HHS Public Access

Author manuscript

Ann Behav Med. Author manuscript; available in PMC 2016 October 01.

Published in final edited form as:

Ann Behav Med. 2015 October ; 49(5): 696–703. doi:10.1007/s12160-015-9702-7.

The relationship of perceived risk and biases in perceived risk to fracture prevention behavior in older women

Salene M. W. Jones, PhD[1,*], **Nancy M. Gell, PhD**[1], **Joshua A. Roth, PhD**[1], **Delia Scholes, PhD**[1], and **Andrea Z. LaCroix, PhD**[1,2]

[1]Group Health Research Institute, 1730 Minor Ave #1600, Seattle, WA 98101

[2]University of California, San Diego, 9500 Gilman Drive #0725, La Jolla, CA 92093-0725

Abstract

Background—A bias in perceived risk for health outcomes, including fracture, exists.

Purpose—We compared perceived risk and biases in perceived risk for fracture to fracture preventive behavior.

Methods—Women over age 55 (n=2874) completed a survey five times over five years and data was pulled from the medical record. Perceived risk was measured by asking women to rate their risk of fracture compared to similar women. Actual risk was measured using FRAX score. Bias was measured using an interaction between perceived and actual risk.

Results—Higher perceived risk was related to lower quality of life and self-reported health, more medication and calcium use, increased bone density scan use and less walking. Bias was only associated with less medication use. Neither perceived risk nor bias predicted medication adherence.

Conclusions—Perceived risk, but not bias, may predict different fracture prevention behaviors. Clinicians may need to base interventions on risk perceptions.

Keywords

optimism bias; unrealistic optimism; risk perception; osteoporosis

Osteoporosis is characterized by low bone mineral density resulting in increased risk for fracture (1). Osteoporosis is a major cause of morbidity and mortality in postmenopausal women and poses a potential threat to women's quality of life, independence and mental well-being (2). While bone formation occurs primarily during childhood, preventive behaviors during adulthood such as weight bearing exercise, calcium supplementation, and medication adherence are known to help mitigate bone density loss (3, 4). Identifying which

*Corresponding author. Address: Group Health Research Institute, 1730 Minor Ave #1600, Seattle, WA 98101 USA. wu.s@ghc.org. Phone: 1-206-287-2108.

Conflicts of Interest: Drs. Scholes, Jones, Gell and Roth do not have any conflict of interest to report. Dr. LaCroix serves on the advisory council of the GLOW study and has been supported by Sanofi-Aventis. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

women are less or more likely to engage in these behaviors, and how perceived fracture risk relates to these behaviors, can help clinicians target specific interventions to the women who might benefit most.

The role of perceived risk, or a person's belief in the likelihood of an event, to health behaviors has been well-studied, although few studies have examined fracture prevention. Perceived risk can be either absolute (what is the actual chance of an event) or comparative/relative (what is the risk compared to similar others; (5)) and is inherently subjective, being an attitudinal construct. Perceived risk is key in many theories of health behavior change. One theory, the behavior motivation hypothesis, posits that increased perceived risk motivates people to change behavior and reduce risk (5). Also, numerous lines of research have linked higher perceived risk to better health behaviors, including mammography screening (6). However, other research has shown that perceiving a higher risk of osteoporosis can lead to a decrease in physical activity (7). Perceived risk may increase certain health behaviors through anxiety but decrease others if people incorrectly believe the behavior increases risk (such as physical activity), leading to avoidance of truly helpful behaviors.

A long research literature has documented the optimistic bias (8), defined as a tendency to view oneself as less likely to experience negative health events compared to others (9), and this construct will also be investigated in this study. This bias represents a mismatch between perceived risk and actual risk, as a person's perceptions of risk may correspond to actual risk (i.e. believes one has elevated risk and based on objective measure is at elevated actual risk) or may be "biased" such that an optimistic bias is characterized by low perceived risk but higher actual risk (9). The optimistic bias is particularly resistant to efforts to reduce the bias (10). The optimistic bias has been shown to be pervasive across various populations and situations (11). Associations between optimistic bias and health behavior have been mixed (9). Inconsistent findings could be explained by differences in the types of behaviors examined and the potential for bias to increase some health behaviors but decrease others.

The optimistic bias may have benefits beyond health behaviors. Research has shown that the optimistic bias is related to better psychological function (12). Potential benefits of an optimistic bias may also help explain its resistance to change. Research in older adults has shown a bias towards positive information (13) and this could also explain resistance of the optimistic bias to change in this population.

