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Efficacy of technology-based and in-person health education for behavior change in college-aged women

Madeline Bremel
College of Saint Benedict/Saint John's University, msbremel@csbsju.edu

EFFICACY OF TECHNOLOGY-BASED AND IN-PERSON HEALTH EDUCATION FOR BEHAVIOR CHANGE IN COLLEGE-AGED WOMEN

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Madeline Bremel

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Abstract

Purpose: The purpose of this study was to determine whether an in-person or technology based bone health intervention improved bone health knowledge and behaviors in college-aged women. **Methods**: 30 college-aged women were randomly divided into three groups: personal intervention (n = 10), technological intervention (n = 10), and control (n = 10). Both intervention groups received identical information regarding the importance of bone health and the appropriate behaviors for maintaining strong bones including weight-bearing exercise, calcium consumption, and vitamin D consumption. The technology group received the information via an online video, and the personal group via a one-on-one health intervention. Changes in bone health knowledge and behavior were measured via questionnaires designed to address specific topics from the intervention. Knowledge was measured immediately before and after the intervention. Behaviors were measured before the intervention and one-month post-intervention. Bone health behaviors were categorized into changes in exercise frequency, exercise duration, food frequency, and food quantity. **Results**: A significant interaction was found between time and group for knowledge ($F_{(2,27)} = 13.5$; $p <.000$). Post hoc analysis revealed the personal group experienced a significantly greater change in knowledge than the control ($p =0.022$). The change in knowledge between the technology and personal group was not significantly different ($p =0.19$). There was no significant difference between groups for change in food frequency behavior ($F_{(2, 27)} = 2.10$; $p =0.14$), food quantity behavior ($F_{(2, 27)} = 1.52$; $p =0.24$), exercise duration behavior ($F_{(2, 27)} = 3.16$; $p =0.059$), or exercise frequency behavior ($F_{(2, 27)} = 2.51$; $p =0.1$). **Conclusions:** The personal intervention experienced greater gains in knowledge than the control group, yet neither the in-person nor the technology intervention was effective at encouraging positive behavior changes. Any potential gain in knowledge from the intervention did not lead to a corresponding significant change in behavior.

Introduction

Researchers continuously find that patients with higher health literacy achieve better overall health outcomes (Baker et al., 2007; Bohanny et al., 2013; Hironaka, Paasche-Orlow, Johnson, Jacobson, Gazmararian & Blake, 2010; Kalichman et al., 2008; Young, Bauchner & Geltman, 2009). The most efficacious interventions are those that teach sustainable habits and not simply facts about good health (Wang et al., 2013). Regardless of methodology, interventions that are more successful in achieving long-term health outcomes build health literacy in addition to intervention-specific efficacy and sustainable accountability in participants (Block et al., 2016; Morgan et al., 2011; Stoutenberg et al., 2016).

Though research on health interventions is highly developed, there is still significant disparity between the results of research designed to improve health and the improvement of individual health outcomes (Volpp & Asch, 2016). Researchers in health psychology, health communication, behavioral economics, and nursing have explored interventions that improve outcomes through provider-patient communication, intensive education, increased accountability for behavior change, and influencing the way that people make health choices (Block et al., 2016; Brendryen et al., 2008; Halbert et al., 2017; Matteson, Merth & Finegood, 2014; Morgan et al., 2011; Stoutenberg et al., 2016). While many interventions have resulted in moderate success, positive long-term health outcomes are still out of the reach of most patients in the clinical setting (Volpp & Asch, 2016).

Health communication researchers recognize a disparity in provider-patient communication (Aese, Hansen, Aese & Reeves, 2016; Matteson, Merth & Finegood, 2014). Aese, Hansen, Aese & Reeves (2016) emphasize discordance between physicians and nurses and a general disinterest in patient-centered perspectives. Providers also tend to lack compassion and empathy while communicating with patients. Patients become frustrated with providers who deliver overly simplistic advice, and do not delve into the details of lifestyle change (Matteson, Merth & Finegood, 2014). Physicians report performing lifestyle counseling in only 34% of clinical visits, and obese patients report receiving lifestyle counseling in only about 25% of their visits with their physicians (Hivert, et al., 2016). Two of the most important barriers to effective lifestyle behavior counseling are limited physician training on the delivery of diet, exercise, and chronic disease management information compared to pharmacological advice, and apprehension on the part of physicians about how information will be received by their patients (Hivert et al., 2016). In the treatment of obesity, clinicians lack empathy and convey frustrating negative messages that limit patients' own visions for behavior change (Matteson, Merth & Finegood, 2014). Despite many gaps in provider-patient communication, researchers identify strong connections between bettering communication and improving patient outcomes and efficacy for behavior change (Matteson, Merth & Finegood, 2014; Mazor et al., 2015; Morgan et al., 2011; Stoutenberg et al., 2016; Voss et al., 2011). From a patient perspective, communication is enhanced when a physician is trusted, and increased physician caring, communication, and partnership efforts are some of the most important factors in establishing trust (Matteson, Merth & Finegood, 2014). Researchers who examine doctor-patient communication emphasize the need for patient-centered perspectives (Aese, Hansen, Aese & Reeves, 2016; Matteson, Merth & Finegood, 2014; Mazor et al., 2015). A patient-centered approach to improving health communication enhances the role of patient trust by improving efficacy of behavior change and supports clear and in-depth provider-patient communication (Aese, Hansen, Aese & Reeves, 2016; Matteson, Merth & Finegood, 2014). Additionally, an increased focus on patient perspectives reveals health interventions that are perceived as efficacious in patients, and underscores the importance of focusing on small incremental behavior change compared to abstract large-scale behavior change. Health interventions that focus on patient-centered perspectives are effective for improving provider-patient communication and personal efficacy for behavior change, which are associated with improved health outcomes (Matteson, Merth & Finegood, 2014). However, discordance between providers and lack of provider-patient understanding and trust are systemically imbedded issues. Accordingly, solving these issues is an ambitious goal that requires the support of research from other disciplines (Aese, Hansen, Aese & Reeves; 2016).

