairy intake. The token system produced the greatest and most sustainable change. These results suggest that giving nutritional information is less important for this population than saving money.

Further evidence that nutritional information is unimportant to university students was found in a study attempting to shift milk selection to the lower-fat varieties. Davis and Rogers (1982) compared the impact of nutrition information only (calories, cholesterol, fat content) to nutrition information plus a sign that also listed recommendations on how to change food selections (no examples were reported). Those in the dormitory cafeteria that provided both nutrition information and recommendations increased their fat free milk consumption significantly more than those in the dormitory cafeteria that only received nutrition information.

Perhaps the most direct way of determining what factors influence young women most when making food choices is to ask them. Focus groups with young women have consistently reported the same influential factors: weight control, energy content, hunger and food cravings, time considerations, convenience, and general benefits of food (Betts et al., 1997; Glanz, Basil, Goldberg, & Snyder, 1998; Neumark-Sztainer, Story, Perry, & Casey, 1999). Based on these results, Buscher, Martin and Crocker (2001) developed POP messages highlighting four specific food properties: Budget-friendly, Energizing, Sensory satisfaction/taste, and Time/convenience (BEST properties). Signs with BEST statements (e.g., "Need a sweet, fast energy boost? Get long-lasting energy and tons of flavor by grabbing a yoghurt") were posted in a university cafeteria for two weeks to promote yoghurt consumption (Study 2). This intervention resulted in a significant increase in calcium-rich yoghurt purchases by 97%. Unlike the studies mentioned above, the increase in yoghurt was sustained for several weeks after the signs were removed. Results from Buscher et al.'s study suggest that targeting those specific aspects of foods that have been shown to influence young women's food choices can have a significant impact on their food purchases.

Overall, it appears that simply listing nutritional information is not an effective way to increase consumption of calcium-rich products. Highlighting factors deemed important to young women's food selection, however, can persuade them to purchase calcium-rich foods. The Osteoporosis Society of Canada's preventive materials focus on amounts of calcium in foods (i.e., nutritional content), and long-term *health consequences* of osteoporosis (e.g., bone loss). Based on the current review, it appears that young women are not motivated to change dietary behaviours by this type of nutritional information. Furthermore, with regards to the impact of stating long-term health consequences of osteoporosis, recall that Smith Klohn and Rogers (1991) found that messages pertaining to the physically disfiguring consequences of osteoporosis increased participant's intentions to consume calcium, but general osteoporosis information describing long-term health consequences of osteoporosis did not. These findings are consistent with the literature cited previously on young women's motives for engaging in health promoting behaviours – this population is more motivated to perform health preventive behaviours for non-health benefits (e.g., losing weight) than for health ones (e.g., maintaining bone

density) (Ali, 1996; Ali & Siktberg, 2001; Georgiou et al., 1996; Hayes & Ross, 1987; Page, 1991).

The Current Study

New interventions should be designed based on previous successes, with amendments made to flaws. The present study proposes to combine the successes of gain-framed messages and targeted messages with the cost-effectiveness of educational interventions, using the HBM as a framework for mediation. Although the HBM has failed to act as a mediator previously, the educational materials used may have failed to produce changes in the HBM constructs because they were not targeted towards the study population. The present study addresses this problem by targeting intervention materials to young women. Although previous research has hinted that public osteoporosis campaigns would be more effective if they were targeted towards subpopulations (Carlsson & Johnson, 2004), this possibility has not been assessed. This is important because the existing public health osteoporosis prevention materials deliver general information about osteoporosis, risk factors, and the calcium RDI for all age groups (OSC, 2001). As has been demonstrated through this literature review, this information is probably of little relevance to young women. Considering focus-group research has delineated some of the most important factors influencing young women's food choices, and given what we know about young women's overarching concerns about physical appearance, an osteoporosis prevention intervention that targets these issues through gain-framed messages seemed particularly promising approach for increasing calcium intake.

Study Purpose

A substantial amount of money has been devoted to developing osteoporosis prevention materials. The Osteoporosis Society of Canada currently has a slide presentation, website, booklets and pamphlets designed to educate Canadians of all ages about the risk factors of osteoporosis. The purpose of the present study was to compare the effectiveness of these standard osteoporosis educational materials versus gain-framed, targeted materials, at changing HBM constructs and increasing calcium intake in young women. This was addressed by conducting a 1-year, prospective randomized controlled trial. HBM variables were assessed five times throughout the year, and calcium intake was assessed four times.

Study Hypotheses

There were four hypotheses for the present study. It was predicted that:

1. Participants who receive an intervention consisting of gain-framed, targeted messages (experimental condition) will have higher calcium intake than participants who receive standard intervention materials (control condition).
2. The experimental condition will have greater changes in every HBM construct than the control condition.
3. The Health Belief Model (HBM) constructs will predict calcium intake.
4. Changes in calcium intake will be mediated by the HBM constructs.

Method

Participants

The required sample size was calculated based on the degree of change expected in bone mineral density, as this variable was expected to change the least. Using previous data from a study examining bone mineral density changes in 15-19 year old females after supplementation with fortified dairy products (Merrilees et al., 2000), sample size was calculated using an alpha level of .05 and beta of .20; N/group = $2[(Zalpha + Zbeta) \bullet (SD/difference)]^2$. This calculation yielded 51 participants per group. In accordance with the typical drop out rate reported in dietary interventions (Merrilees et al., 2000; Uusi-Rasi et al., 2002), a drop rate of $\leq 33\%$ was budgeted. Thus, it was estimated that recruitment of 70 women per group would provide sufficient statistical power to detect changes in bone mineral density.

One hundred and thirty-three (N = 133) female university students volunteered to participate in this study. Eligibility criteria included: absence of any hormone or eating disorder that could affect bone health, currently 18 or 19 years of age, living in university residence, and consuming less than the recommended dietary intake of calcium (RDI; 1200mg/day) as reported in a calcium food frequency questionnaire (see appendix B).

Women aged 18-19 were targeted for this study for three reasons. First, research suggests that women of this age group decrease their consumption of dairy products to below the recommended level in an attempt to lose weight. Thus, women of this age in particular need to be educated about the importance of calcium in their diet. Second, dietary habits are typically set in young adulthood, when young people begin making their own meal choices. It was hoped that, by targeting young women in their first year away from home, we could instil healthy food habits regarding calcium consumption. Third, women can only accrue bone until their early twenties, after which time, bone density decreases gradually each year. Considering the incidence of OP in women, it is crucial for young women to elevate their bone density as much as possible before the inevitable decline begins.

We recruited only women living in residence to minimize potential differences in access to food and control over food preparation that may emerge among women living in private homes. In addition, we were better able to estimate the calcium content of cafeteria foods than home-cooked foods. The latter would have greater variability in ingredients, brands, and varying portion sizes.

All women were recruited during a campus club fair on campus in the first week of September. Interested women who were living in residence and aged 18-19 were encouraged to fill out a calcium food frequency questionnaire, based on what they ate the previous day (see Appendix B). They also completed a ballot to win a university sweatshirt. All women who consumed less than 1200mg of calcium were called using the contact information given on the ballot, and were asked if they would like to participate in a study lasting one year. The protocol and remuneration amount were outlined at this time. Out of 290 eligible women who were contacted, 133 were willing to participate, scheduled their first appointment time, and attended baseline testing.

Measures

Demographic questionnaire. The baseline demographic questionnaire (Appendix B) assessed several descriptive information and lifestyle factors associated with bone density. Descriptive information included contact information, ethnicity, visits to doctors (dietician, family physician, fracture clinic, or orthopaedist) in the past year, location of any previously fractured bones as well as age at fracture, family history of osteoporosis and/or related symptoms, thyroid disease, or kidney stones, age of menarche, frequency of menstrual periods, occurrence of pregnancy, medication and supplement history, and history of any of the following problems: parathyroid, thyroid, kidney stones, osteopenia, eating disorders, and/or osteoporosis. Lifestyle factors included physical activity, dairy sensitivities, milk consumption during childhood, vegan or vegetarian diet, alcohol, caffeine, and smoking behaviours, and recent weight changes. These characteristics were collected for descriptive purposes, and also so that they could be used as potential covariates in statistical analyses.

Three-day food log. For an accurate measure of calcium intake, participants were asked to record everything they ate and drank on three-day food logs. To account for the differing eating and drinking habits throughout the week, two weekdays and one weekend day were to be reported. Often considered the gold standard of dietary analysis, this measure has shown to be valid and reliable (Thompson, Byers, & Kohlmeier, 1994). The quantity and brand of all food and drink reported were subsequently entered into a Canadian dietary analysis program (Nutritionist Five, Version 5). Mean calcium intake for each food log was used in the data analysis.

Health Belief Model Constructs (Rosenstock, 1974). The health belief model constructs measures were modified from Kim, Horan, and Gendler's (1991) osteoporosis health belief scale and piloted in a sample of university students (Martin Ginis & Jung, 2002). The following five cognitions were assessed in five separate questionnaires. All measures are displayed in Appendix C.

Perceived barriers. The perceived barriers measure assessed individuals' level of agreement with six barrier statements. Participants indicated how much they agreed that fat content, cost, and convenience are barriers to consuming both dairy and non-dairy calcium-rich foods using a 5-point likert scale ranging from 1 (strongly agree) to (strongly disagree). Possible scores ranged from 6 to 30. Each item was preceded by the statement "To what extent do you agree with each of these statements?" A sample item is: "Campus food markets do not sell the calcium-rich dairy foods I like." A table listing examples of calcium-rich dairy and non-dairy foods was centred at the top of the questionnaire so that participants could make honest responses as to whether they felt there were barriers to consuming such foods.

Perceived benefits. The perceived benefits measure assessed individuals' confidence that consuming adequate amounts of calcium would lead to various benefits. A total of 15 items varying from outcomes associated with taste (e.g., "pleasurable change to your eating habits") to general long-term health benefits ("prevent you from shrinking as you age") to physical appearance benefits (e.g., "help your hair look shiny and healthy"), were prefaced by "How confident are you that your consumption of calcium-rich foods will" or "How confident are you that eating calcium-rich foods OR

taking a calcium supplement will ... " Responses ranged from 1 (not at all confident) to 5(extremely confident), with possible scores ranging from 13 to 65.

Self-efficacy. The self-efficacy measure assessed individuals' confidence to perform 12 specific actions leading to calcium intake in the next month. Items were prefaced with "How confident are you in your ability to do the following over the next month." Sample items included: Monitor your daily calcium intake, choose calcium-rich foods over calcium-deficient ones, and have access to calcium-rich foods at mealtimes. Participants' responses could range from 0% ("I think I definitely can't") to 100% ("I think I definitely can"), with a possible total score range from 0 to 1200.

Perceived severity. The perceived severity measure assessed individuals' level of agreement with 11 severity statements about the consequences of not consuming adequate amounts of calcium. Participants indicated the extent to which they agreed with statements such as "I would experience a lot of physical pain if I had osteoporosis" and "I would look much worse if I had osteoporosis" using a 5-point likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Possible scores ranged from 11 to 55.

Perceived susceptibility. The perceived susceptibility measure assessed individuals' level of agreement with 10 susceptibility statements. Participants indicated how at risk they felt they were to osteoporosis and other related health problems using a 5-point likert scale ranging from 1 (strongly agree) to 5(strongly disagree). Participants responded to the extent they agreed with statements such as: "Because of my level of calcium consumption, I am more likely to have weak and brittle nails and hair compared to other women my age," and "Because of my level of calcium consumption, the chances of me getting osteoporosis are high compared to other women my age."

Overview of the Intervention Materials

To determine how effective our intervention was in comparison with standard care, the intervention condition's materials were designed to parallel the Osteoporosis Society of Canada's (OSC) current resources. The OSC's "Speaking of Bones" slide presentation, and two pamphlets "Osteoporosis and You" and "Calcium: An Essential Element for Bone Health" served as the educational materials in the control condition, and acted as a template for creating the experimental condition's educational materials. The experimental condition's materials were modified in the same three key ways.

First, information about the health consequences of OP and calcium-deficient diets was complimented with information about physique and appearance-related consequences. As discussed in the literature review, young women's intentions to engage in OP-preventing behaviours are greater when the disease is described as physically disfiguring than when only health implications are mentioned (Smith Klohn & Rogers, 1991). Highlighting both short-term (e.g., brittle nails and hair) and long-term (e.g., developing a humped back) appearance-related consequences may be more meaningful to this population because of their strong concern about physical appearance. Eleven consequences were identified as meaningful in a pilot study (Martin Ginis & Jung, 2002) and inserted into the experimental condition's slide presentation and booklets. For example, participants in the experimental condition were informed that eating a calcium-rich diet could help them look better by "helping your spine stay straight and preventing a 'hump back' " and by "making your hair look shiny and healthy." These physique and

appearance-related statements were not shown to those in the control condition. In addition, a slide containing a picture of two women, one with a hump back and another without, and the heading "The Impact of Osteoporosis on the Individual" was shown only in the experimental condition's slide presentation.

The second key manner in which the intervention materials differed from the standard care was by switching the focus of calcium-rich foods from their nutritional information to the taste, cost, convenience, and weight control aspects of the foods. These four specific aspects of food have been identified as important factors in the selection of foods by Glanz, Basil, Maiback, Goldberg, and Snyder (1998). They were always described in the same manner in the experimental condition: "Got a sweet tooth? Try these inexpensive, yummy, calcium-rich foods!", "Worried about fat content? These are low in fat and high in calcium:", "No time for calcium? These calcium-rich foods are easy to eat on the run:", and "Add variety to your diet with these calcium-rich food ideas." Under each statement, a variety of calcium-rich foods were listed (see appendix D). For the control condition, these food items were simply presented in a table of calcium-rich foods along with their calcium content.