Rationale and Objective of the Current Study

The objective of this study was to evaluate the association between biases for fracture risk and preventive behaviors while concurrently examining perceived risk. This approach allowed for evaluation of the different contributions of bias and perceived risk. The study data were from the Pacific Northwest cohort of the Global Longitudinal Osteoporosis study in Women (GLOW; (14)). The optimistic bias for fracture risk has been documented (15) and perceived risk was related to self-report fractures (16) in the total GLOW sample. However, effects of perceived risk and bias on fracture-related health behaviors have not been investigated in GLOW or with other data. In the current analyses we examined the

longitudinal relationship of perceived risk for fracture, actual risk for fracture, and bias with quality of life (QOL) and preventive behaviors. The behavior motivation hypothesis would predict that perceived risk would increase the use of fracture prevention interventions. However, given the literature on higher perceived risk decreasing physical activity, we examined both directions, as women may incorrectly believe certain behaviors (such as physical activity) are high risk. Previous research on the optimistic and pessimistic bias would predict that the interaction between perceived and actual risk would predict fracture prevention behavior, not just perceived risk. By testing both perceived risk and the interaction of perceived risk with actual risk, we compared the behavior motivation hypothesis with the optimistic and pessimistic bias.

Methods

Study Sample and Procedures

The Global Longitudinal Study of Osteoporosis in Women (GLOW) was an observational prospective cohort study of 60,393 women age ≥55 years from 17 sites in 10 countries. Details of study design, recruitment, data collection and baseline characteristics of the full cohort have been described previously (14). The current study is an analysis of GLOW data from the cohort of 4055 women recruited in the Pacific Northwest region of the United States through a large integrated healthcare system that provides insurance coverage and clinical care. The study procedures were approved by the human subjects review committee and all participants provided informed consent.

Surveys were completed between 2007 and 2012. Community-dwelling women age ≥55 years who had a primary care visit in the 24 months before the first survey were eligible for participation. Stratified sampling by age ensured two thirds of the baseline sample was age 65 and older as fractures occur more often in older women. Exclusion criteria included cognitive impairment, severe illness that would interfere with study participation, or a language barrier. Surveys were self-administered and mailed to participants at baseline and after one, two, three and five years. Telephone interviews were offered if a participant needed assistance to complete the survey or if the mailed survey was not returned within 6 weeks. A total of 6,000 women were invited to complete the survey and 4055 (67.6%) completed the baseline survey. Of the 4055 that completed the baseline survey, 91.8% completed the one-year survey, 88.0% completed the two-year survey, 83.0% completed the three-year survey and 70.9% completed the five-year survey.

Measures

Survey items covered patient demographics (age, education) and health characteristics (history of fracture, comorbidities) as well as information needed to determine fracture risk and perceived fracture risk. Outcomes from both self-report (survey) and electronic medical record data (EMR) were analyzed (see supplementary material for number reporting each outcome).

Exposures: Actual Risk—Fracture risk was assessed by the FRAX tool (17), a validated 11 item survey that estimates the 10-year probability of a major osteoporosis-related fracture

and the 10-year probability of a hip fracture. FRAX scores were calculated from age, body mass index (BMI), prior history of fracture in adulthood, current glucocorticoid use, rheumatoid arthritis, smoking status, parent history of hip fracture, alcohol intake, and potential for secondary osteoporosis based on co-morbidities. Although the FRAX score can provide a measure of absolute risk, we mean-centered the FRAX score to provide a measure of comparative actual risk (risk compared to other women in the study) as the perceived risk question also measured comparative risk. Women with average risk would have scores close to zero.

Exposures: Perceived Risk—Participants rated their perceived risk of fracture compared to other women of the same age on a 5-point scale (Much lower, A little lower, About the same, A little higher, Much higher). This reflects mostly state-specific perceived risk although trait-level perception in risk may have also influenced this measure.

Exposures: Bias—To assess bias, an interaction term of perceived risk (centered) with FRAX score (standardized) was entered. With this coding, positive values indicated more accurate assessments of risk whereas negative values indicated less accurate, possibly biased assessments of risk.