Patient health literacy is also correlated with better provider-patient communication (Mazor et al., 2015). Many types of personal health interventions have successfully improved health outcomes in a research setting through education and improvements in health literacy (Morgan et al., 2011; Stoutenberg et al., 2016; Voss et al., 2011). These interventions are based on establishing effective communication between patients and providers or building accountability between peers working towards the same health outcomes (Morgan et al., 2011; Stoutenberg et al., 2016; Voss et al., 2011). Personal interventions may also allow patients to customize the information they receive from health professional to benefit their health needs most effectively (Mazor, et al., 2015).

Other health and behavior interventions utilize technology in order to save time and cut costs (Block et al., 2016; Brendryen et al., 2008; Walton & Hepworth, 2012). Technology removes the personal aspect from healthcare. While technology interventions do not allow for the benefits of provider-patient communication, they also alleviate the negative effects of provider-patient communication identified above. When used correctly, technology allows for the same type of follow-up and accountability that a personal intervention would. Technology based interventions are less time consuming for health care professionals and may be more effective in obtaining long-term health outcomes (Block et al., 2016; Brendryen et al., 2008; Webb et al., 2010).

While health interventions that focus on educating patients, improving communication, or appealing to the ease of technology use have been effective in research, there is significant discordance between research results and clinical implementation (Volpp & Asch, 2016). Within behavioral economics, researchers have questioned why creating a health informed public does not lead to a healthier population (Volpp & Asch, 2016). Researchers in this field suggest people do not usually make decisions based on their knowledge about what will lead to the best outcome, but based on what is the most convenient in the moment (Haward, Murphy & Lorenz, 2012; McCluskey, Mittelhammer & Asiseh, 2012; Volpp & Asch, 2016). Behavioral economists challenge the widely held belief that humans make consistently rational decisions. Rational decision makers would always make the decision that led to the greatest benefit in the long run. In the healthcare environment, it is apparent that individuals often make conscious short-term decisions that undermine their long-term health. Health related decisions are affected just as much, or even more so, by the messages in advertising as medical advice from a physician (Volpp & Asch, 2016). Human irrationality can substantially inhibit seemingly logical conclusions about health behavior change and is probably why, despite considerable evidence that health literacy and better provider-patient communication are correlated with more positive health outcomes, initiating long-term behavior change is difficult.

There is a limited amount of research that compares different types of interventions and coordinates insights from all of the important disciplines including behavioral economics, health education, nursing, and communication. To achieve long-term health outcomes in the clinical setting for the majority of patients, it may be necessary to coordinate research from all of these disciplines. The purpose of this study is to compare two different types of education oriented health interventions: one technology based and the other resembling provider-patient communication. Due to the well-researched benefits of effective provider-patient communication and the ability to ‘customize’ provider-patient relationships to provide information that supports each patient’s health needs, the primary researcher hypothesizes that the personal intervention group will experience greater gains in knowledge and behavior change than the technology based group.

Methods

A sample of 30 college-aged women were recruited via email correspondence with health-related academic departments. Eligible participants were women over the age of 18. Participants were randomly assigned to one of three groups: technology intervention (n =10), personal intervention (n =10), or control (n =10). Informed consent was obtained from all participants. All study procedures were approved by the Institutional Review Board at the College of Saint Benedict/Saint John’s University.

Bone health was chosen as an intervention topic because it represented a health area that was novel enough for potential participants to experience knowledge gain, and was relevant to a population of college-aged women. Participants in the personal intervention group were scheduled for one-on-one meetings with the primary researcher. Thirty minutes were allotted for each participant. At these meetings, participants completed an initial questionnaire through Google Forms designed to evaluate their pre-test knowledge on bone health (Appendix A), and behaviors related to good bone health including calcium and vitamin D consumption and participation in weight-bearing exercise (Appendix B). Technology and control group participants were emailed the same questionnaire. Personal group information sessions covered topics including: the importance of bone health for young women, genetic and behavioral factors involved in supporting bone health, and diet and exercise practices that support good bone health (Appendix C, average time =9.97 min, SD =0.90). Technology group participants watched an online video that contained the same information (Appendix D, length =10.78 min). All questions from the initial knowledge questionnaire were answered in the video and in the in-person sessions. All participants were given an informational pamphlet on bone health reviewing the relevant lifestyle information in the session (Appendix E). The personal group received a paper copy of the pamphlet; the technology group had the pamphlet emailed to them. Immediately following the intervention, all participants completed the same knowledge questionnaire that they completed pre-test on Google Forms. Control group participants did not participate in any interventions and only completed the questionnaires. One-month post-intervention, participants from all three groups were emailed a post-test behavior questionnaire identical to the one they took pre-test to analyze how bone health behavior had changed one month after completion of the intervention.

The bone health intervention was designed to emphasize the importance of bone health for college-aged women and provide information on lifestyle changes that supported good bone health. In order to increase efficacy of behavior change, the intervention was structured around gain-framed messaging, an educational tool that emphasized the benefits resulting from performing a behavior instead of the losses. Gain-framed messaging has been indicated to significantly increase behavior change related to bone health in college-aged women (Jung, Ginis, Phillips & Lordon, 2011). Participants were not instructed to make any changes in behavior, rather informed about important behaviors for bone health. Three areas of emphasis for the intervention were determined: calcium consumption, vitamin D consumption and weight-bearing exercise. Information for the bone health intervention was gathered from relevant previous research (Bemben, Fetters, Bemben, Nabavi & Koh, 2000; Bloomfield, 2005; Greer & Krebbs, 2006; Hollick, 2004; Yang et al., 2016), National Institute of Health, National Osteoporosis Foundation, and the National Health Service (UK). Specific areas of emphasis included: bone mass varying with age in women (indicating the relevance of adopting habits towards good bone health in young adulthood), specific recommendations for calcium, vitamin D, and weight-bearing exercise, the quantity of calcium and vitamin D in common foods, information on the effectiveness and variation between calcium and vitamin D supplements, an explanation of the process by which weight-bearing exercise contributes to increased bone mass, and information on different types of weight-bearing exercise (Appendix C-D).

Questionnaires were developed to measure both knowledge and behavior change in the context of the intervention. The six-question multiple choice knowledge inventory contained questions from all of the relevant areas of the intervention. All questions from the inventory were answered specifically in the intervention (Appendix A). The behavior questionnaire was designed to evaluate changes in frequency and duration of some of the most common weight-bearing exercises and frequency and quantity of consumption of some of the foods richest in calcium and vitamin D. The behavior inventory also contained questions concerning opinions on calcium and vitamin D consumption and weight-bearing exercise such as: “Do you think that you get enough calcium per day?” (Appendix B).

