

## Heart attack risk perception biases among hypertension patients: The role of educational level and worry

Laurel M. Peterson<sup>a\*</sup>, Marie Helweg-Larsen<sup>b</sup>, Kevin G. Volpp<sup>cde</sup>  
and Stephen E. Kimmel<sup>fg</sup>

<sup>a</sup>Psychology Department, The George Washington University, Washington, DC, USA; <sup>b</sup>Psychology Department, Dickinson College, Carlisle, PA, USA; <sup>c</sup>Center for Health Incentives and Behavioral Economics, Leonard Davis Institute, Philadelphia Veterans Affairs Medical Center, Philadelphia, PA, USA; <sup>d</sup>Department of Medicine, Perelman School of Medicine, Philadelphia, PA, USA; <sup>e</sup>Department of Health Care Management, Wharton School, Philadelphia, PA, USA; <sup>f</sup>Department of Medicine, University of Pennsylvania, Philadelphia, PA, USA; <sup>g</sup>Department of Biostatistics and Epidemiology, University of Pennsylvania, Philadelphia, PA, USA

(Received 5 January 2011; final version received 20 September 2011)

Risk biases such as comparative optimism (thinking one is better off than similar others) and risk inaccuracy (misestimating one's risk compared to one's calculated risk) for health outcomes are common. Little research has investigated racial or socioeconomic differences in these risk biases. Results from a survey of individuals with poorly controlled hypertension ( $N = 813$ ) indicated that participants showed (1) comparative optimism for heart attack risk by *underestimating* their heart attack risk compared to similar others, and (2) risk inaccuracy by *overestimating* their heart attack risk compared to their calculated heart attack risk. More highly educated participants were more comparatively optimistic because they rated their personal risk as lower; education was not related to risk inaccuracy. Neither race nor the federal poverty level was related to risk biases. Worry partially mediated the relationship between education and personal risk. Results are discussed as they relate to the existing literature on risk perception.

**Keywords:** comparative optimism; heart attack risk; hypertension; perceived risk; risk inaccuracy; worry

### Introduction

Individuals often contemplate the risk of negative events when considering adopting or avoiding particular behaviours. Risk perception is a central construct in several health behaviour theories including the Health Belief Model (Becker, 1974), the Protection Motivation Theory (Rogers, 1983), the Prototype/Willingness Model (Gibbons, Gerrard, & Lane, 2003), and the Precaution Adoption Model (Weinstein, 2000). Research also supports the link between perceived risk and health outcomes.

---

\*Corresponding author. Email: laurel\_p@gwmail.gwu.edu

For example, a meta-analysis found that perceived risk (which was measured as likelihood to encounter the negative health outcome) predicted vaccination behaviour for influenza, hepatitis, pneumonia or Lyme disease (Brewer et al., 2007).

Risk perceptions and risk biases can be measured in several ways. The most basic risk measurement is to ask an individual's perception of the chance that a negative event will occur at some point in the future (*personal risk*). Hundreds of studies show that people tend to underestimate their personal risk relative to their assessment of other people's for the same event (e.g., heart attack). This type of risk bias is called *comparative optimism* (or optimistic bias) (for a review see Harris, Griffin, & Murray, 2008; Helweg-Larsen & Shepperd, 2001) and has been demonstrated for a host of different health events including having a heart attack (Avis, Smith, & McKinlay, 1989; Kreuter & Strecher, 1995; Radcliffe & Klein, 2002). Broadly, perceptions of comparative optimism are related to both risk-event characteristics (events that are considered rare, less severe, controllable, and have easily imaginable victims tend to produce greater ratings of comparative optimism) and personal variables (people who are anxious, depressed, or have low self-esteem tend to show less comparative optimism) (Harris et al., 2008; Helweg-Larsen & Shepperd, 2001). Comparative optimism is an important cognition to assess as it is more predictive of worry and precautionary intentions compared to personal risk (Klein, 2003).