The third way in which the standard material was altered for the experimental condition was in the way the factual messages were framed. In accordance with prospect theory (Tversky & Kahneman, 1981), considerable research has shown that when trying to motivate individuals to perform a health preventive behaviour, emphasizing potential gains from performing that behaviour are more effective than emphasizing potential losses from not performing that behaviour (Neilson & Larson-Brown, 1990; Rothman & Salovey, 1997). Because eating a calcium-rich diet is considered a health preventive behaviour, information in the intervention materials was gain-framed, or benefit-framed. In place of the control condition's messages emphasizing the *losses* associated with *not* consuming adequate calcium, those in the experimental condition received messages emphasizing the *benefits* associated with consuming adequate calcium. For example, in replace of "Many individuals can no longer live independently following a hip fracture, and require nursing home care" written in the standard care materials, the experimental condition read the message "Prevention of hip fractures means that many individuals can continue to live independently without requiring nursing home care" (see appendix D for a list of differences between the experimental and control condition).

Procedure

The present study is part of a larger study that included physiological measures of bone health. For completeness, the full protocol will be described here. However, the physiological data are not part of the current project.

Assessment at baseline. Participants were contacted via telephone and scheduled for their initial assessment at a specified date and time. During this phone call, the participant's residence contact information was obtained and the participant was informed that a sterile urine cup would be delivered to her mailbox before her scheduled appointment. The participant was instructed that, on the day of testing, the first urination of the day was to be sampled in the cup, placed back in the brown bag it came in, and placed in the fridge until her appointment time. Those who attended their appointment

without the urine sample were instructed to return to their residence to obtain it immediately.

Upon arrival at the lab on baseline testing day, urine samples were transferred to a -50°C freezer. Details regarding the study protocol were outlined in a consent form, which was completed by participants prior to testing. A copy of this information was also given to participants to take home. Participants then proceeded to one of the following stations: anthropometrics, blood, questionnaires, or bone scan, with the order of assessment stations being randomized such that only one participant was designated to a station at a time.

The anthropometrics station consisted of a scale that measured both weight and height, and a handheld bioelectrical impedance machine to assess body composition. Results from this station were withheld from the participant to limit changes in feeling states in response to learning one's weight and body fat percentage, as these feelings could influence responses to subsequent questionnaires. Participants were told to remove their shoes and stand with their backs to the scale numbers before stepping onto the scale. After documenting their weight to the nearest one-tenth of a pound and height to the nearest one-tenth of a centimetre, participants were instructed to remove all jewellery that could interfere with the electrical signal of the handheld bioelectrical impedance machine and to firmly grasp the conduction handles. The output display of the machine was covered from participants' view. All measurements were recorded by a research assistant.

The blood sampling station was sectioned off from the other areas to allow for adequate privacy while blood was drawn. Approximately 10mL of blood was drawn from the median cubital vein by a certified phlebotomist. Juice was provided for those who experienced nausea. Blood was then centrifuged at 4500 rpm, and the plasma was transferred to a -86°C freezer.

To minimize radiation exposure, the bone scan station was located in a separate room. Two trained researchers (either the primary investigator or LG) asked the participant to remove any jewellery located on the wrist of the nondominant arm. The length of each participant's nondominant forearm, from olecranon to ulnar styloid process, was measured using a tape measure, to the nearest millimetre. Next, the participant's nondominant ultradistal radius was positioned in a peripheral quantitative computed tomography scanner (Stratec XCT 960, serial # 91069). Radiation dose for one scan was 0.3 mSV. The machine was calibrated at the beginning of each testing day using a phantom slice provided by the manufacturer. The scanner first conducted a coronal computed radiograph (scout view) of the forearm. The scout view was used to position the scanner at 4% of forearm length. Calculation of numerical values for all variables assessed was performed using the manufacturer's software.

The questionnaire station was located in a private room, furnished with a table and chairs. The demographics and physical activity measures were completed first, followed by all health belief model construct questionnaires. Order of the HBM measures was randomized to avoid presentation bias. Finally, the first 3-day food log was distributed with detailed instructions on how to complete it within seven days. Specifically, instructions were given to write down the quantity and brand name (if applicable) of everything eaten and drank, immediately after ingestion, for two weekdays

and one weekend day. The researcher then reviewed examples with each participant to emphasize the level of description required for each item. The researcher was available at all times to clarify any questions, distribute and collect each questionnaire, and ensure that all items were answered.

A random numbers table was created to randomize participants to either the control or experimental condition. Consecutively numbered envelopes were then sealed with the corresponding condition code written inside. A receptionist assigned an envelope to each participant based on chronological order of when they arrived at the registration table. For example, the first participant to enter the lab was allocated the envelope labelled one. The researcher opened this envelope and encrypted either "C" or "E" on the participant's file after the participant was sent off to the first station.

Upon completion of baseline testing, participants received $10 and were scheduled for their respective condition's intervention seminar the following week. The educational seminar was held twice for each condition to enable participants to choose a time that best fit their schedule. Participants were reminded to bring their food log to the seminar in order to receive their next remuneration. Reminder phone calls were made one day prior to each participant's seminar appointment time.

Educational seminar (week 1). The primary researcher introduced the registered dietician, who presented a 45 min seminar. Both the experimental and control condition seminars were based around the Osteoporosis Society of Canada's 2001 slide presentation package entitled "Speaking of Bones." This informative slide package was designed for the general public and is accompanied with a script. The control condition received this presentation verbatim, as it was considered standard care. Following the seminar, a manipulation check was administered to ensure each group paid equal attention to the presentation. This check consisted of 10 true or false questions about general osteoporosis information (Appendix E). Next, the HBM constructs were measured. The order of questionnaires was randomized. Participants submitted the completed questionnaires and their 3-day food log to the primary investigator in return for $10 remuneration.

Mail-delivered interventions (weeks 6 and 14) and follow-up (week 25). A package consisting of two coloured booklets and an information letter was mailed to each participant's dormitory room via campus mail during week six. The letter requested that participants read the booklets as soon as possible, and indicated that questionnaires would be arriving in two weeks time. As a standard care intervention, participants in the control condition received the OSC's "Osteoporosis and You" and "Calcium: An Essential Element for Bone Health" booklets. Participants in the experimental condition received modified versions of these two booklets.

At week 8, a second package arrived in participants' mailboxes. This package consisted of a pre-addressed return envelope, manipulation check, and the same 3-day food log, physical activity, and HBM measures packet that they received at baseline. The manipulation check assessed the degree of attention paid to the booklets by asking two open-ended questions (Appendix E). Participants were asked to list five outcomes of consuming calcium in their diet, and five foods high in calcium that they enjoy. Answers were coded as correct or incorrect based on the information provided in the booklets. A

telephone call and electronic mail message were sent out to remind those who did not return their package in 7 days to send it promptly. Participants who returned their completed package received $10 remuneration.

At week 14, the second mail-delivered intervention was distributed. Each participant received a notepad, sticker, and instruction sheet. Participants were instructed to adhere the sticker to an object they used often (e.g., binder or day planner) or to place it in a highly visible location (e.g., computer or mirror in their residence room). Similarly, they were asked to place the notepad where they would most likely use it, such as by the phone or desk area. The control condition's notepad was 50 pages. At the top of each page was the heading "Calcium Rich: FOOD IDEAS," followed by one calcium-rich food item and its calcium content (e.g., yoghurt, 295 mg). Twenty-five different calcium-rich food items and their calcium content each appeared twice in the randomized stack of notepad pages. The experimental condition's notepad also had the heading "Calcium-Rich: FOOD IDEAS" and contained 50 pages. Rather than listing the calcium content in each food item however, each page mentioned the same calcium-rich food items as used in the control condition's notepad, but in a manner more appropriately targeted to young women (e.g., "Try a cold and creamy milk shake or smoothie made with calcium-fortified soy milk"; see appendix D).

The control condition's sticker displayed Canadian recommended calcium intakes for different age groups on 4-inch by 3.5-inch adhesive paper (e.g., "Age 17-18 needs 1200mg"). The experimental condition's sticker displayed preventive effects of consuming adequate amounts of calcium that were targeted to the study population (e.g., "build strong nails").

At week 25, another questionnaire package was mailed out. Similar to the first mail follow-up, this package consisted of a manipulation check questionnaire (Appendix E), a 3-day food log, randomized HBM measures packet, and a pre-addressed return envelope. The manipulation check questionnaire assessed whether both conditions used their notepad and sticker to the same extent by asking 10 questions pertaining to where the materials were placed, if they were used and to what extent. In addition, the same two open-ended questions administered in the booklet manipulation check were asked again here. The RDI of calcium for women between the ages of 17-18 was also asked in an open-ended format. The latter three items were administered to assess whether the content on the intervention materials was read. A telephone call and reminder electronic mail were sent out to participants who did not return this package within 7 days.

Assessment at one year (week 52). Telephone calls were made to participants' permanent home number at week 46 (during students' summer vacation). New school contact information for the upcoming year was requested. Participants were notified that the researcher would be using this information to contact them in September to schedule the final post-testing appointment, as well as to deliver a urine cup to their home. This request was also sent out in an electronic mail message to each participant.

During the first week of September (week 49), participants were contacted by telephone to arrange a post-test appointment and to confirm their new school address. It was explained that the researcher and research assistant would be delivering a bag containing a sterile urine cup in a brown paper bag, a 3-day food log, and a reminder note

specifying their appointment time. Participants were told to bring a urine sample from their first urination of the test day and the 3-day food log in order to redeem their final $10 remuneration. Each participant was contacted by telephone one day prior to their appointment as a reminder.

The post-testing procedure was virtually identical to baseline testing. The only modifications were in the wording of the demographics questions to make them more pertinent to the time period of the study. In addition, a 4-item "usefulness" measure was given to assess perceived effectiveness of the study (Appendix E). Participants were asked to rate how useful specific aspects of the intervention had on their calcium intake (e.g., "Overall, how much of an impact did the mailouts have on increasing your calcium consumption?") Upon completion of post-testing, participants were given their final $10 remuneration. The primary researcher debriefed each participant individually. Those who were interested in receiving results of the study were asked to record their preferred electronic mail address.

Results

Compliance with the Study Protocol

All 133 participants returned for the intervention seminar at week 1 and completed all post-seminar questionnaires (100%). Questionnaire return rate after the first mail out (week 8) was 74.4%; however, one participant failed to return her food log at this time point, so complete data for the first mail out is only available for 73.7% of the study population. Return rate for the second mail out (week 25) dropped slightly to 69.2%. Completion of all measures at post-testing, one year later, was 73.7%. Complete data for all measurement time points were available for 51% of the sample.

Preliminary Analyses

The significance level for all statistical tests was set at $p < .05$. Any data point that was three or more standard deviations away from the mean of that variable was considered an outlier, and was not used in the analysis. To test for potential covariates in the analyses, correlational analyses were conducted between demographic information, lifestyle factors, and all outcome variables. The intervention and control conditions were compared using independent t-tests on all demographic and baseline measures of the study variables. There were no demographic differences between groups. Participants in the two conditions did not differ significantly on kilocalories consumed $t(131) = 1.15, p = .25$ (two-tailed) or amount of calcium ingested $t(131) = .61, p = .55$ (two-tailed) at baseline. Of all baseline measures, only mean perceived severity differed between groups $t(131) = 2.10, p = .04$.

Testing of Assumptions

All data assumptions were tested in accordance with Tabachnick and Fidell's recommendations (2001). Unless otherwise stated, assumptions underlying the use of a multivariate analysis of covariance (normality, homogeneity of variance-covariance matrices, linearity, reliability of covariates, multicollinearity, homogeneity of regression) were met. Likewise, assumptions underlying the use of multiple regression (ratio of cases to independent variables, outliers, multicollinearity and singularity of independent variables, normality, linearity, homoscedasticity, and independence of residuals) were not violated unless otherwise stated. Mediational analysis was conducted as per Baron and Kenny's recommendations via prospective hierarchical linear regressions (Baron & Kenny, 1986).

Scale Reliabilities

The internal consistency for each scale was verified by calculating Cronbach's alpha at each time point. All but perceived barriers had acceptable levels of internal consistency (i.e., $\alpha > .70$, Nunnally, 1978), as presented in Table 1. We examined the possibility that the poor alpha value for the perceived barrier scale might reflect a multidimensional scale structure. Principal components analysis failed to support a multifactorial model (i.e., items did not load clearly on separate factors). Because the poor internal consistency of this scale could not be remedied by deleting items or creating subscales, the sum score of this measure could not be used in subsequent statistical tests. As an alternative, the number of barriers that participants agreed or strongly agreed with at each time point was counted. The sum count of perceived barriers at each time point was used in replace of the sum score of perceived barriers in the following analyses.

Table 1

Internal Consistency (Cronbach's Alpha)

Scale	Baseline	Week 1	Week 8	Week 25	Week 52
Perceived Benefits	.87	.90	.92	.89	.91
Self-efficacy	.90	.92	.93	.92	.92
Perceived Susceptibility	.88	.92	.93	.95	.73
Perceived Severity	.85	.87	.87	.89	.86
Perceived Barriers	.46	.67	.60	.72	.67

Note. Acceptable reliability: alpha > .70

Manipulation Checks

In order to ensure that participants from each group paid equal attention to their condition's week 1 educational seminar, an independent t-test was conducted on the number of correct answers on the manipulation check (see appendix E). There was no significant difference between experimental (97% correct) and control condition (95% correct) on the number of correct answers $t(130) = -1.80, p = .08$ (two-tailed), suggesting that participants received similar knowledge and did not differ in the amount of attention paid to the educational seminars.

In order to ensure that participants from each condition received similar information and paid equal attention to the two booklets that were mailed out at week 6, correct responses to the questions in the second manipulation check (see appendix E) were summed. There was no difference between the experimental (95% correct) and control condition (96% correct) on the number of correct answers $t(97) = -.39, p = .70$ (two-tailed), suggesting that participants received similar knowledge and paid equal attention to the booklets given to each condition.

To assess whether the sticker that was mailed out at week 14 was used to the same extent in each condition, a pearson chi-square test was conducted on the item "Did you affix the sticker somewhere?" (see appendix E). There was no difference between experimental (60% affixed sticker) and control condition (57% affixed sticker) $\chi^2(1, N = 84) = .05, p = .83$. Reasons for posting or not posting the sticker in each condition, as well as where the notepad was placed, are listed in Table 2. In order to ensure there was no difference between conditions on frequency of use of both the notepad and the sticker, a MANOVA was conducted. Condition was the independent variable, and the sum of the five items reflecting use of the sticker and notepad were the dependent variables. No main effect was found $F(5, 75) = .64, p = .67, \eta^2 = .04$, indicating there was no statistically significant difference between conditions on how frequently the notepad and sticker were seen and/or used. In order to ensure that equal attention was paid to the content written on the stickers and notepads between conditions, an independent t-test was conducted on the sum of correct answers to the three items requesting participants to reiterate specific information from the intervention materials. There was no significant difference between the experimental (65% correct) and control condition (61% correct) on the number of correct responses given $t(131) = .59, p = .56$ (two-tailed), suggesting that there was no difference between conditions on the amount of attention paid to the stickers and notepads.