Sum behavior change for five areas of bone health behavior (exercise duration, exercise frequency, food frequency, food quantity, and opinion on behaviors) were calculated. A 3x2 mixed ANOVA was conducted with independent variables for time (repeated measures) and treatment (independent groups) and behavior change sums as the dependent variable. A second 3x2 mixed ANOVA was conducted with knowledge as the dependent variable. Additionally, bivariate correlations were conducted to examine the relationship between knowledge change and each of the five behavior change measures. Data were analyzed using SPSS version 24 (IBM). An alpha level of $\alpha = 0.05$ was used for all statistical tests.

Results

Study participants included a relatively homogenous population of 30 college-aged women randomized to three groups: personal intervention (n =10), technology intervention (n =10), and control (n =10). At baseline, there were no significant differences in bone health knowledge ($F_{(2, 27)} = 0.29$; $p = 0.75$), exercise frequency behavior ($F_{(2, 27)} = 0.15$; $p = 0.87$), exercise duration behavior ($F_{(2, 27)} = 0.10$; $p = 0.91$), food frequency behavior ($F_{(2, 27)} = 0.95$; $p = 0.40$), food quantity behavior ($F_{(2, 27)} = 0.76$; $p = 0.48$), or opinions on bone health ($F_{(2, 27)} = 0.32$; $p = 0.73$) between groups.

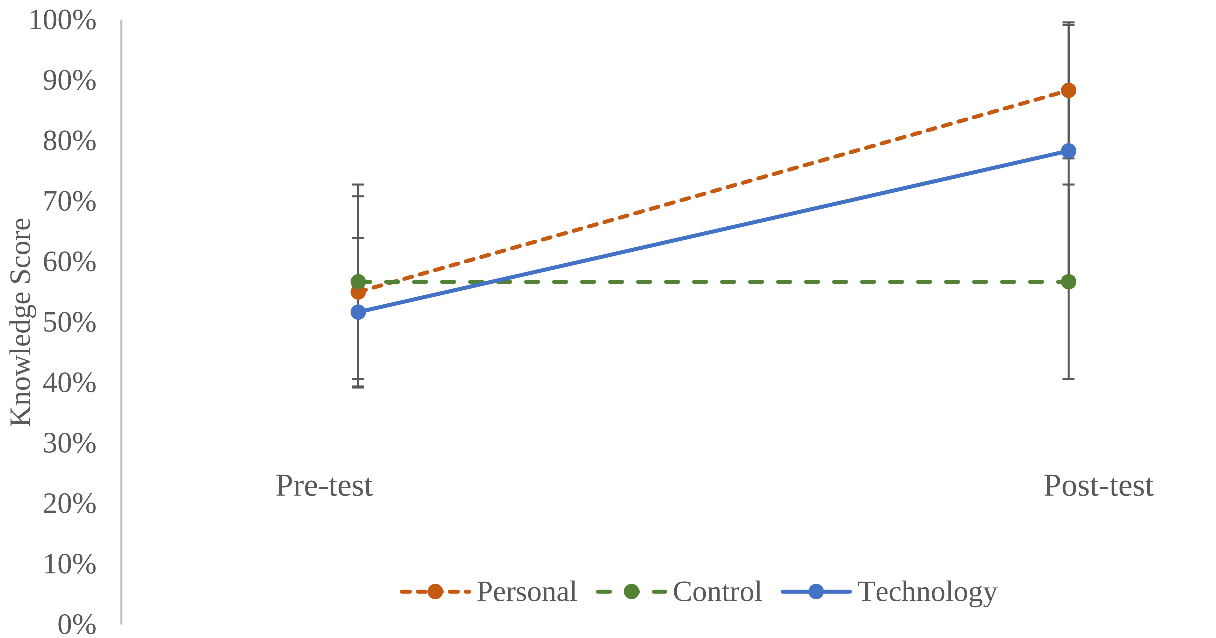

Fig. 1. Bone health knowlege change over time between groups.

A significant interaction was found between time and group for knowledge change over time ($F_{(2,27)} = 13.5$; p <.000) (Fig. 1). Post hoc analysis revealed the personal group experienced a significantly greater change in knowledge than the control group (p =0.022). No significant differences were found between the technology and personal group (p =0.19) or the technology and control group (p = 0.29) (Fig. 1). In the personal intervention group, 100 percent of participants experienced an increase in knowledge, compared to 90 percent of technology group participants (Table 1).

Table 1. Changes in sum knowledge and behavior measures between groups over time

Group		**Knowledge**	**Behavior**				
			Exercise Duration	Exercise Frequency	Food Frequency	Food Quantity	Opinion Total
Personal *n*= 10	*m* *(SD)*	0.33 (0.16)	0.6 (1.08)	0.6 (0.84)	1.2 (1.55)	-0.1 (1.6)	0.4 (0.84)
	n increase	10	6	6	6	3	4
	decrease	0	2	1	1	6	1
	no change	0	2	3	3	1	5
Technology *n*= 10	*m* *(SD)*	0.27 (0.21)	0.2 (0.92)	0 (1.49)	0.2 (1.55)	0.3 (1.34)	0.2 (1.03)
	n increase	9	3	5	5	3	5
	decrease	1	2	4	4	3	2
	no change	0	5	1	1	4	3
Control *n*= 10	*m* *(SD)*	— —	-0.5 (0.97)	-0.6 (1.17)	-0.2 (1.62)	-1.3 (3.06)	-0.3 (0.95)
	n increase	—	1	1	4	2	2
	decrease	—	4	4	5	5	4
	no change	—	5	5	1	3	4
	p	<0.001*	0.059	0.1	0.14	0.24	—
	Personal: Technology	0.19	—	—	—	—	—
	Personal: Control	0.022*	—	—	—	—	—
	Technology: Control	0.29	—	—	—	—	—

*Denotes significance at p<0.05

There were no significant differences between groups for change in food frequency behavior over time ($F_{(2, 27)} = 2.10$; $p = 0.14$), food quantity behavior ($F_{(2, 27)} = 1.52$; $p = 0.24$), exercise duration behavior ($F_{(2, 27)} = 3.16$; $p = 0.059$), or exercise frequency behavior ($F_{(2, 27)} = 2.51$; $p = 0.1$). A higher percentage of participants in the personal intervention group experienced non-significant positive changes in exercise related behavior (personal group: 60%, technology group: 30-50%), and a lower percentage of personal group participants experienced non-significant negative changes or stagnancy in exercise related behavior (personal group: 40%, technology group: 50-70%) (Table 1). For food related behavior change, there was no trend in behaviors between groups (Table 1). Participants who started taking a supplement during the intervention were more likely to decrease the quantity of calcium and vitamin D rich foods they consumed (R =-0.483, *p* =0.007).