A second type of risk bias is *risk accuracy*. Risk accuracy is the difference between personal risk perception and some sort of objective assessment of the actual risk, such as calculated risk obtained from a risk calculator. Risk calculators are available online for several health outcomes and calculate an individual's risk based on epidemiological modelling of risk factors (e.g., age, smoking and family history) related to a specific health outcome (e.g., heart attack, breast cancer or stroke). In contrast to the literature in comparative optimism (which shows that people tend to underestimate their risk relative to other people), risk accuracy varies greatly across studies with some showing that people are overall accurate, some showing pessimism, and some showing optimism in risk accuracy. With respect to risk accuracy and cardiovascular risk, one study found that most participants (72%) accurately estimated their risk for future cardiovascular disease, 13% incorrectly underestimated their risk, and 15% incorrectly overestimated their risk (van der Weijden, van Steenkiste, Stoffers, Timmermans, & Grol, 2007). In contrast, in a study of patients diagnosed with hypertension or diabetes, participants overestimated their risk for future cardiovascular disease (i.e., myocardial infarction, stroke) by 22.9% (Frijling et al., 2004). This inconsistency between studies may be because of differences in whether participants were at risk for a heart attack. Patients were healthy adults in van der Weijden et al.'s study, whereas they had either hypotension or diabetes in Frijling et al.'s study. Additionally, past research had imperfect measures of medical variables to construct the calculated risk. Specifically, Frijling et al. (2004) did not obtain each participant's medical variables and instead used substitute values to input in the heart attack risk calculator. Additional research is important to more thoroughly assess whether individuals accurately assess their heart attack risk.

Despite the extensive research on risk perception biases, little research has investigated whether these biases differ based on demographic variables such as race or socioeconomic status (SES). Compared to their White counterparts, Blacks suffer disproportionately from hypertension (Center for Disease Control and Prevention, 2008). In terms of SES and hypertension outcomes, people of lower SES have the highest incidence of morbidity and mortality for cardiovascular diseases (Pickering,

1999). The existence of the actual race and SES differences in health outcomes for hypertension leads to the question of whether risk perceptions or risk biases differ for these groups. That is, if actual risks differ across race and SES, would individuals differ in how they estimate their risks either relative to how they estimate the risk for other people or relative to their calculated risk?

Only a few studies have examined racial differences in risk biases, often with catch-all categories for non-White groups, and they have produced mixed results. First for comparative optimism, White smokers were more comparatively optimistic than Black smokers for risk of getting lung cancer when controlling for income, education and cigarettes smoked per day (Reimer, Gerrard, & Gibbons, 2010). Among women rating their risk perception for getting breast cancer, the opposite pattern was found in that 30% of White women were comparatively optimistic compared to 44% of non-White women (Skinner, Kreuter, Kobrin, & Strecher, 1998). However, in a nationally representative sample of US women, when controlling for objective risk status, African American women were more likely to be unrealistically pessimistic for their breast cancer risk than White women (Waters et al., 2011).

Second for risk accuracy, among women with breast/ovarian cancer history who were judging their genetic disposition to these cancers, no racial differences were found for risk accuracy for either breast/ovarian genetic disposition to cancer (Bluman et al., 1999) or breast cancer (Skinner et al., 1998). One recent research article is suggestive of cultural differences in risk accuracy among participants with one risk factor for cardiovascular disease in that participants who chose to complete the survey in Spanish were more likely to underestimate their risk for cardiovascular disease than participants who chose to complete the survey in English (Wright, Barnhart, & Freeman, 2010).

Similarly, very few studies have examined SES differences in risk biases. In research reviewing comparative optimism for multiple negative events, there was a small negative correlation between education level and comparative risk, but no correlation between job prestige and comparative risk (Weinstein, 1987). Also research on risks for heart disease and cancer demonstrated that individuals with a college degree were less likely to report comparative optimism than individuals with less than a high school education (Ayanian & Cleary, 1999). In a nationally representative sample of US women examining breast cancer risk, women with higher education were more unrealistically optimistic and less unrealistically pessimistic (Waters et al., 2011). However, research on risk accuracy has demonstrated mixed findings with regard to SES. People with higher education were more likely to overestimate their risk for heart attack relative to a cardiovascular risk calculator (Avis et al., 1989). Among women, those with higher education were more likely to underestimate their risk for breast cancer compared to a breast cancer risk calculator (Skinner et al., 1998). Overall, there is little research on racial or SES differences in risk biases with some evidence pointing to greater comparative optimism with higher education and inconsistent results with respect to risk accuracy and SES.