In summary, no differences between conditions were found on attention paid to any of the intervention materials. All manipulation check scores were relatively high, indicating that the intervention material was adequately read by both conditions. It was thus considered safe to proceed with testing the study hypotheses.

Table 2
Reasons For and Against Affixing the Intervention Sticker and Locale of Notepad

	Control	Experimental
Percentage who did not affix sticker	43%	40%
Reasons preventing use of sticker (frequency of response):		
Did not like sticker	1	0
Lost the sticker	3	6-
Did not get a sticker	2	0
Did not know where to put sticker	6	6
Concerned about affixing a sticker in residence room	1	0
Did not suit decor of residence room	0	1
Did not want to affix sticker	1	2
Already eat enough calcium	0	1
Do not know why did not use sticker	2	1
Location of notepad		
Desk	31	32
Book shelf	4	5
Binder	1	5
Beside phone	2	1
With scrap paper	4	1
Took it home	0	1
Do not remember where placed it	0	1
Last time notepad was noticed		
Yesterday	13	16
Past week	17	18
Past month	14	11
Never saw	0	2

Comparison of Kilocalories Consumed between Groups

To ensure that any potential changes in calcium intake were due to an increased proportion of calcium-rich foods in the diet, and not to an overall increase in calories with the proportion coming from calcium-rich foods staying the same, analysis of mean kilocalories consumed at each time point was conducted. First, a repeated measures ANOVA was performed. There was a significant main effect for time, such that all participants decreased the amount of kilocalories consumed over time $F(3, 198) = 3.67, p = .01$. The main effect for condition and the interaction effect proved nonsignificant $F(1, 66) = 2.16, p = .15$, and $F(3, 198) = .93, p = .43$, respectively. Combined, these results indicate that there was no difference in the amount of decrease between conditions across time (see Table 3 for means and standard deviations of kilocalories for each condition). Because participants were consuming fewer calories throughout the study than at baseline, any increases in calcium intake found in the subsequent analyses must be due to an increase in proportion of calcium to calories in the diet.

Table 3
Descriptive Statistics for Calcium and Kilocalorie Intakes (Unadjusted)

	Week 1		Week 8		Week 25		Week 52	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
EXPERIMENTAL								
Calcium Intake (mg)	927	369	1004	393	1109*	568	1144**	514
Kilocalories (kcal)	2129	458	2096	486	2020	607	1950	441
CONTROL								
Calcium Intake (mg)	891	286	956	344	951*	371	813**	286
Kilocalories (kcal)	2101	453	2033	521	1931	504	1825	456

Note: * indicates significant differences between conditions at $p < .05$
** indicates significant differences between conditions at $p < .01$

Comparison of Calcium Intakes between Groups

The primary purpose of the study was to determine whether the experimental condition would increase their calcium intake more than the control condition. To answer this question, the present data are analyzed and presented in two ways. First, a repeated measures analysis was used to assess whether there was a change in calcium intake over all measurement time points, and whether the magnitude of change varied across conditions. Note that this analysis includes only those participants who returned their diet logs at all time points (N = 68). Second, a pre-post only analysis was used to assess whether an overall change in diet occurred over the course of the study. Note that this was an intent-to-treat analysis that included all participants who returned their post diet log, but who may not have adhered to the study protocol throughout the year (N = 98). The means and standard deviations for calcium intakes at each measurement point are shown in Table 3.

To test the first hypothesis that the experimental group would have higher calcium intakes than the control group at each time point, a 2 (condition) X 4 (time) repeated measures ANOVA on mean calcium intake at each measurement point was conducted. Levene's test of equality of error variances indicated that one of the dependent variables, mean calcium intake during week 52, did not meet the assumption of homogeneity of variance $F(1, 66) = 5.45, p = .02$. A subsequent test of variable normality indicated that the item was mildly skewed according to Tabachnick and Fidell (2001; skewness = 1.6). Failure to meet the assumption of homogeneity of variances is not fatal to ANOVA, which is robust to small and moderate departures from homogeneity of variance, particularly when groups are of equal sample size (Box, 1954). Although sample sizes for experimental (n = 33) and control (n = 35) conditions for this test were almost identical, Tabachnick and Fidell (2001) recommend data transformation in the case of non-normal distributions. To keep the unit of measurement of calcium intake at all time points the same, every calcium intake measurement point was square rooted as a means of transformation. Following data transformation, a subsequent Levene's test was nonsignificant ($p > .05$), indicating that assumptions underlying the use of ANOVA were not violated and that ANOVA could proceed. There was no main effect for time $F(3, 198) = 1.31, p = .27$. As hypothesized, a significant main effect for condition, $F(1, 66) = 4.05, p = .048$, and a time by group interaction were found $F(3, 198) = 2.94, p = .03$, reflecting that those in the experimental condition increased the amount of calcium in their diet in the span of the study, whereas calcium intake decreased slightly in the control condition in the same time frame. Bonferroni adjusted post-hoc independent t-tests (adjusted p value for 4 tests = .013) on the mean calcium intake at each measurement point revealed significant differences between the two conditions only at week 52 $t(96) = 6.62, p < .01$ (two tailed). Calculation of Cohen's d on the difference between conditions on week 52 calcium intake revealed a large effect (d = .81).

To examine pre-to-post changes in this yearlong trial, a 2 (condition) X 2 (time) repeated measures ANOVA was conducted. The main effect for time proved nonsignificant $F(1, 96) = 1.15, p = .29$. The main effect for condition approached significance, such that those in the experimental condition had higher calcium intakes than those in the control condition, $F(1, 96) = 3.70, p = .06$. However, as hypothesized,

this nonsignificant main effect was superseded by a significant time by condition interaction, $F(1, 96) = 8.33, p < .01$. Post-hoc paired t-tests revealed that the experimental condition significantly increased their calcium consumption from the beginning of the study, $t(51) = -2.38, p = .02$, *Cohen's d* = .48 (two-tailed). In contrast, there was a nonsignificant trend for calcium intake in the control condition to decrease, $t(47) = 1.62$, $p = .11$, *Cohen's d* = .27 (two-tailed). Also, the experimental condition had significantly higher calcium intakes than the control condition at week 52, $t(96) = 3.18, p < .001$, *Cohen's d* = .64).

Effects of the Intervention on the HBM Constructs

To test the second hypothesis, that the experimental condition will have greater improvements in each HBM variable than the control condition, repeated measures ANOVAs were conducted for each variable with the exception of perceived severity. Although a repeated measures MANOVA that analyzed all HBM constructs simultaneously would have been ideal, this statistical test would have violated the assumption of adequate sample size (Tabachnick & Fidell, 2001). Each cell is to have more cases than there are dependent variables. With five repeated measures for each of the five HBM constructs and a sample size of only 24 (experimental) and 28 (control) for this specific test, it would have indeed violated this assumption. As noted earlier, the only difference between groups on baseline HBM measures was for perceived severity. Thus, perceived severity was analysed in an ANCOVA that controlled for baseline differences.

Changes in self-efficacy. A 2 (condition) x 5 (time) repeated measures ANOVA was conducted to assess changes in self-efficacy. A significant main effect for time was found, such that participants increased their self-efficacy to consume adequate amounts of calcium over time $F(4, 272) = 7.99, p < .001$ (see Table 4 for means and standard deviations at each time point). A significant main effect for condition was also found, such that those in the experimental condition had higher overall self-efficacy than those in the control condition $F(1, 68) = 3.87, p = .05$. The time by condition interaction was not significant, $p = .80$.

Changes in perceived severity. A 2 (condition) x 4 (time) repeated measures ANCOVA was conducted to assess changes in perceived severity. Baseline severity was used as the covariate to control for baseline differences between conditions. A significant main effect for time was not found $F(3, 177) = .21, p = .89$ (see Table 4 for means and standard deviations at each time point). Neither the main effect for condition nor the time by condition interaction were significant (*ps* = .63 and .08 respectively).

Changes in perceived susceptibility. A 2 (condition) x 5 (time) repeated measures ANOVA was conducted to assess changes in perceived susceptibility. A significant main effect was found for time, such that over time, participants perceived themselves as less susceptible to physical outcomes associated with a calcium-deficient diet $F(4, 236) = 25.37, p < .001$. Neither the main effect for condition or time by condition interaction term were significant (*ps* = .83 and .54 respectively).

Changes in perceived benefits. A 2 (condition) x 5 (time) repeated measures ANOVA was conducted to assess changes in perceived benefits. A significant main effect was found for time, such that participants perceived significantly more benefits to

consuming adequate amounts of calcium from the beginning to the end of the study $F(4, 252) = 16.19, p < .001$. There was a trend towards a significant main effect for condition ($p = .10$), with those in the experimental condition perceiving slightly more benefits than those in the control condition (see Table 4 for means and standard deviations at each time point). The time by condition interaction was not significant ($p = .56$).

Changes in perceived barriers. A 2 (condition) x 5 (time) repeated measures ANOVA was conducted to assess changes in perceived barriers. A significant main effect was found for time, such that participants perceived significantly less barriers to consuming adequate amounts of calcium over the course of the study $F(4, 524) = 5.30, p < .001$ (see Table 4 for means and standard deviations at each time point). Neither the main effect for condition nor the time by condition interaction were significant (*ps* = .60 and .96 respectively).

In summary, the hypothesis that the experimental condition would show greater change in the HBM constructs was only supported for the self-efficacy construct, and not for perceived benefits, barriers, susceptibility, or severity.

Table 4

Descriptive Statistics for Health Belief Model Study Variables (Unadjusted)

	Baseline		Week 1		Week 8		Week 25		Week 52	
Construct	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
EXPERIMENTAL										
Self-Efficacy$_{a,b}$	832.17	180.78	900.79	153.70	906.10	161.87	911.76	137.68	911.77	152.50
Perceived Benefits$_{a}$	43.02	8.14	50.50	8.36	48.13	8.12	47.88	7.47	48.19	8.56
Sum count of Perceived Barriers$_{a}$	1.40	1.18	1.33	1.32	1.07	1.22	1.01	1.42	.90	1.32
Perceived Susceptibility$_{a}$	29.65	7.21	24.46	7.18	28.86	7.72	27.76	8.95	35.46	9.37
Perceived Severity	24.83	5.99	23.39	6.52	22.88	5.81	22.77	6.80	22.75	5.29
CONTROL										
Self-Efficacy$_{a,b}$	800.90	184.98	858.34	173.49	828.88	174.34	827.55	180.17	866.95	172.79
Perceived Benefits$_{a}$	42.77	7.68	46.70	7.80	45.41	8.42	45.72	7.56	46.76	7.50
Sum count of Perceived Barriers$_{a}$	1.48	1.29	1.36	1.47	1.26	1.53	1.03	1.37	1.03	1.28
Perceived Susceptibility$_{a}$	28.88	6.95	26.55	8.36	27.45	9.27	28.54	9.49	35.05	7.93
Perceived Severity	22.60	5.95	21.21	5.59	21.51	6.14	21.56	5.71	21.86	5.94

Note: Possible scale ranges: self-efficacy was 0 – 1200, perceived benefits was 13 – 65, perceived barriers was 0 – 6, perceived susceptibility was 10 – 50 (low scores indicate high susceptibility), perceived severity was 11 – 55 (low scores indicate high severity).

Significant main effects for time are denoted by the subscript a.

Significant main effects for condition are denoted by the subscript b.

Prediction of Calcium Intake

To test the third hypothesis, that the HBM would predict calcium intake at each time point, a series of multiple regressions were conducted. Prior to performing these analyses, potential predictor variables were checked for normality. The sum of perceived barriers at time 3, time 4, and time 5 were moderately skewed (skewness statistic was equal to 1.20, 1.40, and 1.31, respectively). In accordance with Tabachnick and Fidell's recommendations for transforming positively skewed scores (2001), the square root of sum of perceived barriers at time 3, 4, and 5 were calculated and use in the subsequent analysis. Conversely, the mean of self-efficacy calcium intake at baseline and time 2 was slightly skewed in the negative direction (-1.01, -1.10 respectively). As recommended by Tabachnick and Fidell (2001), these scores were reflected and square rooted. Following transformation, all scores were normally distributed and thus used in replace of the original scores in the regression analyses below.

The first prospective regression assessed whether baseline measures of the HBM constructs predicted mean calcium intake measured during the first week of the study. Baseline HBM constructs (sum of perceived susceptibility, benefits, severity, sum count of perceived barriers, and the transformed self-efficacy score) were entered as a block as predictor variables. The overall model was not significant $R^2 = .06$ ($R^2_{adj} = .02$), $F(5, 118) = 1.47$, $p = .21$ (see Table 5). Inspection of the standardized betas indicated that only transformed baseline self-efficacy significantly predicted calcium intake during week 1 ($\beta = -.24$, $p = .03$). This was contrary to hypothesis three, as we proposed that all HBM constructs would predict calcium intake.

Table 5

Prospective Hierarchical Regression Analysis for the Health Belief Model to Predict Calcium Intake During Week 1 (N = 121)

Predictor Variables	ΔR^2	Beta	t for parameter	Probability for t value
Health Belief Model Constructs	.02			
Self-efficacy$_a$		-.24*	-2.25	.03
Perceived severity		.07	.70	.48
Perceived susceptibility		.08	.84	.40
Perceived benefits		-.06	-.55	.59
Perceived barriers		.01	.14	.89

Note. * $p < .05$

$_a$ Self-efficacy scores were transformed (i.e., reflected and square rooted)

All HBM constructs were measured at baseline

To assess whether HBM constructs measured at week 1 would predict calcium intake measured during week 8, the same regression format as above was used. Week 1 HBM variables (perceived benefits, susceptibility, severity, sum count of perceived barriers, transformation of self-efficacy) were entered together as a block. Again, the overall model was not significant $R^2 = .06$ ($R^2_{adj} < .01$), $F(1, 84) = 1.10$, $p = .37$ (see Table 6). Thus, the HBM constructs measured at week 1 failed to explain any variance in calcium intake during week 8. Contrary to hypothesis three, inspection of the standardized betas indicated that none of the HBM constructs significantly predicted calcium intake.