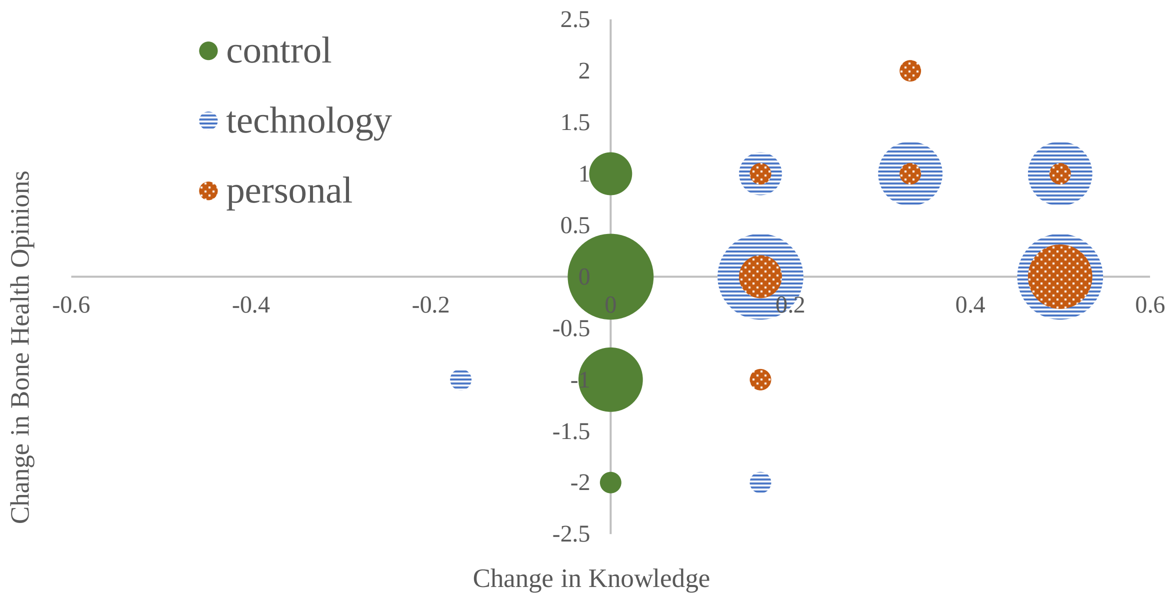

Fig. 2. Knowledge and opinion change across participants between groups. Bubble size indicates the number of participants at each data point. The smallest bubbles represent one data point (e.a. (-0.17, -1)). Distribution of bubbles across quadrants indicates a relationship between knowledge gain and more positive opinions about bone health behavior (R =0.445, *p* =0.014).

Knowledge gain was not correlated with increased exercise frequency (R =0.22, *p* =0.242), food frequency (R =0.231, *p* =0.219), or food quantity (R =0.271, *p* =0.148) and was correlated with exercise duration (R =0.455, *p* = 0.012) independent of groups. Knowledge gain was correlated with more positive opinions on personal behaviors related to calcium and vitamin D consumption and weight-bearing exercise (R =0.445, *p* =0.014) (Fig. 2).

Discussion

The purpose of this study was to compare the efficacy of technology based and personal health interventions designed to educate college-aged women about bone health. The intervention was designed to mimic a clinical health care setting as closely as possible in order to collect data that would be relevant to patients. Although there are many potential benefits of technology based education and provider-patient relationships for patients, other researchers have not directly compared the role of these two education styles in achieving lifestyle behavior change (Block et al., 2016; Brendryen et al., 2008; Halbert et al., 2017; Matteson, Merth & Finegood, 2014; Morgan et al., 2011; Stoutenberg et al., 2016). The primary findings of this study do not indicate significant behavior change resulting from technology based or personal health interventions. Results do suggest discordance between health knowledge and behaviors in college students and that purely education based interventions do not produce sufficient motivation for behavior change in this population group.

The results of the present study indicated minimal significant differences between groups for knowledge change, and no significant differences between groups for any of the behavior change measures. Additionally, there was no significant change in any of the behavior measures over time in any of the groups. These findings differ from other research. Knowledge gain through education-based interventions usually leads to increases in positive health behaviors (Halbert et al., 2017; Morgan et al., 2011; Stoutenberg et al., 2016; Voss et al., 2011). There is some indication from previous researchers that a college-aged population may represent some exception to the expected trends. Although college students are highly educated, they also tend to exhibit poor health behaviors (Hansen, Shneyderman & Belcastro, 2015). There may be some discordance between health knowledge and behaviors that is inherent to this population (Hansen, Shneyderman & Belcastro, 2015).

Other factors influencing knowledge and behavior that were not directly measured may have contributed to high variability in data. For example, participants could have already been educated about positive bone health behaviors. This suggestion is not well-supported by the data.

In the intervention groups, 95 percent of participants experienced gains in knowledge by an average of +30 percent (Table 1). There is indication that those who experienced higher gains in knowledge also experienced more positive changes in exercise duration, but the correlation is not applicable across other behavior change measures. Further, in the personal intervention group, which experienced significant changes in knowledge compared to the control group, there was insignificant data suggesting a higher percentage of participants experienced exercise related behavior change compared to the other two groups. Additionally, food related behavior change seemed especially minimal, even compared to non-significant changes in exercise related behavior. A substitution of supplements for calcium and vitamin D rich foods could have contributed to minimal food related behavior change. Participants who started taking a supplement during the intervention were more likely to decrease the quantity of calcium and vitamin D rich foods consumed. Despite some trends in the data that suggest a correlation between degree of knowledge gain and behavior change, the claim cannot indisputably be concluded based on limited significance in the data.