Worry is one variable that is important to investigate as a mediator between SES/race and risk biases. First, worry is associated with risk perceptions (Bluman et al., 1999; Zajac, Klein, & McCaul, 2006) because current emotions influence cognitive judgments (Lipkus, Klein, Skinner, & Rimer, 2005) and because emotions activate anxious thoughts, leading to more negative future judgments (Butler &

Mathews, 1987). Second, worry is associated with SES/race. Education and worry are negatively correlated (Sjoberg, 1998) and lower SES (as measured by community index) is related to greater worry for bowel cancer (Simon, Steptoe, & Wardle, 2005). Low SES might be associated with greater worry because low SES is actually related to greater risk for many health outcomes. Thus, worry is associated with both risk perceptions and with SES/race, positioning worry as a useful variable to examine as a potential mediator between SES/race and risk biases. Prior research demonstrating increased comparative pessimism among participants with less education proposed that future research could examine worry as potential mechanism explaining this SES and risk bias relationship (Waters et al., 2011).

The health domain of interest for the current study was heart attack risk among patients with uncontrolled hypertension. Hypertension is the single largest contributor to cardiovascular disease (e.g., heart attack) and afflicts 1 in 3 adults in the United States (Center for Disease Control, 2011). This study examined risk biases among individuals with poorly controlled hypertension. Patients recruited through hospital settings reported their personal risk of heart attack and peer risk to determine comparative risk and worry about getting a heart attack. Additionally, risk factors for heart attack were assessed to calculate 10-year heart attack risk and determine risk accuracy.

We had four hypotheses. First we hypothesised that participants would display comparative optimism (rate their heart attack risk as less than that of similar others). Comparative optimism is the standard finding demonstrated in hundreds of research studies on risk perception for future health outcomes (Helweg-Larsen & Shepperd, 2001) including heart attack (Avis et al., 1989; Kreuter & Strecher, 1995; Radcliffe & Klein, 2002). Second, we predicted that participants would show risk inaccuracy by overestimating their personal risk relative to their calculated heart risk. The prior findings on risk accuracy are quite mixed but the health domain of the current study most closely parallels the risk outcome in Frijling et al. (2004) that demonstrated that at-risk participants overestimated their risk for cardiovascular disease. Third, we explored the possibility of SES and race differences in risk biases. This area of research is minimal and has produced such inconsistent results that we tentatively expected to find that people who are actually at greater risk (e.g., Blacks, people of lower education, and people living in poverty) would rate their personal risk as greater than other individuals. Finally, we examined if worry might serve as a mediator between SES/race difference and risk biases in that health-related worry is related both to risk biases and to SES/race.

## **Method**

### ***Participants***

This study was a part of a larger randomised controlled trial assessing the impact of copayment reduction on blood pressure medication adherence (Volpp et al., 2011). Participants were recruited from three hospitals in Pennsylvania: the Philadelphia Veterans Affairs Medical Center, the Veterans Affairs Pittsburgh Healthcare System, and Pinnacle Health Systems in Harrisburg. Potential participants were identified through medical charts if they met the following inclusion criteria: 21 years of age and older and a systolic blood pressure of 140 and above (130 in diabetic patients). At the Philadelphia VA Medical Center and VA Pittsburgh Healthcare System,

letters were sent to participants who qualified, of which 4068 expressed interest. Approximately 80% of these potential participants did not meet inclusion criteria (systolic blood pressure of at least 140 or 130 for individuals who were diabetic, one or more active prescriptions and paying a copay for anti-hypertensive medication, 21 years of age or older) or were excluded due to ineligibility (participation in another experimental study, markedly shortened life expectancy due to diagnosis of metastatic cancer, end-stage renal disease on dialysis, NYHA class IV CHF, or dementia, atrial fibrillation). A remaining total of 501 participants from Philadelphia and 239 participants from Pittsburgh were both screened to ensure eligibility and agreed to participate. At Pinnacle Health Systems, participants were approached and recruited on-site; 73 were both screened to ensure eligibility and agreed to participate.

Participants ( $N = 813$ ) were predominantly male (90.7%), due in part to the overrepresentation of men in veterans hospitals. Because the proportion of women was too small to examine gender differences, we instead controlled for gender in all analyses. Participants had a mean age of 65.58 ( $SD = 11.76$ ; range 22–89) and were predominantly Black (47.4%) or White (44.1%). Participants had an average baseline blood pressure of 159/83, and an average 10-year calculated heart attack risk of 19.7% ( $SD = 8.71$ ). Thus, the participants had high blood pressure and were at high risk for a heart attack. For more detail on sample demographics see Table 1.

Table 1. Demographic description of sample.