Table 6

Prospective Hierarchical Regression Analysis for the Health Belief Model to Predict Calcium Intake during week 8 (N = 95)

Predictor Variables	ΔR^2	Beta	t for parameter	Probability for t value
Health Belief Model Constructs	.06			
Self-efficacy[a]		-.22	-1.5	.13
Perceived severity		-.05	-.44	.66
Perceived susceptibility		.03	.25	.81
Perceived benefits		-.02	-.16	.88
Perceived barriers		-.04	-.32	.75

All HBM constructs were measured at week 1

[a] Self-efficacy scores were transformed (i.e., reflected and square rooted)

The third regression tested whether the HBM constructs measured at week 8 would predict calcium intake measured during week 25. All week 8 HBM variables (perceived benefits, susceptibility, severity, self-efficacy, and the transformation of sum count of perceived barriers) were entered as a block. Unlike weeks 1 and 8, the overall model was significant $R^2 = .21$ ($R^2_{adj} = .15$), $F(5, 66) = 3.50$, $p < .01$ (see Table 7). However, none of the beta weights for the HBM variables were significant.

Table 7

Prospective Hierarchical Regression Analysis for the Health Belief Model to Predict Calcium Intake during week 25 (N = 73)

Predictor Variables	ΔR^2	Beta	t for parameter	Probability for t value
Health Belief Model Constructs	.21*			
Self-efficacy		.22	1.47	.15
Perceived severity		-.23	-1.89	.07
Perceived susceptibility		.21	1.83	.07
Perceived benefits		.04	.27	.79
Perceived barriers		-.02	.11	.91

Note. *$p < .01$
All HBM constructs were measured at week 8

The final prospective regression predicting calcium intake used HBM variables measured at week 25 to predict calcium intake during week 52. Similar to the above models, week 25 HBM variables (perceived benefits, self-efficacy, severity, susceptibility, and the transformation of sum count of perceived barriers) were entered in a block. The overall model was not significant $R^2 = .05$ ($R^2_{adj} = -.03$), $F(5, 63) = .60$, $p = .70$ (see Table 8). Again, contrary to hypothesis two, no HBM construct significantly predicted calcium intake during week 52.

Table 8

Prospective Hierarchical Regression Analysis for the Health Belief Model to Predict Calcium Intake during week 52 (N = 70)

Predictor Variables	ΔR^2	Beta	t for parameter	Probability for t value
Health Belief Model Constructs	.05			
Self-efficacy		.13	.89	.38
Perceived severity		.07	.47	.64
Perceived susceptibility		-.01	-.08	.94
Perceived benefits		.11	.69	.49
Perceived barriers		-.09	-.66	.51

All HBM constructs were measured at week 25

As a post hoc analysis, a concurrent hierarchical regression was conducted on calcium intake measured during week 52. All HBM constructs measured at week 52 were entered together as a block. The overall model was significant $R^2 = .24$ ($R^2_{adj} = .20$), $F(5, 85) = 5.45$, $p < .01$ (see Table 9). Both perceived benefits and barriers significantly predicted calcium intake during week 52 ($\beta = .25$, $p = .01$, $\beta = -.29$, $p < .01$, respectively). Self-efficacy approached significance at $\beta = .18$, $p = .08$.

Table 9

Concurrent Hierarchical Regression Analysis for the Health Belief Model to Predict Calcium Intake (N = 94)

Predictor Variables	ΔR^2	Beta	t for parameter	Probability for t value
Health Belief Model Constructs	.24**			
Self-efficacy		.18	1.77	.08
Perceived severity		.12	1.20	.23
Perceived susceptibility		.11	1.13	.26
Perceived benefits		.25	2.53	.01*
Perceived barriers		-.29	-2.95	.004*

Note. $^{**}p < .01$, $^{*}p < .05$
All HBM constructs measured at week 52

In summary, the hypothesis that the HBM would predict calcium intake was not supported. Of the five HBM constructs, self-efficacy, perceived benefits and perceived barriers predicted calcium intake, and perceived severity and susceptibility approached significance at predicting calcium intake, but all at varying time points.

Testing Self-efficacy as a Mediator in the Group-Calcium Intake Relationship

Using change in calcium intake as the outcome variable, three prospective tests of mediation were conducted using prospective, hierarchical regressions. Change scores were created by subtracting the mean calcium intake from the preceding food log from the antecedent food log (e.g., mean calcium intake during week 8 was subtracted from mean calcium intake during week 1). Intervention condition was the predictor variable and self-efficacy from the previous time point was tested as the mediator. Given that self-efficacy was the only HBM construct to change due to the experimental condition, and that self-efficacy was, overall, the strongest predictor of calcium intake, this was the only HBM variable tested for mediation. Differences in baseline transformed self-efficacy was controlled for by entering it in the first step of the regression model. Prospective hierarchical linear regressions were used to test the four conditions of mediation:

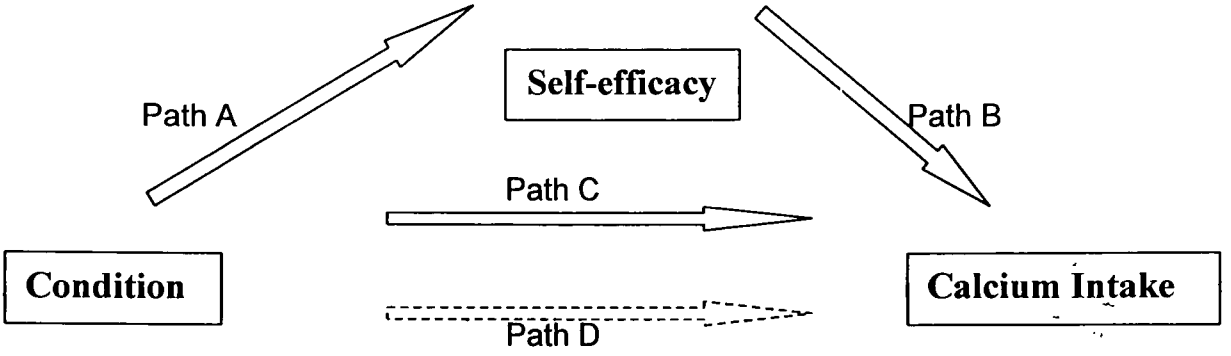
Condition 1. The predictor variable (i.e., intervention condition) must be significantly related to the mediator (i.e., self-efficacy), as shown by the solid line labelled path A in figure 1.

Condition 2. The mediator (i.e., self-efficacy) must be significantly related to the outcome variable (i.e., calcium intake), as shown by the solid line labelled path B in figure 1.

Condition 3. The predictor variable (i.e., intervention condition) must be significantly related to the outcome variable (i.e., calcium intake), as shown by the solid line labelled path C in figure 1.

Condition 4. The effect of the predictor variable (i.e., intervention condition) on the outcome variable (i.e., calcium intake) is eliminated (perfect mediation) or is reduced (partial mediation), when the mediator is controlled for, as shown by the dotted line labelled path D in figure 1.

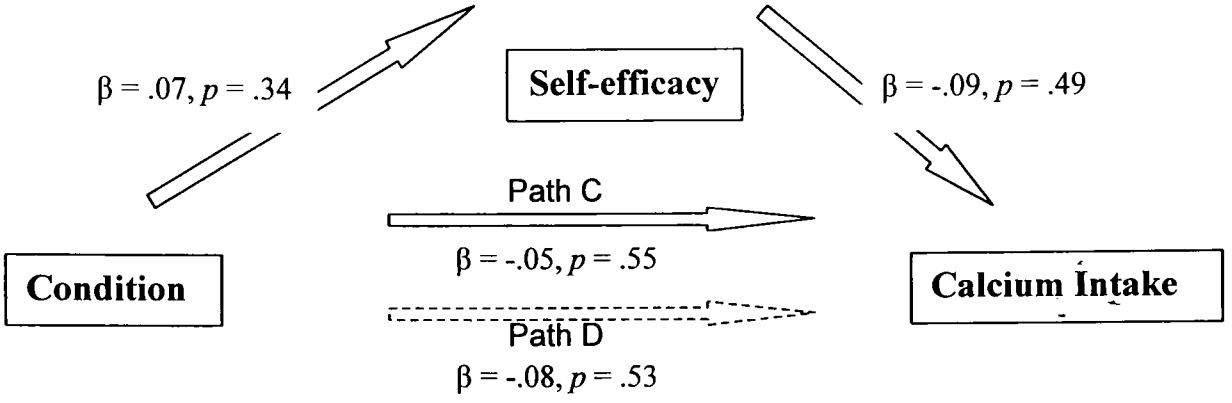
Figure 1
Path Diagram of Self-efficacy as a Potential Mediator of Calcium Intake



Note: The dashed arrow indicates that for mediation to occur, Path D should be nonsignificant after controlling for Path B.

Week 1 self-efficacy as a potential mediator of calcium intake during week 8. After entering baseline transformed self-efficacy, intervention condition did not significantly predict self-efficacy at week 1, $R\Delta^2 < .01$, $F\Delta\ (1, 130) = 1.35$, $p = .34$ ($\beta = .07$, $p = .34$), see Figure 2). Because the first condition of mediation (path A) was not met, subsequent testing of pathways B, C, and D were not performed.

Figure 2
Path Diagram of week 1 Self-efficacy as a Potential Mediator of Calcium Intake During Week 8

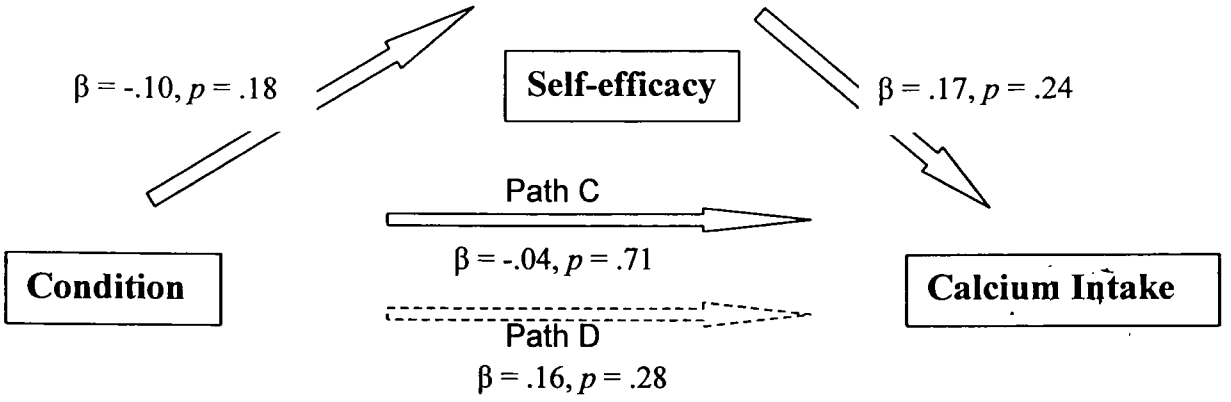


Note: The dashed arrow indicates that for mediation to occur, Path D should be nonsignificant after controlling for Path B.

Week 8 self-efficacy as a potential mediator of calcium intake at during week 25.

Again, intervention condition did not significantly predict self-efficacy at week 8 after baseline transformed self-efficacy was controlled for $R\Delta^2 = .01$, $F\Delta\ (2, 96) = 1.80$, $p = .18$ ($\beta = -.10$, $p = .18$, see Figure 3). Because the first condition of mediation (path A) was not met, subsequent testing of pathways B, C, and D were not performed.

Figure 3
Path Diagram of week 8 Self-efficacy as Potential Mediator of Calcium Intake During Week 25

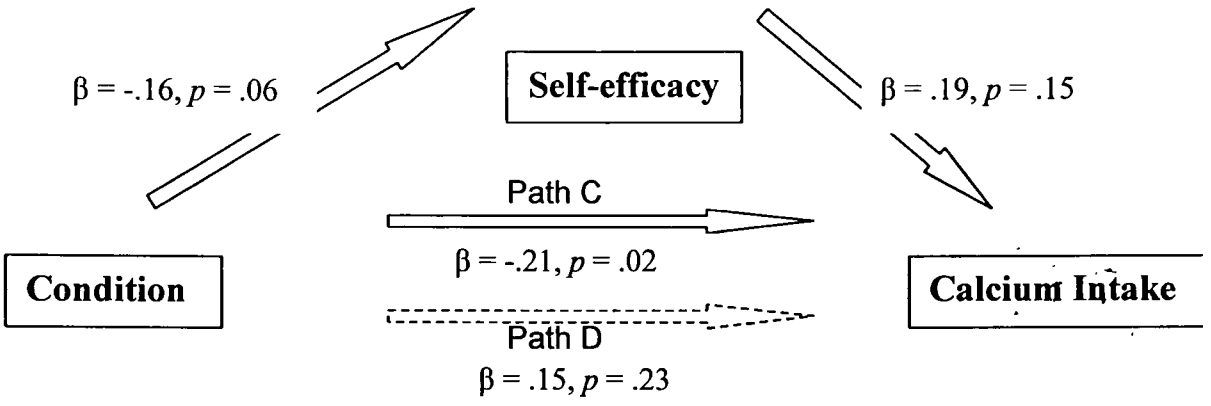


Note: The dashed arrow indicates that for mediation to occur, Path D should be nonsignificant after controlling for Path B.

Week 25 self-efficacy as a potential mediator of calcium intake at week 52.

After controlling for baseline transformed self-efficacy, intervention condition did not significantly predict self-efficacy at week 25 $R\Delta^2 = .03$, $F\Delta$ (1, 90) = 3.79, $p = .06$ ($\beta = -.16$, $p = .06$ see Figure 4). Subsequent testing of pathways B, C and D were therefore not performed.