Another possibility for discordance between knowledge and behavior change could have related to pre-existing adequacy of bone health behavior. If participants were already engaging in adequate bone health behavior (as defined by the intervention) knowledge increases would only have reinforced the behaviors subjects already practiced. There is some indication from the data of behavior reinforcement as opposed to increased motivation for behavior change. Knowledge gains were correlated with more positive opinions about personal bone health behaviors, which indicates that instead of teaching participants to engage in more positive bone health behaviors, the intervention encouraged participants that current behaviors were adequate. 73.7 percent of participants who experienced knowledge gain from the intervention either developed more positive views about their bone health behaviors or maintained already adequate opinions of bone health behaviors (Adequate defined as reporting they met requirements for two out of three of the measured behaviors: calcium consumption, vitamin D consumption, and weight-bearing exercise). Only 6.67 percent of participants experienced both knowledge gains from the intervention and developed more negative opinions about their bone health behaviors (Fig. 2).

These trends may suggest that a bone health intervention was not perfectly suited for the study population. Halbert et al. (2017) compared the effects of two education-based interventions designed to reduce obesity in a specific community through increased exercise and fruit and vegetable consumption. In order to arrive at the topic for the intervention, researchers met with community leaders, who addressed a lack of practical knowledge about healthy lifestyle behaviors to reduce obesity in their community as an area of concern. Researchers subsequently designed an intervention around the identified health concerns of the community. Comparatively, designation of bone health education for the population of the present study was not based on feedback directly from the population. A limitation of the present study was that participants seemed to be satisfied with their bone health behaviors after the intervention. Future research should compare technology and personal health interventions in populations with acknowledged behavior and knowledge disparities on specific health topics.

Additionally, although participants reported adequate bone health behaviors one month after the intervention, the true adequacy of behaviors could not be determined due to the format of the behavior questionnaire (Appendix B). Regardless of the true adequacy of bone health behaviors, more positive opinions of personal behaviors indicated low motivation for further behavior change. These findings further support the claim that health education and health behaviors may be discordant in a college-aged population.

This intervention was designed to inform participants about positive behavior change, but did not instruct them to change their behavior. The purpose of this methodology was to control for external motivating factors that would not have been based on knowledge gains. Interventions that encouraged personal accountability through education were more successful at achieving long-term outcomes than interventions that were rooted in extrinsic motivation to satisfy a provider (Morgan et al., 2011; Stoutenberg et al., 2016; Voss et al., 2011). However, interventions that are based upon provider-patient accountability could show more positive short-term effects. These effects may not be sustainable long-term. In the current intervention, instructing patients to change behaviors instead of informing them may have led to greater changes in behavior. According to ‘choice architecture’, the decision made by an individual is strongly affected by the way the options are presented (McCluskey, Mittlehammer & Asiseh, 2012; Volpp & Asch, 2016). The tendency of individuals to make choices based on what is most readily available to them can be used to improve health outcomes. McCluskey, Mittlehammer & Asiseh (2012) conducted a study where they replaced the unhealthy 'default option' for kid's meal sides in a restaurant with a healthy side option. Sales of the unhealthy side option decreased. However, 'default options' can also be controversial. In the context of hypothetical delivery of premature infants resulting in trauma, decision makers who were presented with resuscitation of the infant as the default option were twice as likely to opt to resuscitate the baby as those who were presented with comfort care as the default option for a premature infant (Haward, Murphy & Lorenz, 2012). This adds an additional weight to decision making. In the case of the above study, the 'default option' is not the difference between fries and apples, but the difference between life and death. Relying exclusively on ‘choice architecture’ in the case of medical decisions is not universally applicable, and the role of educating patients in these situations cannot be lost. Instead of manipulating the way people make decisions, behavioral economics research can be used to educate people about the way they make decisions, and correspondingly lead to better health outcomes. Behavioral economics concepts applied health interventions hav been effective in several instances (Halbert et al., 2017; Oikonomou, Arvanitis & Sokolove, 2017; Haward, Murphy & Lorenz, 2012), but the role of these powerful factors for sustainable health outcomes should be investigated further.

Interventions in previous literature rooted in specific behavior change theory were more successful than those that were not (Glanz & Bishop, 2011; Stoutenberg et al., 2016). While the present intervention was loosely based upon gain-framed messaging and utilized relevant research on bone health, it was not reinforced by a specific behavior change theory. The purpose for this distinction was to be more realistic to the clinical situation, where it is difficult to maintain controlled and consistent methodology among a variety of providers who have countless other concerns (Aese, Hansen, Aese & Reeves; 2016). However, the intervention may have been more successful with a basis in behavior change theory. Future research should compare various behavior change theories and standardize theories across clinical practice.

Additionally, provider-patient communication based upon human relationships, accountability, and support might be more important in high-stress clinical situations and life-threatening illnesses (Mazor, et al., 2015). Whereas, the practical and individualized benefits of technology based interventions may be adequate in more simplistic lifestyle change interventions, indicating further support for the lack of significance between groups. The efficacy of technology based interventions for improving health outcomes should be compared between lifestyle interventions and across other disease groups.

Some important limitations of the present study include a small sample size and some weakness in longitudinal design. Knowledge gain was measured immediately after participants finished the education based intervention and does not indicate knowledge retention over time, rather immediate comprehension of information. Knowledge retention at the one-month follow-up would have been an additional indicator of the correlation between patient knowledge and behavior change which may be an important consideration in a population of college-students. Additionally, a small sample size limited the significance of the data.

In summary, the personal health education intervention produced greater gains in knowledge than the control intervention, and neither the personal nor the technology intervention was effective at encouraging positive behavior changes. Any potential gain in knowledge from the intervention did not lead to a corresponding significant change in behavior. Future research should compare behavior change interventions related to specific lifestyle areas in target populations and across health areas, investigate the role of choice manipulation in long-term behavior change, and compare behavior change theories in clinical practice.