	<i>n</i>	%
Gender		
Male	737	90.7
Female	76	9.3
Marital Status		
Married	366	44.6
Age		
Over 65 year old	407	50.1
Race		
Black	389	47.4
White	362	44.1
Other	69	8.4
Ethnicity		
Hispanic	25	3.0
Education		
Less than high school	139	17.2
High school graduate or GED	275	34.1
Some college	270	33.5
College graduate and more	122	15.1
Federal poverty level		
<100% FPL	177	21.8
100 through <200% FPL	290	35.7
200 through <300% FPL	182	22.4
300% FPL and greater	164	20.2
Cardiovascular risk factors		
Diabetes	436	53.2
High cholesterol	117	27.2
Smoker	214	26.1

SES measures between Black (non-Hispanic) and White (non-Hispanic) participants were compared. Independent sample t-tests were performed to ascertain differences in the level of education and federal poverty level. Blacks ( $M=2.31$ ,  $SD=0.91$ ) had significantly less education than Whites ( $M=2.60$ ,  $SD=0.97$ );  $t(742)=4.22$ ,  $p < .001$ ,  $d=0.31$ , but there was no significant difference in the scores for federal poverty level between Blacks ( $M=2.42$ ,  $SD=1.07$ ) and Whites ( $M=2.40$ ,  $SD=1.01$ );  $t(749)=-0.21$ ,  $p=0.84$ ,  $d=-0.02$ . Additionally, ANOVAs were run with site as the independent variable with the main risk perceptions of interest as dependent variables (i.e., personal risk and other risk) and no differences were found ( $ps > 0.05$ ).

### Measures

Participants completed the high blood pressure study survey, a 24-page survey that took 30–40 min to complete and had their blood pressure taken. The survey sections of interest for the current study included items assessing risk perceptions, worry, demographics and health indicators. Other medical data (e.g., cholesterol lab work) were collected from participants' medical records.

### Medical data

Each participant was instructed to relax for 5 min before their blood pressure was taken; then the participant's arm (the dominant arm unless the participant expressed a preference to use the other arm) was supported on a chair or desk, and the blood pressures were measured while the participant was sitting. Three measurements were taken, 2 min apart, and averaged. Blood pressure measurements were not revealed to the study participants.

Cholesterol levels were collected from existing lab work in participants' medical records. After participants filled out the survey, research assistants accessed participant medical records and recorded the most recent total and HDL cholesterol lab work. Research assistants only collected cholesterol lab work if the results were reported in medical records in the year prior to when the participant completed the survey. The cholesterol lab work could have been from before or after the participant completed the survey.

### Calculated risk

Using answers from the participants' survey (i.e., smoking status and age), information from their medical records (i.e., total and HDL cholesterol), and blood pressure assessed the day the participant filled out the survey, we calculated each participant's 10-year predicted risk of heart attack using the National Cholesterol Education Program's risk calculator (National Heart, Lung, and Blood Institute). This heart attack risk calculator is an equation-based model derived from the Framingham heart study, and recent research has demonstrated that this version of the calculator has greater risk classification accuracy than other versions (Gordan, Polansky, Boscardin, Fung, & Steinman, 2010). Chart cholesterol data were collected from Philadelphia VA Medical Center, resulting in a smaller sample size for analyses utilising calculated risk. Additionally, the risk calculator

could not reliably compute calculated 10-year risk at levels above 30%, and the highest category is therefore labelled '30% or higher'. Eighty-five participants (22.3% of participants for whom we could calculate heart attack risk) were coded with a calculated risk level of 30% or higher.

### ***Risk perceptions***

Personal and other risks were measured with two questions, namely, 'What is the chance that you will have a heart attack in the next 10 years?' and 'Imagine an average person your race and age who has high blood pressure. What is the chance that he or she will have a heart attack in the next 10 years?' Participants indicated their risk judgment by placing an *X* on a scale ranging from 0% (*definitely will not*) to 100% (*definitely will*) that was segmented at 10% intervals. Although averaging across multiple risk perception items can be desirable, research shows that a composite risk perception scale is only marginally more predictive of a behavioural outcome ( $r=0.30$ ) than the percentage scale used here ( $r=0.26$ ) (Weinstein et al., 2007). The 0–100% response scale was selected to correspond with the risk estimates provided by National Cholesterol Education Program's heart attack risk calculator; the response scale and outcome time frame (i.e., 10 years) are standard in this research (Frijling et al., 2004).

### ***Comparative risk***

Comparative risk was defined as the difference between each participant's personal perception of risk as compared to the participant's risk estimate for others with hypertension of a similar race and age. This variable was assessed using the indirect method of comparative risk by subtracting the participants' perceptions of their peer's risk from their personal risk estimate (Helweg-Larsen & Shepperd, 2001). This resulted in a continuous variable of comparative risk, with positive numbers indicating comparative optimism and negative numbers indicating comparative pessimism.