Outcomes- Self-report—The EQ-5D consists of 5 items, each rated on a three-point scale, assessing QOL and has been validated in several countries (18). Participants also rated their health on a five-point scale (excellent, very good, good, fair and poor). Participants indicated if they were current users, ever users, or never users of calcium supplements and anti-osteoporosis medication (AOM). Participants reported the number of days in the past month they walked for at least 20 minutes on a six point scale with the following response options: 0 days; 1–2 days; 3–5 days; 6–9 days; 10–19 days and 20 or more days. Walking was dichotomized into 20 or more days vs. 19 or fewer as only the highest category would meet physical activity recommendations (19). Participants indicated whether they had a bone density test in the previous year.

Outcomes- Electronic Medical Record—Pharmacy fills for AOM were obtained from the EMR of participants for each year from the year before the baseline survey to the year of survey completion (see supplementary materials for specific medications). Previous research has shown data from this system's EMR to be a valid measure of medication fills (20). We calculated AOM treatment duration based on the "current episode" of AOM use, defined as continuous supply of AOM with no more than 90 gap days. To calculate gap days, we used the days' supply field from the pharmacy dispensing data. History of having a dual-energy X-ray absorptiometry (DXA) within the integrated health care system was obtained from the clinical DXA machines (Hologic, Waltham, MA) for the same timeframe as the pharmacy data. The self-reported bone mineral density (BMD) testing included any test such as DXA or ultrasound while the EMR testing only included DXA testing.

Statistical Analyses

Perceived risk was centered before analyses so that women who rated themselves as having average risk were coded as zero. Continuous FRAX score for all fractures was used as the

measure of actual risk. The interaction of actual and perceived risk was used to test whether bias had a unique relationship to outcomes beyond the effects of actual and perceived risk for fracture. We chose to use FRAX score instead of whether a woman experienced a subsequent fracture, as the perceived risk question more closely corresponds to FRAX score (an estimate of risk) than whether a woman had a fracture (an event to be predicted). Women for whom FRAX score could not be calculated were excluded (N=1,181, 29%; see supplementary materials for comparison of included and excluded women). Statistical analyses were conducted with SPSS version 21.

The first set of analyses examined the relationship of bias and perceived risk to QOL, self-reported health and fracture preventive behaviors. Hierarchical linear modeling (HLM) with an autoregressive covariance structure was used to model the relationship of perceived risk and bias on QOL and self-reported health, due to assessments being nested within participants. Generalized estimating equations (GEE) using a binomial distribution and logit link function were used to model the relationship of perceived risk and bias on self-reported AOM use (current use), self-reported calcium supplement use, walking, self-reported BMD testing, EMR AOM use (any use in the assessment year) and EMR BMD testing (any test in the assessment year). These statistical methods allow for missing data and estimate the parameters from the data that is available. To examine concurrent relationships, the outcomes were QOL, self-reported health, AOM use, calcium use, walking, and BMD testing at 1-, 2-, 3- and 5-year assessments and the independent variables were perceived risk and bias at the same assessment. To examine the relationship of perceived risk and bias to subsequent fracture preventive behavior, self-reported health and QOL, lagged HLM and GEE models were used in which perceived risk and therefore bias from the previous year (baseline, 1- and 2-year) predicted outcomes at the subsequent years (1-, 2- and 3-years, respectively) so that the coefficients and odds ratios indicated if bias predicted the outcomes one year later. Due to the differences in time between the surveys, the 5-year survey was excluded from the lagged analyses and only included in the concurrent analyses. Models controlled for the following: education, race/ethnicity, health insurance status, disease count, whether a woman experienced early menopause and baseline falls. All controls were fixed while perceived risk and therefore bias was time-varying. Actual risk was fixed because the FRAX score calculates fracture risk for 10 years, and the study only lasted five years. We elected not to control for baseline levels of the outcomes because this can bias results, especially when the baseline level is associated with the exposure (21). However, there is some controversy about whether to control for baseline levels (22) as controlling can underestimate the relationship but not controlling can overestimate the relationship so we ran additional analyses controlling for baseline levels. Benjamini-Hochberg Type I error correction was used (23).

The medication adherence analyses were limited to women who ever took AOM within the study period and had a FRAX score (2007 to 2012; n=376). Adherence was defined as the number of episodes of use. More episodes were assumed to indicate worse adherence, and the variable was dichotomized into one episode of use vs. multiple episodes of use as the majority of women had one episode of use. Adherence was also defined as using the AOM for at least one or three years during the study as women need to take bisphosphonates for at least one year, preferably longer, to achieve a clinically meaningful effect (24). Adherence

therefore had three dichotomous variables: multiple episodes of use vs. one episode of use; used for at least one year vs. used for less than one year; and used for at least three years vs. used for less than three years. Adherence variables were calculated using bisphosphonate use data during the study period. A logistic regression was used to predict adherence during the study period (adherent/non-adherent) from baseline bias while controlling for covariates listed above.