Figure 4
Path Diagram of week 25 Self-efficacy as Potential Mediator of Calcium Intake During Week 52



Note: The dashed arrow indicates that for mediation to occur, Path D should be nonsignificant after controlling for Path B.

Discussion

The purpose of the present study was to test the effects of message framing and targeted messages on calcium intake behaviour. Young women who were consuming less than adequate amounts of calcium attended a one-hour seminar, received two pamphlets, one sticker, and one notepad in the mail over the course of one year, all containing information about osteoporosis, bone, and how calcium intake relates to each. Using message framing and targeted messaging as the intervention, participants were randomly assigned to receive the standard care seminar and materials (control condition), or the gain-framed, population-targeted seminar and materials (experimental condition). Examination of the data revealed that only the experimental intervention had significant effects on calcium intake behaviour. Specifically, participants in the experimental condition significantly increased their calcium intake whereas those in the control condition showed a slight decrease. All HBM constructs changed over time in both conditions except for perceived severity. Self-efficacy was the only construct to improve significantly more in the experimental versus control condition. The HBM constructs failed to predict calcium intake behaviour, and accordingly, self-efficacy did not mediate changes in calcium intake. Potential explanations for each of the study findings and implications are discussed below.

Effects of the Intervention on Calcium Intake

Framing messages in terms of benefits and targeting calcium information for the study population had a large, positive effect (*Cohen's d* = .81) on young women's calcium intake. While all women were consuming less than the recommended daily amount at the onset of the study, those in the intervention condition significantly increased their calcium intake by 18.2%, and those in the control condition decreased their calcium intake by 6.6%. This finding supports the primary hypothesis and is consistent with prospect theory (1979); young women were more likely to perform a preventive behaviour (i.e., consume adequate amounts of calcium) when they were informed of the benefits associated with that behaviour than if informed of the losses associated with not performing that behaviour.

The present study extends upon previous health prevention research by showing the effects of message framing over an extended period of time. Gain-framed messages have been shown to be more successful than loss-framed messages in increasing intentions to exercise (Robberson & Rogers, 1988), exercise adherence (McCall & Martin Ginis, in press), using infant car restraints (Christophersen & Gyulay, 1981), and using sunscreen with the appropriate SPF level, but only immediately after the intervention (Rothman et al., 1993). Unfortunately, these studies do not tell us whether the impact of gain-framed messages is sustained longer-term. Unlike the previous message framing literature (see Rothman et al., 1993 for a review), this study assessed behaviour over 12 months. It is the only study that we are aware of, to use gain-framed messages and find long-term change in behaviour.

In addition to the gain-framed messages used in this study, another factor that likely contributed to our intervention's success was targeting the materials to be more meaningful to the study population. This population-specific targeting was achieved by changing information about the consequences of OP, calcium-deficient diets, and

information about aspects of calcium-rich foods written in the standard care materials to information that is more meaningful for this population. It was rationalized that, because young women have been shown to respond more to warnings concerning their physical appearance than to warnings concerning their health (Hayes & Ross, 1987), including physique-related consequences of OP and a calcium-deficient diet would lead to greater changes in dietary behaviour than would standard care messages about health consequences. The promotion of calcium-rich foods focused on taste, convenience, and fat content. These characteristics have been identified as important factors used by young women when selecting foods (Neumark-Sztainer et al., 1999). These more meaningful aspects of calcium-rich foods replaced the calcium content information presented in the control materials. While young women may acknowledge a product's calcium content, nutritional information of this sort has not been shown to influence food choice as much as factors such as taste and convenience (Neumark-Sztainer et al., 1999). In the present study, calcium intake actually decreased when the materials were not tailored to the study population (control condition). Population-specific messages in the experimental condition lead to greater change in calcium intake than general messages did, supporting the hypothesis that targeting messages to the population would lead to greater behavioural change. While it seems logical that more meaningful messages would lead to greater behavioural change, empirical evidence of the mechanisms driving this change is lacking.

The present study contributes to the health messaging literature by demonstrating that making the messages relevant to the study population can change a health behaviour. While many studies have tailored their interventions at the individual level (i.e., according to stage of change in the transtheoretical model; Bellis, Grimley, & Alexander, 2002; Dijkstra, De Vries, Roijackers, & van Breukelen, 1998; Prochaska, DiClememte, Velicer, & Rossi, 1993), we are aware of only one health behaviour study that has targeted the intervention to an entire study population (Schneider et al., 2001). In an attempt to persuade women to obtain breast cancer mammograms, Schneider and colleagues displayed videos that were either gain or loss framed and either targeted specifically to the participant's ethnicity or were multicultural. Surprisingly, loss-framed, multicultural (nontargeted) messages were most persuasive at increasing this health detection behaviour.

Contrary to Schneider and colleagues' findings, the present data showed that targeted messages changed behaviour. Differences between Schneider et al.'s and our study findings may be due to the demographic variable targeted (age versus ethnicity) or the level of "meaningfulness" achieved by the targeted material. Specifically, Schneider et al.'s intervention altered only the ethnicity of the snapshot pictures in the intervention video, which may not have been enough for the participants to feel the information was particularly relevant to them. In contrast, the targeted messages used in the present study highlighted issues shown to be of high concern to women the same age as our study population.

Future Directions

Parts of the elaboration likelihood model (ELM; Petty & Cacioppo, 1979) may help to explain why targeting an intervention to the population works better than general,

may be the elaboration likelihood model (ELM; Petty & Cacioppo, 1979). The ELM states that information that is found interesting will receive greater attention, be processed more thoroughly, and be retained longer than messages that are not considered interesting (ELM; Petty & Cacioppo, 1981). Within the context of the ELM, our findings suggest that the calcium content information given to the control condition may have been ineffective because it was also uninteresting, making it difficult to remember and to apply on the next trip to the cafeteria. Conversely, the simple, short messages in the experimental condition, highlighting valued benefits of calcium-rich foods (e.g., "In a rush? Grab a yogurt!" "Worried about fat content? These are low in fat and high in calcium"), may have been remembered better, recalled more often, and thus had a greater impact on women's food choices.

Effect of the Intervention on HBM Cognitions

The cognitions hypothesized to cause change in calcium intake were those captured by the health belief model (HBM; Rosenstock, 1974). Contrary to hypothesis, the experimental intervention only improved more than the standard care intervention on one measures of HBM construct (self-efficacy). Although there may have been more significant differences between experimental and control conditions had we compared the experimental condition to a no-treatment control condition, it is important to evaluate the effectiveness of standard care. The primary focus of the Osteoporosis Society of Canada (standard care control) materials is to increase calcium consumption as a way to prevent osteoporosis. Thus, it should not be surprising that in our control condition, measures of the HBM constructs also changed. Potential reasons for the lack of an interaction between condition and each HBM construct will be discussed in turn.

Self-efficacy. Although there was no interaction between time and condition for self-efficacy, it was the only HBM construct to show a main effect for group, with higher self-efficacy scores emerging across all time points except baseline for the experimental than the control condition. This finding supports the hypothesis that the experimental intervention would lead to greater changes than the standard care intervention. The gain-framed messages stating the benefits of consuming adequate amounts of calcium probably contributed little to the improvements in self-efficacy, as they focused on the outcomes of a calcium-rich diet, not how one succeeds in consuming a calcium-rich diet. Rather, the population-specific information probably had an effect on self-efficacy because it made reference to how easy it is to incorporate calcium-rich foods in to one's diet (e.g., "No time for calcium? These calcium-rich foods are easy to eat on the run").

These targeted messages can be considered a form of verbal persuasion as they boost confidence in one's ability to consume calcium-rich foods in the face of various barriers. Encouraging statements were provided in the experimental condition on how to consume calcium-rich foods when in a rush, having a sweet or salty craving, worried about fat content, and when trying to buy inexpensive foods. While verbal persuasion is one of four sources of self-efficacy, mastery experiences (i.e., purchasing calcium-rich foods over non-calcium foods) is the strongest source (Bandura, 1997). While self-efficacy may have improved because of verbal persuasion in the experimental condition, long-term improvements in self-efficacy to consume calcium-rich foods were likely a result of participants in this condition having some initial success in consuming more

calcium-rich foods which in turn would lead to greater improvements in self-efficacy. To examine this possibility, a posthoc analysis was conducted. Linear regressions of calcium intake at each time point were tested as predictors of self-efficacy at the succeeding time point. All four regressions were significant, suggesting that self-efficacy improved as a result of mastery experiences associated with consuming calcium-rich foods. Thus, it is possible that persuasive, population-relevant messages acted as a form of verbal persuasion that improved self-efficacy in the experimental condition and, in turn, lead to more actual mastery experiences of consuming calcium-rich foods. Long-term improvements in self-efficacy were likely due to these mastery experiences.

Perceived severity. Contrary to our hypothesis, there were no changes over time or between conditions in perceived severity of calcium-deficient diets and osteoporosis. It is possible that both standard care and experimental materials did not emphasize the severity of calcium-deficient diets enough to cause a change in cognition. The only consequences included in the standard care materials were consequences of osteoporosis, and not of calcium-deficient diets per se. The two mentioned consequences of osteoporosis, painful fractures and getting a humped back, were only briefly referred to. Although the experimental materials mentioned that eating a calcium-rich diet may prevent these consequences, their severity was not explicitly described. It is also possible that participants were already aware of the consequences associated with calcium-deficient diets and osteoporosis that were mentioned in the materials, thus reiterating them in this study did not lead to an increase in perceived severity.

The targeted messaging may also have downplayed the severity of OP and eating appropriate amounts of calcium. The consequences highlighted in these messages were satisfying a sweet tooth, reducing fat content, increasing convenience, and adding variety to one's diet. While these issues are relevant factors young adults consider when purchasing foods (Buscher et al., 2001), they may have been perceived as advertisements for calcium-rich foods, and not as messages emphasizing the severity of failing to consume adequate amounts of calcium. It should be noted, however, that the intervention condition did not have poorer perceived severity than the control condition. In retrospect, both experimental and control conditions did not focus enough on the severity of not consuming enough calcium to cause a change in perceived severity. The standard care materials focused more on the severity of osteoporosis itself, while the experimental materials highlighted the benefits of consuming adequate amounts of calcium and made calcium-rich foods seem appealing.

Perceived susceptibility. Failure to induce greater changes in the experimental condition versus the control condition in perceived susceptibility is consistent with message framing research in this area. Of the few message-framing studies that have assessed perceived susceptibility, most have failed to produce changes in this HBM construct (Meyerowitz & Chaiken, 1987; Robberson & Rogers, 1988; Rothman et al., 1993). However, most studies, including our own, have manipulated the framing of the health behaviour's *consequences* (also known as behavioural framing; Williams, Clarke & Borland, 2001). In contrast, it has been suggested that *statistical* framing (e.g., "among women who develop osteoporosis, *80%/20% will/will not* fracture their hip"), where the information is presented in terms of the probability of experiencing versus not

experiencing the negative outcome, may be more likely to influence perceived susceptibility than behavioural framing (Williams et al., 2001). Had we used statistical framing rather than behavioural framing, we may have been able to induce greater changes in perceived susceptibility.

Although the interaction between time and condition for perceived susceptibility was not significant, there was a significant main effect for time. It is alarming to note that this main effect for time was in the negative direction—participants felt less susceptible to osteoporosis and its consequences over time. These results suggest that the information provided in both the standard care and experimental conditions had a negative effect on perceived susceptibility.

Just as the messages may have also diverted attention from perceived severity, the impact of the population-relevant messages may have diverted attention from perceived susceptibility. Messages that made calcium-rich foods more appealing for this population (i.e., "Got a sweet tooth? Try these inexpensive, yummy, calcium-rich foods!") may have diverted participants' attention from being prone to osteoporosis to considering how appetizing calcium-rich foods are. Thus, neither the gain-framed messages nor the appealing, population-relevant messages invoked changes in perceived susceptibility.

In both conditions, an osteoporosis risk factor checklist designed by OSC was included in the pamphlets. It is possible that, because many of these factors did not apply to the young women (i.e., prolonged sex hormone deficiencies, past menopause, family history of osteoporosis, primary hyperthyroidism, excess use of medication), participants felt less susceptible to the disease. Another explanation for this negative result is that these women were participating in a one-year calcium study. Even though the control condition did not actually increase their calcium intake, the act of being in a year-long study about calcium intake may have made the participants feel that they were actively taking steps towards preventing osteoporosis.

Perceived benefits. Perceived benefits of a calcium-rich diet increased over time for both conditions. There was a trend for the experimental condition to perceive more benefits than the control condition. The experimental materials explicitly listed 11 benefits of consuming adequate amounts of calcium as part of the gain-framed messages. We suspect that simply reading more benefit-framed messages explains the tendency for participants in the intervention condition to have perceived more benefits than the control condition.

In addition to the overall gain-framed disposition of the materials, the population-relevant messages promoted calcium-rich foods as inexpensive, tasty, low-fat, convenient and exciting foods. As a result, participants *may have* perceived these characteristics of calcium-rich foods as benefits. For example, a benefit of consuming calcium-rich foods is that it can satisfy a craving for sweet (e.g., milkshake) and/or salty (e.g., soy nuts, almonds) foods. Making calcium-rich foods more appealing in the experimental materials likely contributed to the trend for participants in the experimental condition to perceive more benefits than those in the control condition.

Perceived barriers. Perceived barriers to consuming adequate amounts of calcium decreased equally over time in both conditions. The absence of differences between the conditions indicates that the standard care materials were just as effective as

the experimental materials at minimizing perceived barriers to consuming enough calcium daily. Reflecting on our perceived barriers measure, this is not surprising. Of the six barriers measured, only one ("I think calcium-rich foods are fattening") was targeted in the experimental materials through population-relevant messages. The remaining five measured barriers were not addressed through the intervention (campus not selling the calcium-rich dairy and/or non-dairy foods they like, suffering from gas, inability to afford calcium-rich foods, calcium-rich foods spoiling too quickly), and thus, scores on these items would not be expected to change. Another measurement problem was that the barriers scale lacked internal consistency, and as a result, could not be summed. Counting the number of barriers participants agreed or strongly agreed as having resulted in a small range of scores. Although the range of scores was limited to 0 – 6, both conditions' mean barrier scores at all time points hovered at one, indicating a floor effect. The low scores suggest that the scale items were not barriers that were preventing participants from consuming adequate amounts of calcium.