### ***Risk accuracy***

Risk accuracy was defined as the difference between an individual's calculated risk and perceived personal risk. This variable was also continuous, with positive numbers indicating a pessimistic inaccuracy in that participants see their personal risk as greater than it actually is (Frijling et al., 2004). Negative numbers indicate an optimistic inaccuracy in which participants see their personal risk as smaller than the calculated risk.

### ***Worry about heart attack***

Worry was assessed with one item, 'How much you have worried in the last month about having a heart attack'. Response options ranged 1 (*I haven't worried about this at all in the last month*) to 7 (*I have worried about this all the time in the last month*). The average score was 2.81 (SD = 1.91).

### ***Race and socioeconomic status***

Participants reported race, level of education, income, and number of persons per household. Race was measured using check boxes with the following options: *Black or African American, White or Caucasian, Asian/Asian American, North American Indian/Northern Native, Native Hawaiian/Other Pacific Islander* and *Other (please specify)*, with an additional checkbox for Hispanic ethnicity. For this study, only participants who reported their race as only Black (and not Hispanic) or only White (and not Hispanic) were included in analyses investigating race.

SES was assessed in two ways, namely by the educational level and federal poverty level. The educational level was assessed by asking participants to check their highest level of education. These responses were combined into four levels: less than high school diploma, high school graduate or GED, more than high school and college graduate and more. Federal poverty level is a comprehensive SES variable in that it accounts for total household income as well as the number of persons supported by that income. We calculated the federal poverty level using the 2007 federal poverty level guidelines (see Table 1 for sample demographics).

### **Procedure**

At each site, pre-recruited eligible participants were scheduled to complete the survey at a time that usually coincided with their next personal medical appointment at the hospital. Blood pressure was assessed at this research appointment. All participants completed an IRB-approved informed consent and a Health Insurance Portability and Accountability Act (HIPAA) consent to allow researchers access to patients' medical charts. Approximately 1 year after the participants' initial research appointment, research assistants collected medical chart data. Participants received \$20 for participating. The study adhered to universal ethical principles (Emanuel, Wendler, & Grady, 2000) and was approved by the Institutional Review Boards of the Philadelphia VA Medical Center, VA Pittsburgh Healthcare System, and the University of Pennsylvania.

### **Results**

First, we examined the extent to which these at-risk participants were comparatively optimistic or accurate in their risk estimates. Second, we examined whether race, federal poverty level and education predicted comparative risk and risk accuracy, respectively. Finally, we investigated whether worry mediated the obtained SES differences in risk.

### ***Prevalence of comparative optimism and risk accuracy***

As displayed in Figure 1, participants showed comparative optimism in that they estimated their personal risk ( $M = 39.69$ ,  $SD = 24.33$ ) as lower than they estimated the risk of other participants ( $M = 50.12$ ,  $SD = 24.17$ ),  $t(806) = -13.27$ ,  $p < 0.001$ ,  $d = 0.47$ . To illustrate the prevalence of biases in comparative risk, we assessed comparative risk categorically allowing for a 10% margin of error (Radcliffe & Klein, 2002). Specifically, 54.2% of participants estimated their own risk to be similar to that of others (within  $\pm 10$  percentage points), 10.7% were



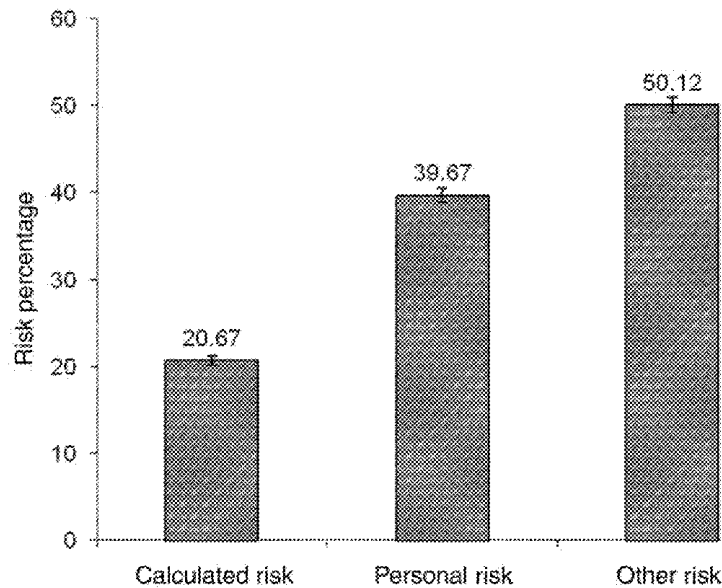


Figure 1. Mean and standard errors for heart attack risk ratings.