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Appendix A

Knowledge Questionnaire

1. Around what age do most women reach their peak bone mass?
   a. 13-15
   b. 20-30
   c. 45-50
   d. 60-70
2. Which of these foods would satisfy your recommended daily amount of calcium?
   a. 3 glasses of milk
   b. 4 1/2 oz mozzarella cheese (1 oz = approximately 2 dice)
   c. 6 cups of ice cream
   d. All of the above
3. Which of these are considered weight-bearing exercise?
   a. Swimming
   b. Cycling
   c. Sitting
   d. Running up and down stairs
   e. All of the above
4. How much calcium are you supposed to have every day?
   a. 3 glasses of milk worth
   b. 2 glasses of milk worth
   c. 100 mg
   d. 1000 mg
5. How much vitamin D are you supposed to have each day?
   a. 200 mg
   b. 600 IU
   c. 5000 mg
   d. 1000 IU
6. Which contains the most calcium
   a. A glass of milk
   b. 6 oz container of low fat yogurt
   c. 1 cup of frozen collard greens
   d. 2 cups of carrots

Appendix B

Behavior Questionnaire

In an average week, how often do you engage in the following activities?

1. Resistance training
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week
2. Jogging
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week
3. Climbing stairs
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week
4. Ball sports (tennis, soccer, hockey, basketball, etc.)
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week
5. Dancing
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week
6. Rock climbing
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week
7. Martial arts
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week
8. Gymnastics
    a. Never
    b. Once a week or less
    c. 2-3 times a week
    d. Greater than 4 times a week

How many hours per week do you spend on the following activities?

1. Lifting weights

    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours
2. Jogging
    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours
3. Climbing stairs
    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours
4. Ball sports (tennis, soccer, hockey, basketball, etc.)
    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours
5. Dancing
    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours
6. Rock climbing
    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours
7. Martial arts
    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours
8. Gymnastics
    a. 1-2 hours
    b. 4-5 hours
    c. Greater than 6 hours

1. Are you lactose intolerant?
    a. Yes, and I never eat dairy
    b. Yes, but I sometimes eat dairy
    c. No

How often do you consume each of the following foods?

2. Milk
    a. Less than once a day
    b. 1-2 times per day
    c. 3 times per day
    d. Greater than three times per day

    Serving size?

    e. Less than 1 cup

        f. Greater than 1 cup
        g. About 1 cup

1. Yogurt
    a. Never
    b. Less than once a week
    c. 2-3 times a week
    d. 4-5 days a week
    e. Every day

    Serving size?

    f. One 6 oz container
    g. One 8 oz cup
2. Cheese
    a. Never
    b. Less than once a week
    c. 2-3 times a week
    d. 4-5 days a week
    e. Every day

    Serving size? (1 oz hard cheese = a cube the size of two dice, one slice of sandwich cheese. 1/4 cup of shredded cheese = 2 oz)

    a. 1 oz
    b. 2 oz
    c. 4 oz
    d. 8 oz
3. Ice cream
    a. Less than once a week
    b. 2-3 times a week
    c. 4-5 days a week
    d. Every day

    Serving size?

    a. 1/4 cup
    b. 1/2 cup
    c. 1 cup
4. Frozen yogurt
    a. Never
    b. Less than once a week
    c. 2-3 times a week
    d. 4-5 days a week
    e. Every day

    Serving size?

    a. 1/4 cup
    b. 1/2 cup
    c. 1 cup
5. Kale

   a. Never
   b. Less than once a week
   c. 2-3 times a week
   d. 4-5 days a week
   e. Every day

   Serving size?

   a. 1/2 cup
   b. 1 cup
   c. Greater than 1 cup

6. Salmon
   a. Never
   b. Less than once a week
   c. 2-3 times a week
   d. 4-5 days a week
   e. Every day

   Serving size? (3 oz = the size of the palm of your hand)

   a. 3 oz
   b. 6 oz

7. Tuna
   a. Less than once a week
   b. 2-3 times a week
   c. 4-5 days a week
   d. Every day

   Serving size? (3 oz = the size of the palm of your hand)

   a. 3 oz
   b. 6 oz

Do you have any other known sources of calcium or vitamin D in your diet? Please list which foods and how much you eat per week (ex. Supplements, sardines, collard greens, lactose free milk (what type), etc.)

8. How much time do you think you spend in the sun per day on average?
   a. Less than an hour
   b. 1-2 hours
   c. 2-4 Hours
   d. Greater than 4 hours
9. Do you wear sunscreen?
   a. Yes
   b. No
10. Do you think you get enough vitamin D every day?
    a. Yes
    b. No
11. Do you think you get enough calcium every day?
    a. Yes

   b. No

12. Do you think you participate in enough weight-bearing exercise?
    a. Yes
    b. No

Appendix C

Outline of bone health intervention

Slide 1

- I'm Madeline
- Here to talk to you about bone health: why it's important, how you can have good bone health

Slide 2 (1)

- Bone health is particular relevant for women
- This graph shows why
    - 90% of bone is acquired by age 18 in women
        - But, bone mass continues to rise steadily until age 30
        - So, in our twenties we have a lot of potential to maximize our peak bone mass
    - After age 30, bone mass will stay pretty constant until menopause
    - With menopause comes a STEEP decline in bone mass
        - THIS is when you're at risk for osteoporosis and osteopenia
    - [arrow] By maximizing peak bone mass *now* your bones will also be healthier later.
        - If your peak bone mass is higher you have a lesser chance of developing osteoporosis later
        - You will have a high quality of life into old age: do more activities, be less restricted
    - Moral-- increasing bone mass now will help for the rest of your life

Slide 3 (1)

- 75% of peak bone mass is affected by genetics, but 25% is controlled by your lifestyle and behaviors (1)
- 25 percent is actually pretty big margin to have control over

  Important factors:

    - Calcium and vitamin D consumption
        - Calcium is important because:
            - Your bones store and are made of calcium
            - When you are younger—you need calcium so your bones can use it to grow
            - When you get older—you need calcium in your diet so that your body doesn't have to break down the calcium stored in your bones to carry out its necessary processes
        - Vitamin D is important because
            - You can't absorb calcium without vitamin D
    - Weight-bearing exercise
        - Is important because you can increase the density of your bones even further with weight-bearing exercise
            - Will talk about how that happens in a few minutes

  We'll talk about these today

Slide 4: calcium consumption (4)