In summarizing the impact of the intervention on the HBM constructs, changes in self-efficacy, perceived susceptibility, benefits, and barriers occurred in both conditions. The experimental materials were more effective at improving self-efficacy, and to some extent perceived benefits, than the standard care materials. Self-efficacy has been referred to as one of the most potent cognitive predictors of health behaviours (Bandura, 1997). We were successful at improving self-efficacy more in the experimental condition than the standard care, probably through verbal persuasion and subsequent mastery experiences. Perceived severity was not changed in either condition, and changes in perceived susceptibility were in the wrong direction (i.e., participants felt less susceptible to OP over the course of the study). Although we failed to support our hypothesis that the experimental materials would change all HBM constructs more than the standard care, we were still able to increase calcium intake in the experimental condition.

Effect of HBM Constructs on Calcium Intake

The third hypothesis was that the HBM constructs would predict calcium intake. The health belief model posits that the decision to perform or not perform a preventive behaviour is made upon logical, rational decision-making (Janz & Becker, 1984). According to the HBM, how threatening the perceived outcome is (i.e., perceived severity and susceptibility of osteoporosis) and one's evaluation of the behavioural outcome (whether perceived benefits outweigh perceived barriers of consuming adequate amounts of calcium) should determine if adequate calcium is consumed. Contrary to these predictions, the HBM failed to predict calcium intake. The only significant predictor of calcium intake was self-efficacy, which only predicted calcium intake during week one. Overall, our intervention had similar effects on HBM constructs as the control condition, but only those in the experimental condition increased their calcium intake. Having found no significant time by group interaction effects for the HBM variables, it is not surprising that the HBM failed to predict calcium intake. These nonsignificant regression results suggest that there are factors other than health beliefs that are important in determining whether young women consume adequate amounts of calcium. One of those factors may simply be how interested one is in the information provided.

As with all sociocognitive theories and models, the HBM assumes that individuals are cognitively taking the intervention materials into consideration. One aspect that we were not able to assess in the current study was the level of processing of materials. It has been suggested that high participant interest leads to systematic processing (Petty & Cacioppo, 1981). Although we gave the same number of intervention materials to each group, it may have been that those in the intervention condition were more interested in their materials, and thus referred to their material more frequently and/or remembered more of the calcium-rich food suggestions than the control condition. Indeed, the elaboration likelihood model (ELM; Petty & Cacioppo, 1979) suggests that messages that attract greater attention are processed more thoroughly, are remembered longer, and are taken into greater consideration than messages that are of less interest. For example, each page of the notepad given to the intervention condition had a gain-framed message aimed at enticing the participants to consume calcium-rich foods. Paraphrasing each calcium-rich food item with appetizing adjectives may have lead to greater interest as compared to the control condition notepad, in which only the amount of calcium in milligrams was written beside each calcium-rich food.

The population-specific messages may have also lead to greater systematic processing of the materials. Petty and Cacioppo (1979) found that by making messages relevant to participants, they were able to increase the cognitive response to the issue. In our study, we made the messages relevant to our study sample by targeting issues of high concern to women of this age. Since the population-specific materials were designed to target physique issues proven to be of high concern to young women (e.g., "Eating a calcium-rich diet can help you look better by building strong, healthy nails" and "making your hair look shiny and healthy"), it is quite possible that the women in the intervention condition were processing the material more systematically than the control condition, where the issues in the standard care materials were not as of high concern. Because greater cognitive integration of the materials is achieved through systematic processing, it is possible that those in the intervention condition were better able to recall the calcium-rich food suggestions than the control condition. If systematic processing was the reason for the differences in calcium intake between groups, this would explain why the HBM failed to predict calcium consumption.

In response to the HBM's failure to mediate the effects of message-framing on other preventive health behaviours (Schneider et al., 2001; Banks et al., 1995; Detweiler et al., 1999; McCall & Martin Ginis, in press; Rothman et al., 1993), researchers have suggested that the decision to perform such behaviours may have less to do with cognitive decision making and more to do with basic emotion (Lee, 1996; 1998; Williams et al., 2001). While much of theory development explaining human behaviour focuses on cognitive predictors, Lee argues that behaviours may be altered with little cognitive thought processes (Lee, 1996). For example, when message framing was used to try to increase physical activity in older adults with cardiovascular disease, the intervention had minimal impact on the HBM cognitive measures used, despite changes in exercise behaviour (McCall & Martin Ginis, in press). Similarly, in a study attempting to change breast cancer detection practices through message framing, Williams, Clarke and Borland (2001) had parallel results as the present study—the messages had a direct influence on

behaviour with no significant changes in proposed cognitive mediators. It was suggested that participants might have attended more breast cancer screening programs after the intervention to simply avoid anxiety or guilt. Likewise, anticipated regret (fear of guilt that would result if the behaviour was not performed and consequently one developed the preventable disease) was a very strong predictor of future cancer screening behaviour (Lechner, de Vries, & Offermans, 1997) and intention (Lechner, de Vries, 2002). Unfortunately, basic emotions such as guilt and anticipated regret were not analyzed in the present study. However, the present study findings coincide with most other failed research attempts to find cognitive mediators in message framing interventions.

Practical Implications

Implications for developing osteoporisis preventive, public health standard care materials are twofold. The present research provides evidence that framing messages in terms of the benefits to be gained is more effective for promoting calcium intake than framing messages in terms of what stands to be lost. Rephrasing existing materials to be gain-framed would require little time and cost, and could result in a change in actual behaviour, not just knowledge (Sedlak et al., 2000). The second key to improving the current standard care materials would be to target the materials to the population of concern. It is unrealistic for the Osteoporosis Society of Canada to create new materials for every subset of the population. However, young women must be given special attention because of their susceptibility to osteoporosis in the future and their ability to prevent osteoporosis if they take action now. Considering the impact of consuming adequate amounts of calcium on growing bones (Teegarden, Lyle, Proulx, Johnston, & Weaver, 1999) and the importance peak bone density plays in the prevention of OP (Hansen, Overgaard, Riis, & Christiansen, 1991; Khan et al., 2001), it would be advantageous to create a new set of preventive-OP materials that are targeted to discuss issues that are of highest concern to young women.

Future Research

The present study provided little support for the HBM's ability to predict calcium intake. While message framing has been shown repeatedly to work at changing behaviours (Christophersen & Gyulay, 1981; McCall & Martin Ginis, in press; Rothman et al., 1993), there remains almost no evidence of its cognitive mediators (Detweiler et al., 1999; McCall & Martin Ginis, in press; Rothman et al., 1993; Schneider et al., 2001). The fact that gain-framing and targeting messages changed young women's dietary behaviour without changing HBM cognitions adds to a growing body of literature that suggests human behaviour may not always be the result of a complex cognitive decision-making process. The scientific community could learn much from future research assessing the effect of gain-framed, targeted interventions on emotions such as guilt, which could mediate changes in behaviour. This study has shown that the HBM cognitions are not the mechanisms by which targeted messages and message framing works to change behaviour. The next step is to uncover the underlying mechanisms so that future interventions can be more cost-efficient (focusing on only the variables that mediate change in behaviour) and consistently successful at causing behavioural change (Baranowski, Anderson, & Carmack, 1998).

Other understudied potential mechanisms by which message framing and targeting affect behaviour may be through the constructs of the ELM (Petty & Cacioppo, 1981). More quantitative research is needed on the relationship between message framing and level of interest, population-specific messaging and level of interest, as well as the potential role played by level of interest and issue involvement in performing health behaviours. Again, discovering the mechanisms by which the current intervention worked is crucial to create more effective public health campaigns.

Increasing calcium intake is one of many preventive behaviours that are addressed through public health campaigns. The success of the intervention in the present study warrants assessment in other health preventive behaviours. Since there are several existing public health campaigns (e.g., for using sunscreen, seatbelts, decreasing risk of coronary heart disease), researchers could follow the framework used in this study and make the campaign materials gain framed and specific to the population targeted. Testing the effectiveness of gain-framed, targeted materials versus standard public health materials would assess the generalizability of the intervention principles used in this study. Considering the increasingly high mortality rate due to preventable diseases in North America, it is imperative that we learn how to best promote positive behavioural change (Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 1999).

Limitations

To the best of our knowledge, the present study is the first to successfully change young women's calcium intake behaviour without the use of expensive, labour-intensive bone density testing. There are, however, limitations to these findings. First, the intervention materials were designed to improve upon the standard care materials in two ways: utilizing gain-framed messages and targeting messages to the study population. While this intervention proved very successful, we were not able to tease out which aspect of the intervention led to improvements in the experimental condition or whether its success was the combination of the two aspects.

Another limitation is that the primary outcome, calcium intake, was assessed by self-report food logs throughout the year. Although considered a valid and reliable measure, it is a common phenomenon for individuals to alter their diet when they know it is going to be assessed (Thompson, Byers, & Kohlmeier, 1994). It is possible that participants in this study altered their typical diet on the days in which they were asked to complete a food log. This phenomenon, however, cannot explain why the experimental condition reported significantly more than the control condition, as the control condition was given the same information as the experimental condition, and also had to report their diet on food logs. Thus, the possibility of participants misreporting on the food logs cannot explain the group differences in calcium intake observed in this experiment.

A third limitation was the lack of congruence between study intervention materials and the HBM. The Osteoporosis Society of Canada's (OSC) materials used in the control condition provided the framework for developing the experimental materials. The OSC materials did not directly target all constructs of the HBM in their materials, thus, neither did the experimental materials. As a result, failure to produce changes in all of the HBM constructs may have been due to the fact that they were not addressed in the

interventions adequately. Nonetheless, significant changes were made in dietary intake. We can only conclude that dietary changes can be made without altering the HBM constructs.

Conclusion

Unlike many other osteoporosis preventive studies, we were able to increase calcium intake for an extended period of time without the use of expensive equipment or one-on-one counselling. The present intervention was probably successful because it made calcium-rich products enticing to young women. Simple changes to the current standard care materials that could make them more effective are phrasing the messages in a gain-framed manner, and targeting the population of concern by making the materials relevant for them. Findings from the present study have important implications for the prevention of OP in women, but may also be of use in the promotion of health behaviours in general.

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Appendix A

Participant Letter of Information and Informed Consent Letter

McMASTER UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

You are asked to participate in a research study conducted by Drs K. Martin and S. Phillips, M.Sc. student Mary E. Jung, and Ph.D. student Lora Giangregorio from the Department of Kinesiology, McMaster University. This study is funded by the Danone Institute of Canada.

If you have any questions or concerns about the research, please feel free to contact Mary Jung at (905) 525-9140 extension 27624 or the primary Faculty Investigator: Dr. K. Martin at (905) 525-9140 extension 23574.

PURPOSE OF THE STUDY
This study is designed to look at young women's' response to educational interventions aimed at increasing dietary calcium.

PROCEDURES
If you volunteer to participate in this study, we will ask you to come in to the laboratory two times for sampling and to fill out a few brief pen and paper questionnaires. The testing includes 1 blood and urinary sample, and 1 low-dose upper arm scan per visit. In addition, you will be sent questionnaires and asked to return them completed a total of three times throughout the study. Questions pertain to the number of times you consume calcium, and your thoughts and beliefs about obtaining enough calcium in your diet. If you choose to be in this study, you may refuse to answer any questions you don't want to answer or withdraw at any time without any consequences. Prepaid envelopes will be included in all mail packages sent to you. A copy of this signed consent form will be given to you at the following meeting time.

POTENTIAL RISKS AND DISCOMFORTS
There will be two scans of your arm spaced 1 year apart. The exposure to radiation from this machine is not considered more than what one would receive from everyday natural radioactivity during a typical day. Two blood samples will be drawn over the span of 1 year for a total of 20 mL. Slight bruising may occur at the sight of puncture.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY
As a participant, you may derive benefit from learning about the essential nutrient calcium and how it affects you. At the end of the study, you will also receive results of your physiological bone calcium markers: urinary deoxypyridinoline, serum osteocalcin, and pQCT values, which may detect any warning signs of osteoporosis or abnormal bone status. Increases in the amount of calcium ingested during this critical time of bone growth will improve bone health and decrease the risk of osteoporosis.

The scientific community will benefit by being able to expand its knowledge known about influences on dietary choices.
These findings can benefit society by leading to the development of educational interventions that more effectively reach the target population, young females, who tend to have the lowest calcium intake and are therefore the most at risk for bone and health diseases.

PAYMENT FOR PARTICIPATION
You will be awarded $10 each time you visit the IWC for an appointment (at week 1, 2 and 52 of the study, for a total of $30). In addition, for every package of questionnaires you complete and return, you will be compensated $5 for you time and efforts. Thus, a total of $50 will be awarded to each participant who completes this year-long study.

CONFIDENTIALITY
Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law.

Having participant data being referred to by numerical codes will ensure anonymity of all information received from you. All data will be secured in a locked filing cabinet in the Health and Exercise Psychology Laboratory at McMaster University, accessible only by the student researcher and faculty investigators. Should the results be published in a research journal, participant names will not be disclosed.

PARTICIPATION AND WITHDRAWAL
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS
You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the McMaster Research Ethics Board (MREB). If you have any questions regarding your rights as a research subject, you may contact the Hamilton Health Sciences Patient Relations Specialist at 905-521-2100, Ext. 75240.

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE
I understand the information provided for the study "**CALCIUM INTAKE IN YOUNG WOMEN** " as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Name of Participant

_____ _____
Signature of Participant Date

SIGNATURE OF INVESTIGATOR

In my judgement, the participant is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent to participate in this research study.

_____ _____
Signature of Investigator Date

Appendix B

Eligibility Food Frequency Questionnaire

Demographics Questionnaire

The aim of this questionnaire is to get an estimate of your present calcium intake. Please be honest and fill in all spaces where appropriate.