Notes: Means and standard errors reported here represent values derived from the entire sample. Paired sample *t*-tests comparing each pair of ratings revealed that all means differed significantly ( $ps < 0.01$ ). 'Other risk' signifies participants' perceptions of the average person's risk of heart attack.

comparatively pessimistic in that they estimated their own risk as greater than they estimated the risk of others, and 35.2% were comparatively optimistic in that they estimated their own risk as smaller than they estimated the risk of others.

In contrast, participants showed pessimism in risk accuracy in that they estimated their personal risk ( $M = 38.24$ ,  $SD = 23.77$ ) as higher than their calculated risk ( $M = 19.73$ ,  $SD = 8.68$ ),  $t(379) = -14.19$ ,  $p < 0.001$ ,  $d = -0.73$  (see Figure 1). We also reran this analysis filtering out participants whose calculated risk scores were coded as greater than 30% and the same significant pattern emerged. To illustrate the prevalence of biases in risk accuracy, we assessed risk accuracy categorically using the same conceptualisation as comparative risk, allowing participants a 10% margin of error. Specifically, 25.3% of participants estimated their own risk to be similar to the calculated risk (within  $\pm 10$  percentage points), 60.5% estimated their own risk as greater than their calculated risk, and 14.2% estimated their own risk as smaller than the calculated risk. In sum, participants showed the usual comparative optimism in that they estimated their own risk as smaller than the risk of other individuals with hypertension. Also similar to some research on accuracy of risk estimation (Frijling et al., 2004), the participants overestimated their actual risk.

### *SES/race and comparative risk*

To assess whether race, education and federal poverty level were related to comparative risk (other risk minus personal risk) we conducted a multiple regression analysis, with gender as a control, in which *comparative risk* was predicted from (1) race (Black vs. White), (2) education and (3) federal poverty level. All predictor variables were entered on the same step. Across these analyses, education emerged as

Table 2. Race and SES differences among heart attack risk variables.

Risk variables	Race			Education		Federal poverty level	
	Black <i>M</i> (SD)	White <i>M</i> (SD)	<i>n</i>	<i>r</i>	<i>n</i>	<i>r</i>	<i>n</i>
Personal risk	39.82 (24.62)	40.41 (24.13)	746	-0.09*	801	-0.02	806
Other risk	48.92 (24.29)	51.52 (24.52)	745	0.00	800	0.03	805
Comparative risk	10.10 (21.75)	11.08 (23.20)	745	0.10**	800	0.05	805
Calculated risk	19.76 (8.35)	19.48 (9.07)	359	0.02	376	0.07	380
Risk accuracy	18.48 (25.46)	18.49 (24.26)	358	-0.09†	375	0.01	378
Worry	2.91 (1.97)	2.58 (1.75)	744*	-0.10**	800	-0.02	804

Notes: All of the above analyses control for gender. Black and White differences were examined using independent sample *t*-tests. Education and federal poverty level differences were examined using correlation coefficients. 'Other risk' signifies participants' perceptions of the average person's risk of heart attack.

† $p \leq 0.10$ , \* $p \leq 0.05$ , \*\* $p \leq 0.01$

the only predictor for comparative risk ( $\beta = 0.10$ ,  $p = 0.011$ ), such that those with higher education reported greater comparative optimism for heart attack risk. Similarly, simple correlation results in Table 2 (third row) showed that comparative optimism was only related to the educational level and not race or federal poverty level.

Since comparative risk is calculated from personal risk and other risk, we conducted analyses to determine whether the relationship between education and comparative risk was driven by personal risk or other risk. We again conducted a multiple regression analysis, controlling for gender, in which *personal risk* was predicted from (1) race (Black vs. White), (2) education and (3) federal poverty level. For personal heart attack risk, education again emerged as the only significant predictor ( $\beta = -0.09$ ,  $p = 0.016$ ), such that those with higher education reported their heart attack risk as lower. Similarly, we conducted a multiple regression analysis in which *other risk* was predicted from (1) race (Black vs. White), (2) education and (3) federal poverty level. For other heart attack risk, none of the variables emerged as significant predictors ( $ps > 0.05$ ). Similar results were obtained in separate correlations (Table 2, first and second rows). These results show that the relationship between education and comparative risk is driven by lower perceived *personal risk* among more highly educated participants. Additionally, these more highly educated participants perceived their risk as lower despite a null relationship between *calculated risk* and education (Table 2, fourth row).