Results

A total of 2,874 women were included in the study. Demographics for the sample are reported in Table 1. A large proportion reported their risk as average at baseline (41.2%, n=1184). Another 43.8% (n=1251) reported their risk of fracture as below or very below average while another 14.3% (n=413) reported their risk as above or very above average. At the follow-up surveys, most women reported their risk as either average (37.5% at 1 year to 39.0% at 5 year) or below average risk (48.6% at 1 year to 46.7% at 5 years). Across the follow-up surveys, few women reported their risk as above average (15.6% at 1 year to 12.4% at 5 years).

Perceived Risk, Bias and Fracture Preventive Behaviors

Results from testing the concurrent relationship of perceived risk, actual risk and bias are reported in Table 2. The interaction of perceived risk and standardized, actual risk was not significant for QOL and EMR AOM use after type I error correction. For self-reported AOM use, the interaction of perceived risk and actual risk was significant (p=.001) such that the effect of perceived risk was particularly large for women with higher actual risk such that having an optimistic bias greatly decreased the likelihood of taking AOMs. For self-reported health, only perceived risk, and not bias, was significantly related (p<.001) such that higher perceived risk was related to lower self-reported health. Perceived risk was related to calcium supplement use (p<.001) such that higher perceived risk was related to greater likelihood of using calcium. For walking, perceived risk was related such that higher perceived risk was related to lower likelihood of walking most days (p<.001). For bone density tests, higher perceived risk (p<.001) was related to higher likelihood of self-reporting a bone density test and to greater likelihood of having a bone density test by the EMR (p<.001). Results did not change when controlling for baseline values (see Table 3). Concurrently, perceived risk was related to increased odds of most health behaviors and lower odds of walking most days but lower QOL and perceived health while bias was only related to AOM use.

When examining the longitudinal associations between perceived risk and bias to subsequent outcomes, many of the relationships seen cross-sectionally were maintained, but a few changed (see Table 2). First, the significant interactions indicating an effect of bias with self-reported medication use was not significant following Type I error correction. Prospectively, perceived risk was not related to calcium supplement use (p=.328) or walking. For self-reported health, QOL and bone density tests, relationships seen concurrently were maintained prospectively. Perceived risk was related to self-reported health (p<.001) one year later, such that higher perceived risk predicted lower self-reported

health at the subsequent assessment. Similar to the concurrent results, perceived risk (p<. 001) predicted a self-reported bone density test and a bone density test from the EMR (p<. 001). Results did not substantially change when controlling for baseline values except perceived risk no longer predicted QOL (see Table 3).

For medication adherence, the analyses were limited to women who had filled at least one AOM between 2006 and 2012 (n=376). Overall, perceived risk and bias were not related to adherence to AOMs over the five year follow-up. Perceived risk was unrelated to multiple episodes of medication use (OR=1.315, p=.073), using AOMs at least a year (OR=.838, p=. 255) and using AOMs at least 3 years (OR=.948, p=.629). The interaction of perceived risk and actual risk (bias) was unrelated to multiple episodes of medication use (OR=.826, p=. 079), using AOMs for at least one year (OR=.923, p=.509) and using AOMs for at least 3 years (OR=.865, p=.134). Prospectively, higher perceived risk was related to increased use of medical interventions (AOM use, bone scans) but negatively related to QOL and self-reported health. Bias was not related to any outcome.

Discussion

This study examined the association between perceived risk and the optimistic and pessimistic biases for fracture risk to QOL and fracture preventive behaviors in older women. Women with a bias were less likely to use osteoporosis medication concurrently and this effect was associated mainly with the optimistic bias. However, bias was unrelated to QOL and other health behaviors both concurrently and prospectively. Higher perceived fracture risk was related concurrently and prospectively to increased likelihood of bone density scans and AOM use and decreased QOL, lower self-reported health, and less likelihood of walking. Medication adherence was unrelated to either bias or perceived risk. Overall, this study supported the behavior motivation hypothesis for some behaviors (AOM, bone density scan) but not others (walking/physical activity) and did not support an association of the optimistic or pessimistic biases with behaviors. The study also showed that perceived risk, regardless of actual risk or biases in those perceptions, was related to several key health behaviors.