Student ID #: | X | X | | | | | | Phone ext: _____
Age: _____

1. Think of what you ate yesterday.
2. Find the items you ate yesterday in the lists of foods.
3. Enter the number of servings you had of that item, using half sizes if necessary (e.g., 0, 0.5, 1, 1.5, 2, etc.)

Remember to count the milk you put in tea or coffee and on cereal when completing your milk intake!

This table is a modified excerpt from the Calcium Calculator - copyright BC Dairy Foundation, 1999.

FOOD:	USUAL SERVING SIZE:	# OF SERVINGS YESTERDAY:
Bread	2 slices	
Broccoli, cooked	3/4 cup (188mL)	
Kidney beans, lima beans, or lentils	1 cup (250 mL)	
Orange (fruit, not juice)	1 medium	
Tahini (sesame seed paste)	2 Tbsp	
Bok choy or kale, cooked	1/2 cup (125 mL)	
Chickpeas (garbanzo beans)	1 cup (250 mL)	
Cottage cheese (regular or low fat)	1/2 cup (125 mL)	
Ice cream	1/2 cup (125 mL)	
Parmesan cheese	1 Tbsp	
Almonds	1/4 cup (84 mL)	
Baked beans, soybeans or white beans	1 cup (250 mL)	
Frozen yogourt or ice milk (regular or low fat)	1/2 cup (125 mL)	
Pancakes or waffles made with milk	3 medium	
Pudding made with milk	1/2 cup (125 mL)	
Soft cheese such as Feta, mozzarella,	1 1/4" cube (50g)	

camembert (regular or low fat)		
Soup made with milk	1 cup (250 mL)	
Tofu fortified with calcium	3 oz (75 g)	
Firm cheese such as cheddar, Swiss, or gouda (regular or low fat)	1 1/4" cube (50 g)	
Processed cheese slices (regular or low fat)	2 slices	
Canned salmon with bones	1/2 can	
Canned sardines with bones	1 can	
Fruit flavoured yogourt (regular or low fat)	3/4 cup (150 mL)	
Milk (skim, 1%, 2%, homo, buttermilk, or chocolate)	1 cup (250 mL)	
Calcium fortified soy or rice beverages	1 cup (250 mL)	
Calcium fortified orange juice	1 cup (250 mL)	
Skim milk powder	1/3 cup (84 mL)	
Plain yogourt (regular or low fat)	Small tub (150 g)	

Any other foods consumed yesterday that contained calcium?	YES: _____ NO: _____	If yes, what? _____ Amount eaten: _____ Brand name: _____
Was your food intake yesterday typical?	YES: _____ NO: _____	If no, what was different? _____ _____
Calcium supplement (e.g. Tums, Rolaids, Calcitriol)	Name of supplement: _____	How many you take each day: _____ Mg of calcium in each: _____ How many days/wk you take: _____

Thank you for your time. Please be sure that you have answered all questions before moving on.

DEPARTMENT OF KINESIOLOGY, MCMASTER UNIVERSITY

For the purpose of this study, it is important that we know a little bit about your medical history. Your responses to the following questions will be kept strictly confidential. If you are unsure of what any question is asking you, please consult the investigator for clarification.

Current/School Contact Information:

Email: ____________________________

Phone extension #: (905) 525 - 9140 x. ______ Other Phone #: (______) ___-____

Residence Building: ______________ Room #: ______

Permanent/Home Contact Information:

Email: ____________________________

Phone #: (______) ___-____

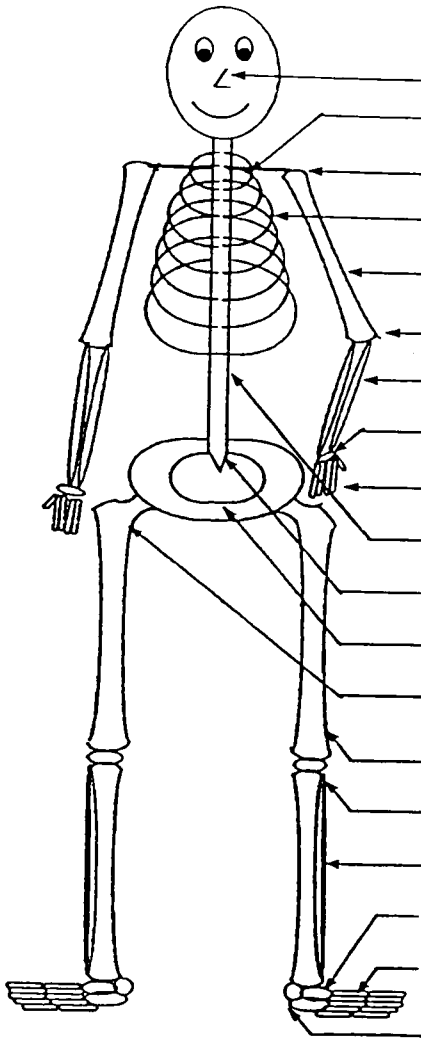
Street: ______________ Postal Code: ___ ___

1. In the past 12 months, how many times have you been to each of the following:

	Total number of times:		How many times of these were related to bone health and/or calcium intake?
a. Family doctor	____	→	____
b. Orthopaedist	____	→	____
c. Fracture clinic	____	→	____
d. Dietician	____	→	____

2. Which hand do you write with predominantly?
   RIGHT ☐ LEFT ☐
3. If you play sports using hand-held equipment, which hand do you use predominantly?
   RIGHT ☐ LEFT ☐
4. If you've ever fractured a wrist or forearm, indicate where:
   RIGHT ☐ LEFT ☐
5. If you've ever fractured any of the highlighted body parts below, use the diagram below to indicate which side of the body (or check both if you broke right AND

left) and what age(s) each fracture occurred. If you have never broken any of these bones, skip to question 6.



	Side R/L	Age at 1st fracture	Age at 2nd fracture
Nose			
Collarbone	☐ R ☐ L		
Shoulder	☐ R ☐ L		
Ribs	☐ R ☐ L		
Upper arm	☐ R ☐ L		
Elbow	☐ R ☐ L		
Lower arm	☐ R ☐ L		
Wrist	☐ R ☐ L		
Hand (not incl. fingers)	☐ R ☐ L		
Spine			
Tailbone			
Pelvis			
Hip	☐ R ☐ L		
Upper leg	☐ R ☐ L		
Knee	☐ R ☐ L		
Lower leg	☐ R ☐ L		
Ankle	☐ R ☐ L		
Foot (not incl. toes)	☐ R ☐ L		
Heel	☐ R ☐ L		

6. At approximately what age did you first begin menstruating?

YEAR: |1|9|__|__| MONTH: |__|__|

7. Considering your menstrual cycles, your periods are or were:

a) During adolescence (onset -17 yrs old)

every 14-24 days	every 25-35 days	every 36-90 days	1-2 x's year	3-4x year	absent
☐	☐	☐	☐	☐	☐

b) Within the last year (18-19 yrs old)

every 14-24 days	every 25-35 days	every 36-90 days	1-2 x's year	3-4x year	absent
☐	☐	☐	☐	☐	☐

8. When did you last menstruate?
   ☐ last month ☐1-3months ago ☐ 4-6 months ago ☐ 7-12 months ago
   ☐ more than 1 year ago

   Calendar date of beginning of last menstrual period: DAY: |__|__|
   MONTH: |__|__|
9. Have your periods ever been **absent** for more than 6 months? ☐ no ☐ yes
   →Why? _____

10. Have you ever been pregnant? ☐ yes ☐ no → if no, skip to the next question.
# of children you've given birth to: |__|__| # of pregnancies not carried to term: |__|
# of months you've breastfed: |__|__|

11. Have you ever taken any of the following?
If yes, total duration:

Birth control pills ☐ never ☐ yes, in the past ☐ yes, currently |__|__|months
(or other forms of hormone contraceptive)

Estrogen ☐ never ☐ yes, in the past ☐ yes, currently |__|__|months
(e.g., Premarin, Estrace, Ogen, patches)

Thyroid medication ☐ never ☐ yes, in the past ☐ yes, currently |__|__|months

Medication to regulate your periods ☐ never ☐ yes, in the past ☐ yes, currently |__|__|months
or menstrual symptoms (not including birth control)

Calcium (including TUMS) ☐ never ☐ yes, in the past ☐ yes, currently |__|__|months

Vitamin D (incl. Halibut liver oil) ☐ never ☐ yes, in the past ☐ yes, currently |__|__|months

Calcitonin (e.g., Calcimar) ☐ never ☐ yes, in the past ☐ yes, currently |__|__|months

If you answered yes to any of the above, please indicate the name and date started (and ended, if applicable) of any of the above:

Name of drug	Reason for taking drug	Date when started	Date when ended	Dose in mg in each tablet

Have you ever taken any of the following medications:
☐ antiepileptics → name, dates taken:

_____

☐ corticosteroids → name, dates taken:

_____

☐ cancer chemotherapies → name, dates taken:

_____

☐ immunosuppressants → name, dates taken:

_____

12. List any other medication, supplement, herbs, vitamins and minerals that you are taking at this time:

Name of substance:	**Reason for taking:**	**Date when started:**	**Amount taken per day (e.g., how many tablets each day):**	**Dose in each tablet:**

13. Have you ever been treated for:
    a. Parathyroid problems? ☐ no ☐ yes → If yes, how long ago were you diagnosed? |__|__| months ago
    b. Thyroid problems? ☐ no ☐ yes → If yes, how long ago were you diagnosed? |__|__| months ago
    c. Kidney stones? ☐ no ☐ yes → If yes, how long ago were you diagnosed? |__|__| months ago Osteopenia? ☐ no ☐ yes → If yes, how long ago were you diagnosed? |__|__| months ago Eating disorder(s)? ☐ no ☐ yes → If yes, how

long ago were you diagnosed? |__|__| months ago
Osteoporosis/osteopenia? ☐ no ☐ yes → If yes, how long ago were you diagnosed? |__|__| months ago

14. Has your grandparent(s), parent(s), aunt(s), uncle(s), or sibling(s) had any of the following conditions:
    a. Fracture of the hip ☐ no ☐ yes → If yes, whom? _____ At what age? |__|__|
    b. Fracture of the spine ☐ no ☐ yes → If yes, whom? _____ At what age? |__|__|
    c. Fracture of wrist or other ☐ no ☐ yes → If yes, whom? _____ At what age? |__|__|
    d. Developed humped back ☐ no ☐ yes → If yes, whom? _____ At what age? |__|__|
    e. Osteoporosis ☐ no ☐ yes → If yes, whom? _____ At what age? |__|__|
    f. Thyroid disease ☐ no ☐ yes → If yes, whom? _____ At what age? |__|__|
    g. Kidney stones ☐ no ☐ yes → If yes, whom? _____ At what age? |__|__|

15. Do you have a dairy product sensitivity, allergy, or intolerance? ☐ yes ☐ no →if no, go to question #17.

Age at onset: |__|__| years Has it caused you to supplement your diet with other foods? ☐ yes ☐ no

16. Estimate how many cups (1 cup = 250mL) of milk you consumed daily between the ages of 10-18: |__|__| cups/day
17. Are you vegetarian (no meat products)? ☐ no ☐ yes → if yes, for how long? |__|__| months
18. Are you vegan (no animal foods, dairy or eggs)? ☐ no ☐ yes → if yes, for how long? |__|__| months
19. Do you consume alcoholic beverages? ☐ yes ☐ no →if no, skip to question #21.
    *1 drink = 1.5 oz shot = 12 oz. beer = 4 oz. wine
    a. If yes, how many drinks* per week do you currently consume? |__|__| drinks/week
    b. How long have you been drinking in this fashion? |__|__| months

20. How many cups (1 cup = 250 mL) of the following do/did you drink per day, on average?

Type of drink	**Ave. # of cups/day now:**	**Ave. # of cups/day in past**	**Brand name, if known:**
Coffee (not decaf.)			
Black Tea (not decaf. or herbal)			
Hot chocolate			
Green Tea (not decaf. or herbal)			
Cappuccino			
Other caffeinated beverages (e.g., pop)			

21. Each ethnic background has unique bone characteristics. Because we will be looking at bone density, it would be useful to know your racial origin:

☐ Black (e.g., African, Haitian, Jamaican, Somali)
☐ Caucasian
☐ Arab/West Asian (e.g., Egyptian, Iranian, Lebanese)
☐ Indigenous Peoples (e.g., Inuit, Mètis, North American Indian)
☐ Asian (e.g., Chinese, Japanese, Korean)
☐ other (specify): _____

22. Have you **ever** smoked tobacco?

☐ never → go to question #24
☐ not now, but previously from time to time
☐ not now, but previously on a regular basis
☐ yes, currently from time to time
☐ yes, currently on a regular basis

a. How long have/did you smoked in total? |__|__| months

b. On average, how many cigarettes do you smoke per day? |__|__| cigarettes/day

23. Have you experienced weight loss or weight gain in the last five years? If so, fill out the chart below:

Total change in weight (in lbs):	When weight change occurred:	How long new weight was maintained:	Cause of weight change:

REGULAR EXERCISE DONE IN THE **PAST 12 MONTHS**

Student ID #: | X | X | | | | | | Date: | 2 | 0 | 0 | | | | | | |
YEAR MONTH DAY

Please read through the list of activities below. If you have done any of the following types of exercises regularly (at least once per week for 3 consecutive months or more) during your spare time (i.e., walking does not include commuting to and from school), indicate how much time you spend per week engaging in this activity at each specified intensity. If you do not partake in one or all of the listed activities, leave that row blank. Remember, all information is kept strictly confidential. Please answer as honestly as possible.