- You should get about 1000 mg of calcium every day
- Put into perspective that equals
    - 3 glasses of milk OR

    - 6 servings of ice cream OR
    - 19 oz (2 ½ servings) plain low fat yogurt OR
    - 4 ½ oz mozzarella cheese
- Seems pretty easy to get in these foods, especially if you drink milk with meals

Slide 5:

- But also: there are a lot of other foods that contain calcium
  Here are a few listed
    a. Milk, yogurt, and cheese are very high in calcium and easy to fit into meals (2)
    b. Frozen yogurt, ice cream, and flavored yogurts are also good ways to get in a little extra calcium
        - You don't want to rely on these foods for calcium primarily, but it's an easy way to get a little extra
    c. Some greens contain a lot of calcium
        - A little bit: 8 oz of cooked broccoli contains 21 mg of Ca (2)
        - 8 oz of frozen collard greens contains 360 mg of Ca (2)
            - More than a glass of milk
            - Taste pretty good: if you sauté with some olive oil and seasoning and pair with rice
        - 8 oz of frozen kale contains 180 mg of Ca (2)—over half a glass of milk
        - Both kale and collard greens: don't lose calcium from cooking, you actually usually get more this way because the cooked greens lose their shape and become more dense
    d. Some fish has a lot of calcium
        - 3 oz of salmon contain 181 mg Ca (4)—over half a glass of milk
        - 3 oz of canned sardines contain 325 mg Ca (4)—about a glass of milk
- If you are lactose intolerant, you can usually get calcium fortified dairy-free products, but they often don't contain as much calcium as real dairy products. It is best to read labels closely.
- Calcium supplements are also an easy way to get extra calcium if you don't like dairy, or just aren't able to fit it into your eating schedule easily
    - You should try to take these supplements with food (2)
    - You absorb calcium best in small quantities at a time so it is better to get in throughout the day in food than once a day in a supplement (2)
    - Two types of supplement: (8)
        - Calcium carbonate—example: Tums
        - Calcium citrate—found in other more specific calcium supplements
    - Both types are absorbed well IF THEY ARE TAKEN WITH FOOD (8)
        - If you're not taking your supplement with food: calcium citrate is absorbed better
- It's pretty hard to get too much calcium because your body usually won't absorb it in extremely large quantities (2)
    - There are some adverse effects that come with having WAY to much calcium, but you would have to have a lot to see these effects
        - >5000 mg/day (7)

Slide 6: vitamin D

- In order to absorb calcium, you also need vitamin D

- There are a few ways to get vitamin D
    a. Sunlight (2)
        - Not easily absorbed
            - Requires a considerable amount of time in the sun, pretty direct sunlight, and very little covering your skin
            - A study found that SPF 8 sunscreen (WEAK) reduces vitamin D absorption by 95% (5)
            - This is not the most effective way to get vitamin D
            - Even if you are in the sun a lot, you will probably need to rely on other sources of vitamin D as well
    b. Food (2)
        - You should try to get as much of your vitamin D from food.
        - However, vitamin D is not in very many foods
        - You can get some from fatty fish including
            - Mackerel
            - Tuna
            - Salmon
        - Many dairy products are also fortified with vitamin D since it is important for calcium absorption, so you can also get some from here
    c. Supplements (2)
        - Supplements are a great way to make sure you get all of your vitamin D

Slide 7: Weight-bearing exercise (3)

- You can also build your bone mass with exercise
- This is because of a principle called Wolff's Law
    - If you put bones under stress they will become stronger to prepare to be under more stress in the future
        - The chain of events (9):
            - With weight-bearing exercise>>> extra pressure is placed on your bones from gravity>>> pressure receptors in bone signal the production of more bone tissue>>> bone mass increases

2. [Show picture] compares a bone with low bone density (osteoporosis) to a healthy bone
    - Notice the lack of bone density (whiteness) on the left image
        - Shows the density of the bone

Slide 8

- There are lots of different types of weight-bearing exercise (3, 1)
- You can adjust different types of exercise for what you have time for and what you are capable of
- The more work you put in-- the more stress you put on your bones and muscles-- the more your bone mass increases
    - Don't be stupid-- realize what your capable of
- Some exercise should be relatively strenuous even if it doesn’t last for a long period of time
    a. In studies, short bouts of high impact exercise have been proven effective for increasing bone mass (6)

5. It would be best to engage in vigorous intensity exercise approximately 3 days a week (3)

Slide 9

- Doing things that promote good bone health is very important at this stage of life