The larger research literature gives context to the results on perceived risk and bias. The potential benefits of the optimistic bias and lower perceived risk (higher QOL) could explain the resistance to change (9, 10). The Strength and Vulnerability Integration model (13) posits that healthier older adults have higher emotional well-being due to focusing more on the positive and avoiding stressful or negative situations. Increasing perceived risk could be a stressor and could lead to more negative emotions, hence older women who are relatively healthy will avoid higher perceived risk. Women with higher perceived risk had worse quality of life and self-reported health, supporting this hypothesis. They were more likely to engage in medical strategies to prevent fracture (e.g., medication) rather than increasing physical activity. However, this also indicates that while women with lower perceived risk had better quality of life and self-reported health, this may have come at a cost for some health behaviors (taking AOMs, bone scans) but not other behaviors (physical activity). As women with lower perceived risk were more likely to walk and perceive better health, this suggests that women may have believed they did not need medications. However, these

women may also have attempted to avoid the stress of side effects from AOMs. This highlights that intervention strategies may need to focus on specific behavioral changes rather than on increasing risk perceptions, as changing risk perceptions could have unintended consequences such as decreasing some positive health behaviors and QOL. Interventions may also need to focus on changing several behaviors, rather than one target behavior, as older women may find changing certain behaviors more stressful than others.

Study Strengths and Potential Limitations

The study demonstrates the longitudinal relationship of perceived risk and the optimistic and pessimistic biases for fracture prevention behaviors in older women. In addition to the longitudinal data with an excellent response rate over the follow-up, the large sample size was a strength and provided an opportunity to examine both the optimistic and pessimistic biases. Another strength of the study was the combination of EMR and survey data. The study also had several limitations. First, the perceived risk question asked about comparative risk not absolute risk and results may not translate to bias in absolute risk. The risk question also did not specify whether behavior remained the same or not. Also, higher perceived risk may reflect depression or personality traits such as neuroticism and these were not measured in the current study. The physical activity measure was not comprehensive and not objective. Sample characteristics (only older women from one region in the United States) limit generalizability to other populations such as men, young adults and other regions of the world but do have implications for older women in the US. Also, the differences in women who were excluded for missing FRAX score may also limit generalizability. The study population also had a high percentage with self-reported health insurance. However, this emphasizes that even though this population had high access to medical care, perceived risk was still related to health behavior.

Summary and Conclusions

Overall, this study suggests that perceived risk for fracture risk is related to several health behaviors and QOL. For practitioners, these results imply that focusing on non-pharmacologic interventions may be most amenable for women with low perceived risk. Changing women's perceptions may not be necessary provided they are engaging in sufficient fracture prevention behaviors. Higher perceived risk also increase use of healthcare services, and may have detrimental long-term effects on QOL. The study results have several implications for future research. As perceived risk was positively related to some fracture preventive behaviors but negatively related to others, future research should consider measuring different health behaviors such as supplement use and physical activity. This is crucial for studies that attempt to change perceived risk as changing risk perceptions may lead to unintended changes in other health behaviors or QOL.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors would like to thank the study participants and all the research staff who worked on this project. Drs. Jones, Gell and Roth are supported by fellowships from the National Institute of Aging (T32 AG027677). Funding for this study was provided by The Alliance for Better Bone Health (Procter & Gamble Pharmaceuticals and Sanofi-Aventis) to The Center for Outcomes Research, University of Massachusetts Medical School.