ACTIVITY	AVERAGE # OF MINUTES PER WEEK SPENT AT EACH INTENSITY LEVEL:		
	LIGHT	**MODERATE**	**HEAVY**
	Slight increase from normal breathing	Some sweat, above normal breathing	Excessive sweating, fast paced breathing
Ball sports (e.g., basketball, soccer)			
Callisthenics (e.g., pushups, sit-ups)			
Cardio fitness classes (e.g., step, tai boxing)			
Fast-paced martial arts (e.g., karate, kickboxing)			
Hiking/backpacking			
Jogging/running			
Muscle fitness classes (e.g., sculpting classes)			
Racquet sports (e.g., tennis, squash)			
Resistance/weight training			
Skipping			
Walking/power-walking			
Yoga or Pilates			

Appendix C

Study Outcome Questionnaires

FOOD LOG FOR WEEKDAY

Student ID #: |_X_|_X_|___|___|___|___|___| Day: _____ Month: _____ Year: _____

Time (e.g., 8:15 am)	Place (e.g., Commons)	Food Eaten - **Include brand names + be specific!** (e.g., multigrain Cheerios with 1% milk, can of MinuteMaid orange juice)	Amount Eaten (e.g. 1 1/4 cups cereal, 1 (250mL) carton milk, 355mL juice)
BREAKFAST			
SNACK			
LUNCH			
SNACK			
DINNER			
SNACK			
SNACK			

WHAT DO YOU THINK ABOUT CALCIUM-RICH FOODS?
The table below lists some examples of common dairy and non-dairy foods that are high in calcium.

CALCIUM-RICH **DAIRY** FOODS	CALCIUM-RICH **NONDAIRY** FOODS
Milk (skim, 1%, 2%, whole, buttermilk, or chocolate) Yogurt Cheese (hard or soft varieties) Ice cream Pudding made with milk	Fortified soy milk Tofu (soybean curd) Almonds Broccoli Sardines with bones or salmon with bones Sesame seeds Hazelnuts/Filberts

Please indicate the extent to which you agree with each of the following statements, by placing a √ in the appropriate box.

To what extent do you agree with each of these statements?	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1. I think calcium-rich foods are fattening.					
2. Campus food markets do not sell the calcium-rich **dairy** foods I like.					
3. Calcium-rich **dairy** foods spoil too quickly to keep on hand.					
4. I suffer from gas when I consume calcium-rich **dairy** foods.					
5. Campus food markets do not sell the calcium-rich **nondairy** foods I like.					
6. I cannot afford calcium-rich **nondairy** foods, such as soymilk, almonds. or tofu.					

WHAT DO YOU THINK YOU COULD GAIN FROM INCREASING YOUR CALCIUM INTAKE?

The table below lists some examples of common dairy and non-dairy foods that are high in calcium.

CALCIUM-RICH **DAIRY** FOODS	CALCIUM-RICH **NONDAIRY** FOODS
Cheese (hard or soft) Ice Cream Pudding made with milk Yogurt Milk (skim, 1%, 2%, whole, buttermilk, or chocolate)	Fortified soy milk Tofu (soybean curd) Almonds Broccoli Sesame seeds Hazelnuts/Filberts Sardines with bones or salmon with bones

For each question, place a √ in the box that most closely represents your level of confidence.

How confident are you that your consumption of calcium-rich foods will:	**Not at all confident**	**A little confident**	**Fairly confident**	**Very confident**	**Extremely confident**
1. be pleasurable to your eating habits.					
2. help you get the protein that you need.					
How confident are you that eating calcium- rich foods OR taking a calcium supplement will:	**Not at all confident**	**A little confident**	**Fairly confident**	**Very confident**	**Extremely confident**
3. decrease your chances of developing cancer.					
4. decrease your chances of developing heart disease.					
5. promote essential blood clotting.					
6. prevent you from developing a humped back as you get older					
7. prevent you from shrinking as you get older.					
8. prevent you from getting shin splints and/or bone fractures.					
9. help your nervous system function properly.					
10. help your fingernails grow long and healthy.					
11. prevent you from developing osteoporosis.					
12. make you feel good about your eating habits.					
13. help your hair look shiny and healthy.					

ARE POSSIBLE CONSEQUENCES OF A CALCIUM-DEFICIENT DIET IMPORTANT TO YOU?

Please indicate the degree to which you agree with each of the following statements by placing a √ in the appropriate box.

To what extent do you agree with each of these statements?	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1. Developing shin splints and/or fractures due to inadequate calcium consumption would have a major impact on my life.					
2. My feelings about myself would change if I had osteoporosis.					
3. Developing brittle hair or nails due to inadequate calcium consumption would change the way I feel about myself.					
4. I would experience a lot of physical pain if I had osteoporosis.					
5. I would look much worse if I had osteoporosis.					
6. The thought of having osteoporosis scares me.					
7. If my failure to eat calcium-rich foods led to brittle hair and nails, I would look a lot worse.					
8. My body would be crippled if I had osteoporosis.					
9. In addition to osteoporosis, there are other serious health conditions associated with a calcium deficient diet.					
10. I am scared by the thought of developing other health problems (**besides osteoporosis**) due to inadequate calcium consumption.					
11. If I were to experience other health problems (**besides osteoporosis**) as a result of inadequate calcium consumption, this would have a major impact on my life.					

DO YOU THINK YOU ARE LIKELY TO EXPERIENCE CERTAIN PHYSICAL OUTCOMES?

For each question, place a √in the box that most closely represents your level of agreement.

To what extent do you agree with each of these statements?	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1. Failure to consume enough calcium puts you at risk for poor muscle functioning (e.g., muscle cramps, unsatisfactory workouts). *I am at risk for poor muscle functioning.*					
2. Because of my body build, *I am more likely to develop osteoporosis.*					
3. Failure to consume enough calcium puts you at risk for developing a humped back when you get older. *I am at risk of developing a humped back.*					
4. Failure to consume enough calcium puts you at risk for dental problems such as chipping and/or losing teeth. *I am at risk for dental problems.*					
5. Failure to consume enough calcium makes the chances of you developing osteoporosis high. *I am at risk of developing osteoporosis.*					
6. Failure to consume enough calcium makes the chances of me developing ***other*** health problems (**besides osteoporosis**) high. *I am at risk of developing other health problems.*					
7. My family history makes it more likely that *I will get osteoporosis.*					
8. Failure to consume enough calcium puts you at risk for experiencing painful shin splints and bone fractures. *I am at risk of experiencing shin splints and bone fractures.*					
9. There is a good chance that *I will get osteoporosis.*					
10. Failure to calcium consumption makes you more prone to have weak and brittle nails or hair. *I am at risk to developing weak and brittle nails or hair.*					

HOW CONFIDENT ARE YOU IN YOUR ABILITIES OVER THE NEXT MONTH?

For each question, place a √in the box that most closely represents your level of confidence.

	I think I definitely can't		I think I probably can't			I think maybe I can			I think I probably can		I think I definitely can
How confident are you in your ability to do the following over the next month:	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
1. Include calcium-rich foods in your diet.											
2. Monitor your daily calcium intake.											
3. Afford to buy calcium-rich foods.											
4. Know what foods are good sources of calcium.											
5. Choose calcium-rich foods over calcium-deficient ones.											
6. Include calcium-rich foods into 1 meal/day.											
7. Include calcium-rich foods into 2 meals/day.											
8. Include calcium-rich foods into 3 meals/day.											
9. Have calcium-rich snacks on-hand.											
10. Order calcium-rich foods in cafeterias and restaurants.											
11. Determine whether you need to take a calcium supplement or not.											
12. Have access to calcium-rich foods at mealtimes.											

Appendix D

Intervention Materials

Messages Written on Notepad

CONTROL	EXPERIMENTAL
Milk (2%, 1%, skim) 1 glass has 300 mg of calcium	Got a sweet tooth? Try a cold and creamy milk shake or smoothie made with calcium-fortified soy milk.
Buttermilk 1 glass has 285 mg of calcium	Got a sweet tooth? Try a sweet and tasty yogurt or frozen yogurt.
Mozzerella Cheese 1 ¼" cube has 200 mg of calcium	Sweet treats: ice cream, a milk chocolate bar, hot chocolate with milk, and chocolate milk.
Cheddar, Edam, or Gouda Cheese 1 ¼" cube has 245mg of calcium	Got a sweet tooth? Smooth and creamy pudding made with milk can satisfy your craving.
Plain Yogurt ¾ cup has 295 mg of calcium	Worried about fat content? Skim milk (non-fat milk) actually has more calcium than whole milk.
Powder or Dry Milk 1/3 cup has 270 mg of calcium	Worried about fat content? Fat-free calcium-fortified soy milk and soy beverages are tasty dairy alternatives.
Ice Cream ½ cup has 80 mg of calcium	Worried about fat content? Try yogurt in low-fat and fat-free varieties.
Cottage Cheese (1% or 2%) ½ cup has 75 mg of calcium	Worried about fat content? Fat-free bean curd (tofu) is a satisfying meat alternative.
Sardines, with bones ½ can has 200 mg of calcium	No time for calcium? A smooth and creamy yogurt drink is easy to eat on the run!
Salmon, with bones - canned ½ can has 240 mg of calcium	No time for calcium? A carton of refreshing calcium-fortified orange juice is easy to eat on the run.
Fortified Soy Beverage 1 glass has 285 mg of calcium	Need a salt fix? Grab a handful of crunchy almonds or brazil nuts.
Almonds ¼ cup has 95 mg of calcium	Party time? Choose a slice of cheese pizza.
Sesame Seeds ½ cup has 95 mg of calcium	No time for calcium? Cheddar cheese sticks are satisfying snack.
Beans – cooked (kidney, lima) 1 cup has 50 mg of calcium	Packing your lunch? Add variety to your diet. Canned salmon with bones makes a great salad or sandwhich.
Soybeans – cooked 1 cup has 170 mg of calcium	Add variety to your diet! Sprinkle grated cheddar cheese on your salad and vegetables for added taste.
Tofu – with calcium sulfate 3 oz. Has 150 mg of calcium	Add variety to your diet! Broccoli, beans, and bok choy add variety as well as a

	modest amount of calcium.
Bran Muffin 1 muffin has 100 mg of calcium	
Whole Wheat Bread 2 slices has 40 mg of calcium	
Broccoli – cooked ¾ cup has 50 mg of calcium	
Orange 1 medium has 50 mg of calcium	
Banana 1 medium has 10 mg of calcium	
Bok Choy ½ cup has 75 mg of calcium	
Dried Figs 10 have 150 mg of calcium	
Homemade Lasagna 1 cup has 285 mg of calcium	
Soup made with milk, such as cream of chicken, mushroom or celery 1 cup has 175 mg of calcium	

Messages Written on Stickers

CONTROL: Calcium Helps Me...	EXPERIMENTAL: Calcium Helps Me...
Age 7-9 needs 700mg Age 10-12 needs 1400mg Age 13-16 needs 1200-1400mg Age 17-18 needs 1200mg Age 19-49 needs 1000mg Age 50+ needs 1000-1500mg	Prevents Fractures Avoid Shin Splints Build Strong Nails Prevent "Hump Back" Keep a Straight Spine Prevent Colon Cancer Prevent Muscle Cramps Prevent Shrinking as I Age Reduce High Blood Pressure Ensure Proper Blood Clotting Ensure Proper Nerve Conduction Make My Hair Shiny and Healthy

Appendices E

Manipulation Check Questionnaires

Student ID #: |_X_|_X_|___|___|___|___|___|Date: |_2_|_0_|_0_|__| |__|__| |__|__|

YEAR MONTH DAY

Please list five outcomes of consuming calcium in your diet.

1. _____
2. _____
3. _____
4. _____
5. _____

Please list five foods high in calcium that you enjoy:

1. _____
2. _____
3. _____
4. _____
5. _____

When we receive the following COMPLETED surveys from you, $10 will be sent to you within 48 hours. Please use this checklist to make sure that all necessary papers in the preaddressed envelope are enclosed:

☐ blue stapled package
☐ white food log package
☐ yellow exercise sheet
☐ this checklist sheet

To ensure speedy delivery of your monetary remuneration, we would like to verify your address:

Residence: _____
Room #: _____
Mailbox #: _____
Student ID: _____

Thank you so much for your time filling out these papers and sending them back. Looking forward to hearing from you soon.

Student ID #: | X | X | | | | | | Date:_____

Please complete this brief survey **honestly** by circling the response that best corresponds with your behaviour and filling in the blanks truthfully. Regardless of what your responses are, you will be remunerated $10 when you mail this back to us. Thank you!

1. Did you receive the following from us: Sticker YES/NO
   Notepad YES/NO

2. Did you affix the sticker somewhere? YES/NO

3. If no, what prevented you from using the sticker?

_____

4. If you did place the sticker somewhere, where?

_____

5. When was the last time you saw the sticker?
   YESTERDAY PAST WEEK PAST MONTH
   NEVER SAW

6. On average, how many times per week do you notice the sticker?
   0 1 3-5 6-10 11-15 16+

7. If you received the notepad, where did you put it?

_____

8. On average, how many times per week do you use the notepad?
   0 1 3-5 6-10 11-15 16+

9. Approximately how many pages have you used of the notepad?
   0 pages ¼ of the pad ½ of the pad ¾ of the pad all pages

10. When was the last time you saw the notepad?
    YESTERDAY PAST WEEK PAST MONTH
    NEVER SAW

11. Please list five outcomes of consuming adequate calcium in your diet:
    1. _____
    2. _____
    3. _____
    4. _____

5. _____

12. Please list five foods high in calcium that you enjoy:
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____

13. Did you attend the bone lecture on January 29th at the hospital? YES/NO

14. How much calcium should 17-18 year old women consume each day?

_____

15. Will you be returning to McMaster in the fall? YES/NO

16. If planning on attending a different school, where do you plan on going?

_____

How useful was this study to you?

1. How much impact did the lecture you saw one year ago have on increasing your calcium consumption?

Not at all useful	somewhat useful	moderately useful	very useful	extremely useful

2. How much impact did the mailouts you got have on increasing your calcium consumption?

Not at all useful	somewhat useful	moderately useful	very useful	extremely useful

3. Overall, how useful was this study to you with regards to increasing your knowledge about calcium?

Not at all useful	somewhat useful	moderately useful	very useful	extremely useful

4. Overall, how useful was this study to you for changing your diet?

Not at all useful	somewhat useful	moderately useful	very useful	extremely useful

And finally....A GREAT BIG THANKS!
Your continued participation was really appreciated. We couldn't have done this without you! We hope to have the results ready before December 2003. If you'd like to hear about them, please write the email address you'd like them sent to:

_____

Also, considering the novelty of this educational intervention, we may wish to contact you (briefly) for some follow-up information. Could we contact you later on?

NO ☐ Yes ☐ : email address _____