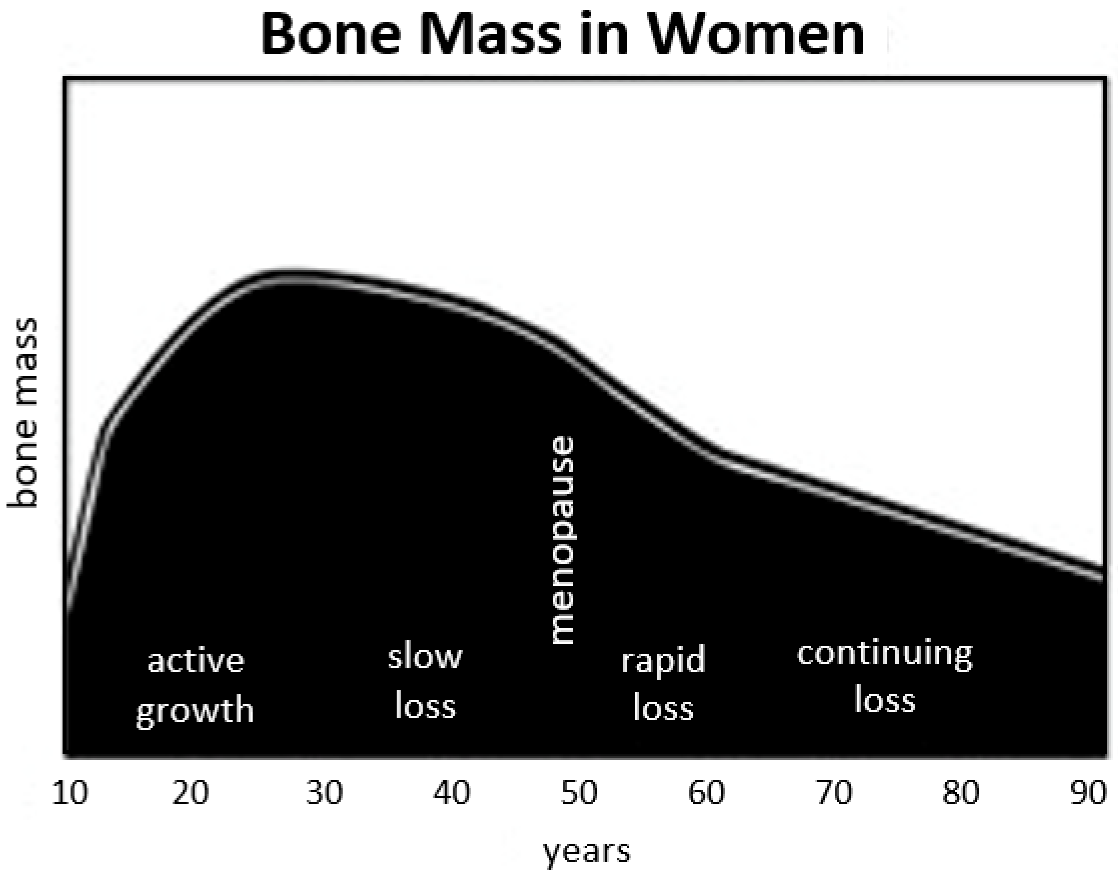
- Some of the best things you can do to achieve that are
    - Make sure you're getting enough calcium (1000 mg = 3 glasses of milk per day) and enough vitamin D (400-800 IU/day) (4, 2)
    - Do weight-bearing exercises whenever you can (three times a week) (3)
        - Short bouts of intense exercise are effective! (6)
- If you make these behaviors part of your lifestyle, you will likely be able to enjoy the benefits of it throughout your life.
- Thanks for listening and participating. I hope this information has been interesting to you!

Link to online lesson

https://www.youtube.com/watch?v=Trcuyusm85M&t=5s

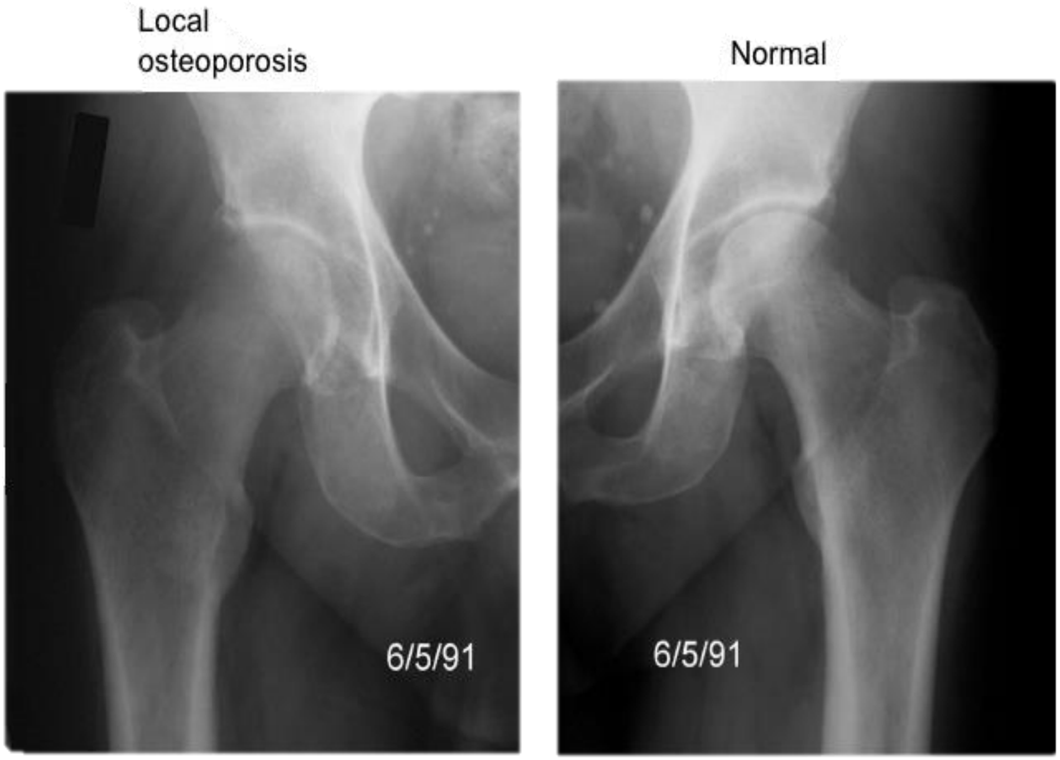
Appendix D

Figures used in lesson



CALCIUM CITRATE

CALCIUM CARBONATE


Local
osteoporosis
Normal
6/5/91
6/5/91

Appendix E

Bone health pamphlet

BONE HEALTH

Weight-bearing exercise: vigorous - 3x per week
Vitamin D: 400-800 IU/day
Calcium: 1000 mg/day

Calcium Rich Foods[2]

Cow's Milk	Salmon
Yogurt	Kale
Cheese	Broccoli
Ice cream	Calcium fortified non-dairy milk
Collard greens	Calcium supplement
Sardines	

Vitamin D Sources[2]

1. Food
   Fish: salmon, mackerel, tuna
   Vitamin D fortified milk and dairy
2. Vitamin D supplement
3. Sunlight
   Considerable time in direct, unprotected sunlight

Weight-Bearing Exercise [3,1]

Resistance training	Martial arts
Jogging	Ball sports
Stairs	Jumping
Tennis	Short bouts of high impact exercise
Dancing	
Rock-climbing	

Websites with information on bone health

1. Peak bone mass- https://www.niams.nih.gov/health_info/bone/osteoporosis/bone_mass.asp
2. Calcium and Vitamin D- https://www.nof.org/patients/treatment/calciumvitamin-d/
3. Exercise for maximum bone health- http://www.nhs.uk/Livewell/healthy-bones/Pages/exercises-for-strong-bones.aspx
4. Calcium in various foods- https://www.nichd.nih.gov/health/topics/bonehealth/conditioninfo/Pages/sources.aspx