References

1. van Staa TP, Dennison EM, Leufkens HG, Cooper C. Epidemiology of fractures in England and Wales. Bone. 2001; 29(6):517–22. Epub 2001/12/01. [PubMed: 11728921]
2. Abrahamsen B, van Staa T, Ariely R, Olson M, Cooper C. Excess mortality following hip fracture: a systematic epidemiological review. Osteoporos Int. 2009; 20(10):1633–50. Epub 2009/05/08. [PubMed: 19421703]
3. South-Paul JE. Osteoporosis: part II. Nonpharmacologic and pharmacologic treatment. American family physician. 2001; 63(6):1121–8. Epub 2001/03/30. [PubMed: 11277549]
4. Jackson RD, LaCroix AZ, Gass M, Wallace RB, Robbins J, Lewis CE, et al. Calcium plus vitamin D supplementation and the risk of fractures. N Engl J Med. 2006; 354(7):669–83. Epub 2006/02/17. [PubMed: 16481635]
5. Brewer NT, Weinstein ND, Cuite CL, Herrington JE. Risk perceptions and their relation to risk behavior. Ann Behav Med. 2004; 27(2):125–30. Epub 2004/03/18. [PubMed: 15026296]
6. Katapodi MC, Lee KA, Facione NC, Dodd MJ. Predictors of perceived breast cancer risk and the relation between perceived risk and breast cancer screening: a meta-analytic review. Preventive Medicine. 2004; 38(4):388–402. Epub 2004/03/17. [PubMed: 15020172]
7. Reventlow SD. Perceived risk of osteoporosis: restricted physical activities? Qualitative interview study with women in their sixties. Scand J Prim Health Care. 2007; 25(3):160–5. Epub 2007/09/12. [PubMed: 17846934]
8. Weinstein ND. Unrealistic optimism about future life events. Journal of Personality and Social Psychology. 1980; 39:806–20.
9. Klein, WMP. Optimistic Bias. Washington, DC: National Cancer Institute; 2008. [cited 2014 3/7/2014]
10. Cho H, Lee JS, Lee S. Optimistic bias about H1N1 Flu: Testing the links between risk communication, optimistic bias and self-protection behavior. Health Commun. 2014; 28(2):146–58. [PubMed: 22490123]
11. Sharot T. The optimism bias. Curr Biol. 2011; 21(23):R941–5. Epub 2011/12/14. [PubMed: 22153158]
12. Harris PR, Griffin DW, Murray S. Testing the limits of optimistic bias: event and person moderators in a multilevel framework. J Pers Soc Psychol. 2008; 95(5):1225–37. Epub 2008/10/29. [PubMed: 18954204]
13. Charles ST. Strength and vulnerability integration: a model of emotional well-being across adulthood. Psychological Bulletin. 2010; 136(6):1068–91. Epub 2010/11/03. [PubMed: 21038939]
14. Hooven FH, Adachi JD, Adami S, Boonen S, Compston J, Cooper C, et al. The Global Longitudinal Study of Osteoporosis in Women (GLOW): rationale and study design. Osteoporos Int. 2009; 20(7):1107–16. Epub 2009/05/27. [PubMed: 19468663]
15. Siris ES, Gehlbach S, Adachi JD, Boonen S, Chapurlat RD, Compston JE, et al. Failure to perceive increased risk of fracture in women 55 years and older: the Global Longitudinal Study of Osteoporosis in Women (GLOW). Osteoporos Int. 2011; 22(1):27–35. Epub 2010/04/02. [PubMed: 20358360]
16. Gregson CL, Dennison EM, Compston JE, Adami S, Adachi JD, Anderson FA Jr, et al. Disease-specific perception of fracture risk and incident fracture rates: GLOW cohort study. Osteoporos Int. 2014; 25(1):85–95. Epub 2013/07/26. [PubMed: 23884437]
17. Kanis JA, Johnell O, Oden A, Johansson H, McCloskey E. FRAX and the assessment of fracture probability in men and women from the UK. Osteoporos Int. 2008; 19(4):385–97. Epub 2008/02/23. [PubMed: 18292978]

18. Oemar, M.; Janssen, B. EQ-5D-5L User Guide: Basic information on how to use the EQ-5D-5L instrument. 2013.
19. Services DoHaH. 2008 physical activity guidelines for Americans. Washington, DC: Department of Health and Human Services; 2008.
20. Garg RK, Glazer NL, Wiggins KL, Newton KM, Thacker EL, Smith NL, et al. Ascertainment of warfarin and aspirin use by medical record review compared with automated pharmacy data. Pharmacoepidemiol Drug Saf. 2011; 20(3):313–6. Epub 2011/02/26. [PubMed: 21351314]
21. Glymour MM, Weuve J, Berkman LF, Kawachi I, Robins JM. When is baseline adjustment useful in analyses of change? An example with education and cognitive change. American journal of epidemiology. 2005; 162(3):267–78. Epub 2005/07/01. [PubMed: 15987729]
22. Weinstein ND. Misleading tests of health behavior theories. Ann Behav Med. 2007; 33(1):1–10. Epub 2007/02/13. [PubMed: 17291165]
23. Thissen D, Steinberg L, Kuang D. Quick and easy implementation of the Benjamini-Hochberg procedure for controlling the false positive rate in multiple comparisons. Journal of Educational and Behavioral Statistics. 2002; 27(1):77–83.
24. Black DM, Cummings SR, Karpf DB, Cauley JA, Thompson DE, Nevitt MC, et al. Randomised trial of effect of alendronate on risk of fracture in women with existing vertebral fractures. Fracture Intervention Trial Research Group. Lancet. 1996; 348(9041):1535–41. Epub 1996/12/07. [PubMed: 8950879]

Table 1

Demographics and descriptive statistics for the sample at baseline.