### ***SES/race and risk accuracy***

To assess whether race, education and federal poverty level were related to risk accuracy (personal risk minus calculated risk), we conducted a multiple regression

analysis controlling for gender in which *risk accuracy* was predicted from (1) race (Black vs. White), (2) education and (3) federal poverty level. None of the proposed variables emerged as significant predictors ( $ps > 0.05$ ); also see Table 2 (fifth row). Because the risk calculator capped the calculated risk scores at 30%, we reran these analyses converting the calculated risk score and the personal risk score to  $z$ -scores. Thus, the new risk accuracy variable was computed from the  $z$ -scores of calculated risk minus the  $z$ -scores of personal risk. The results using the standardised measure of risk accuracy did not differ from the unstandardised measure of risk accuracy, as none of the variables emerged as significant predictors ( $ps > 0.05$ ).

### ***Worry mediator analysis***

In the above analyses of SES variables predicting comparative optimism and risk accuracy, only education emerged as a significant predictor of personal risk. We examined worry about having a heart attack as a mediator. Specifically, those who have less education might rate their risk as higher because they worry more. Table 2 (sixth row) shows that those with less education were more worried about heart attack and worry was correlated with personal risk.

To test the significance of the mediation we employed the indirect effect using Preacher and Hayes (2008) that allows for control of potential covariates. In this case, we controlled for gender, and ran the mediation analysis to determine if heart attack worry mediated the relationship between education and personal heart attack risk. Heart attack worry's confidence interval around the indirect effect did not contain 0 (point estimate unstandardized  $b = -0.5101$ , 95% confidence interval around  $b$  from  $-1.0574$  to  $-0.1739$ ,  $n = 799$ , 1000 bootstrapped resamples). Thus, worry mediated the relationship between education and personal risk.

In sum, participants underestimated their risk relative to other people with hypertension but overestimated their risk relative to their calculated risk. Among the three indicators (race, federal poverty level, and education) predicting both comparative risk and risk accuracy, one significant result appeared: education predicted comparative risk such that more education was associated with greater comparative optimism. Furthermore, this resulted because more educated individuals thought that their personal risk was lower whereas educational level was not related to perceptions of other people's risk. Mediation analyses showed that heart attack worry mediated the relationship between education and personal risk perception. That is, the path from education to personal risk went through worry – those who were more educated worried less and rated their risk as lower.

### **Discussion**

This study examined risk perception biases for heart attack among participants with hypertension. Participants showed comparative optimism in that they underestimated their heart attack risk compared to the risk of a similar person with hypertension and risk inaccuracy in that they overestimated their personal risk relative to their calculated heart attack risk. Participants who were more highly educated were more comparatively optimistic, which was driven by a negative relationship between education and personal risk (as opposed to estimation of other

risk that was not related to education). Worry about having a heart attack partially mediated the relationship between education and personal risk.

As expected, participants on average thought their personal risk of heart attack was less than that of another person with hypertension of the same gender, race and age. This finding is consistent with other research (Avis et al., 1989; Kreuter & Strecher, 1995; Radcliffe & Klein, 2002), and provides further evidence to illustrate the prevalence of this risk bias (Helweg-Larsen & Shepperd, 2001). Also, as expected, participants on average thought their personal risk of heart attack was greater than their calculated heart attack risk. This finding replicates Frijling et al.'s (2004) research using more accurate medical data to compute calculated heart attack risk for each participant.

The current research demonstrated that individuals with higher education reported greater comparative optimism because they had lower estimates of personal risk relative to their estimation of others' risk. This educational difference persisted even when controlling for actual risk which supports previous findings of a relationship between higher education and less comparative optimism for breast cancer risk (Waters et al., 2011). In addition to replicating these findings, this study demonstrated that worry about having a heart attack in part explained the relationship between education and personal risk such that people with less education worried more and in turn reported higher personal risk perceptions. The relationship between risk perception and worry is consistent with research showing that worry is related to personal risk perceptions (Zajac et al., 2006). Recent research also demonstrates that perceptions of comparative risk function differently for individuals who express different levels of worry for a particular health outcome. Specifically, individuals who are highly worried may actually have reduced intentions to take preventative action when informed their risk is above average (Klein, Zajac, & Monin, 2009).