	Total sample (n=2874)
Variable	**%(n) or Mean(SD)**
Age at baseline	69.4 (9.5)
Education, Bachelor's or higher	41.0% (1178)
BMI	27.97 (6.52)
Race/Ethnicity	
Caucasian	93.7% (2694)
African American	1.9% (55)
Asian	4.1% (117)
Other	1.5% (42)
Any health insurance	92.3% (2654)
Number of comorbidities (disease count)	1.0 (1.0)
History of fracture between age 45 and baseline	22.1% (636)
Early menopause	14.4% (413)
History of fall at baseline	44.8% (1289)
FRAX score	16.25 (10.66)

Table 2

Analyses of the relationship of perceived risk and bias with concurrent and lagged outcomes. Actual risk was measured by FRAX score. Bias is indicated by the interaction of standardized actual risk and perceived risk. Perceived risk and bias (interaction of perceived risk and standardized actual risk) at baseline, 1- and 2- years was used to predict the outcomes at 1-, 2- and 3- years in the lagged analyses. Bold indicates significant following Type I error correction. SR=self-report, EMR=electronic medical record.

		Concurrent Analyses			Lagged Analyses		
Outcome	**Predictor**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**
EQ-5D	Perceived Risk	**−.015**	**−.018, −.013**	**<.001**	**−.006**	**−.009, −.003**	**<.001**
	Actual Risk	−.0001	−.0006, .0003	.516	−.0001	−.0005, .0003	.661
	Perceived Risk * Actual Risk	−.003	−.006, −.0005	.017	.0005	−.002, .003	.720
Self-reported Health	Perceived Risk	**−.131**	**−.145, −.116**	**<.001**	**−.052**	**−.069, −.035**	**<.001**
	Actual Risk	−.002	−.005, .001	.188	−.002	−.005, .0008	.168
	Perceived Risk * Actual Risk	.003	−.011, .017	.705	−.002	−.018, .014	.795
Medication use, SR	Perceived Risk	**1.555**	**1.408, 1.717**	**<.001**	**1.365**	**1.229, 1.507**	**<.001**
	Actual Risk	**1.038**	**1.029, 1.047**	**<.001**	**1.039**	**1.030, 1.049**	**<.001**
	Perceived Risk * Actual Risk	**.904**	**.850, .962**	**.001**	.909	.849, .974	.007
Medication use, EMR	Perceived Risk	**1.336**	**1.211, 1.473**	**<.001**	**1.240**	**1.117, 1.376**	**<.001**
	Actual Risk	**1.040**	**1.031, 1.050**	**<.001**	**1.040**	**1.030, 1.051**	**<.001**
	Perceived Risk * Actual Risk	.935	.880, .992	.027	.930	.866, .999	.046
Supplement use	Perceived Risk	**1.082**	**1.036, 1.129**	**<.001**	1.024	.977, 1.074	.328
	Actual Risk	**1.022**	**1.014, 1.030**	**<.001**	**1.016**	**1.009, 1.024**	**<.001**
	Perceived Risk * Actual Risk	1.001	.958, 1.047	.949	.957	.912, 1.005	.076
Walking	Perceived Risk	**.856**	**.812, .902**	**<.001**	.936	.881, .994	.031
	Actual Risk	1.003	.996, 1.010	.428	1.002	.995, 1.009	.606
	Perceived Risk * Actual Risk	1.038	.986, 1.092	.154	1.024	.968, 1.083	.403
Bone test, SR	Perceived Risk	**1.156**	**1.093, 1.221**	**<.001**	**1.153**	**1.078, 1.234**	**<.001**
	Actual Risk	1.006	1.001, 1.012	.030	1.008	1.001, 1.015	.018
	Perceived Risk *	1.047	.993, 1.104	.089	.989	.929, 1.053	.726

		Concurrent Analyses			Lagged Analyses		
Outcome	**Predictor**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**
	Actual Risk						
Bone test, EMR	Perceived Risk	**1.194**	**1.126, 1.266**	**<.001**	**1.251**	**1.162, 1.347**	**<.001**
	Actual Risk	1.003	.997, 1.008	.379	1.005	.998, 1.012	.135
	Perceived Risk * Actual Risk	.967	.913, 1.024	.253	.989	.931, 1.050	.717

Covariates in all models included: education, race/ethnicity, health insurance status, disease count, whether a woman experienced early menopause and baseline falls.

Ann Behav Med. Author manuscript; available in PMC 2016 October 01.

Table 3

Analyses of the relationship of perceived risk and bias with concurrent and lagged outcomes controlling for baseline levels. Actual risk was measured by FRAX score. Bias is indicated by the interaction of standardized actual risk and perceived risk. Perceived risk and bias (interaction of perceived risk and standardized actual risk) at baseline, 1- and 2- years was used to predict the outcomes at 1-, 2- and 3- years in the lagged analyses. Bold indicates significant following Type I error correction. SR=self-report, EMR=electronic medical record.

		Concurrent Analyses			Lagged Analyses		
Outcome	**Predictor**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**
EQ-5D	Perceived Risk	**−.012**	**−.014, −.009**	**<.001**	−.002	−.004, .001	.202
	Actual Risk	−.0002	−.001, .0001	.164	−.0002	−.001, .0001	.266
	Perceived Risk * Actual Risk	−.002	−.004, .001	.156	.001	−.001, .004	.254
Self-reported Health	Perceived Risk	**−.100**	**−.113, −.087**	**<.001**	**−.025**	**−.040, −.010**	**.001**
	Actual Risk	−.002	−.004, −.0003	.019	−.002	−.004, −.001	.012
	Perceived Risk * Actual Risk	.007	−.006, .019	.301	−.003	−.017, .011	.669
Medication use, SR	Perceived Risk	**1.489**	**1.335, 1.661**	**<.001**	**1.303**	**1.151, 1.475**	**<.001**
	Actual Risk	**1.017**	**1.007, 1.027**	**.001**	1.016	1.003, 1.028	.013
	Perceived Risk * Actual Risk	**.887**	**.827, .951**	**.001**	.896	.810. .991	.032
Medication use, EMR	Perceived Risk	**1.322**	**1.189, 1.470**	**<.001**	**1.198**	**1.047, 1.371**	**.009**
	Actual Risk	**1.015**	**1.004, 1.026**	**.006**	1.009	.996, 1.023	.180
	Perceived Risk * Actual Risk	.903	.838, .973	.008	.871	.783, .970	.012
Supplement use	Perceived Risk	**1.107**	**1.046, 1.170**	**<.001**	1.016	.957, 1.078	.605
	Actual Risk	**1.015**	**1.008, 1.023**	**<.001**	1.008	1.001, 1.015	.026
	Perceived Risk * Actual Risk	.991	.939, 1.046	.743	.931	.879, .986	.015
Walking	Perceived Risk	**.874**	**.824, .927**	**<.001**	.961	.898, 1.028	.243
	Actual Risk	.999	.992, 1.007	.875	.998	.990, 1.006	.605
	Perceived Risk * Actual Risk	1.036	.980, 1.096	.212	1.017	.959, 1.079	.572
Bone test, SR	Perceived Risk	**1.151**	**1.088, 1.219**	**<.001**	**1.141**	**1.065, 1.223**	**<.001**
	Actual Risk	1.005	.999, 1.011	.101	1.006	.999, 1.014	.084
	Perceived Risk *	1.045	.990, 1.104	.111	.994	.932, 1.060	.853

		Concurrent Analyses			Lagged Analyses		
Outcome	**Predictor**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**	**Coefficient or Odds Ratio**	**Confidence Interval**	**P-value**
	Actual Risk						
Bone test, EMR	Perceived Risk	**1.182**	**1.115, 1.253**	**<.001**	**1.219**	**1.132, 1.312**	**<.001**
	Actual Risk	1.002	.996, 1.008	.483	1.004	.998, 1.011	.203
	Perceived Risk * Actual Risk	.965	.912, 1.022	.225	.990	.932, 1.052	.754

Covariates in all models included: education, race/ethnicity, health insurance status, disease count, whether a woman experienced early menopause and baseline falls.