Although there is little research on SES and worry, the present findings support research demonstrating that individuals with lower SES reported greater worry for bowel cancer (Simon et al., 2005). Low SES might be associated with greater worry because low SES is actually related to greater calculated risk, although interestingly in the current study lower education was not associated with greater calculated risk. Future research will have to examine more fully both the direction of the relationship and the role that SES plays.

There were two primary limitations in this study. First, the sample consisted mostly of veterans with uncontrolled hypertension who volunteered to participate in a clinical trial. These participants also differed from the general population in that their calculated risk for heart attack did not differ between races or by SES (Table 2, fourth row). The VA system may have fewer barriers to care that contribute to fewer racial and SES disparities than in the general US healthcare system. VA-based medical care sometimes shows no racial differences in outcomes and even better outcomes among Blacks compared to Whites (Gurmankin, Polsky, & Volpp, 2004). Perhaps a sample from the broader population of people living with hypertension would be more apt to illustrate racial or SES differences in risk biases.

Second, although the objective measure of risk was a major strength of the study, there were still imperfections in the assessment of actual risk. The risk calculator was capped at a 'greater than 30%' 10-year risk for heart attack because the algorithm for the risk calculator cannot accurately compute risk above 30%. This could artificially reduce the calculated risk values although none of the results differed

when we standardised the calculated heart attack risk values. Furthermore, all values used in the risk calculator were not obtained the same day the survey was completed (i.e., cholesterol counts). Future research could improve actual risk calculation by collecting cholesterol levels on the same day as the participant self-report risk factors.

Future analyses of risk perception should continue to assess demographic differences in risk biases especially on risk outcomes for which those demographic elements are a risk factor. Given that the more highly educated individuals in this sample perceived themselves to be at lower risk, despite no medical reduction in calculated risk, leads to the question of whether something about higher education makes people feel less vulnerable and worry less. Perhaps education itself leads these individuals to feel less at risk, or ignore or downplay objective risk information. Future research should tease apart these issues. Examining risk perceptions, biases and worry for heart attack risk among individuals with hypertension is an important undertaking given that medication adherence can reduce the risk for heart attack. Poorly treated hypertension is a formidable medical challenge to overcome given that patients are asymptomatic and often non-adherent to the prescribed treatment (Aggarwal & Mosca, 2010). Given that hypertension has no external symptomatic cues, ensuring that individuals who live with hypertension have accurate perceptions of their heart attack risk is especially important to encourage preventative action for future heart attack risk (e.g., medication adherence). One important direction for future research is further elucidating how risk perception affects illness understanding and preventive behaviours.

### Acknowledgements

The work in this article was primarily supported by a grant from the Commonwealth of Pennsylvania, titled *Collaboration to Reduce Disparities in Hypertension*; grant number ME-02-382. Supplemental support was received from Pfizer, Inc. The sponsors/funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript. Dr. Volpp has received funding from Astra Zeneca to conduct a conference on medication adherence as well as research funding from the Aetna Foundation, honoraria from Aetna, Inc. and research funding support from McKinsey, Inc. Dr. Kimmel has done consulting for several pharmaceutical companies, including Pfizer, all unrelated to the topic of this article. Other than what is listed above, there are no known financial conflicts of interest among any of the authors including but not limited to employment/affiliation, all grants or funding, honoraria, paid consultancies, expert testimony, and patents filed, received or pending. At the time data were collected the primary author, Laurel M. Peterson, was a student at Dickinson College. The authors would like to thank William M.P. Klein, Jennifer Perry, and Mina Miljevic for their assistance with this manuscript. The authors would like to thank Jane Jaskowiak for her management of data collected for this manuscript.

### References

- Aggarwal, B., & Mosca, L. (2010). Lifestyle and psychosocial risk factors predict non-adherence to medication. *Annals of Behavioral Medicine*, *40*, 228–233.
- Avis, N.E., Smith, K.W., & McKinlay, J.B. (1989). Accuracy of perceptions of heart attack risk: What influences perceptions and can they be changed? *American Journal of Public Health*, *79*, 1608–1612.
- Ayanian, J.Z., & Cleary, P.D. (1999). Perceived risks of heart disease and cancer among cigarette smokers. *Journal of the American Medical Association*, *281*, 1019–1021.

- Becker, M.H. (1974). The health belief model and sick role behavior. *Health Education Monographs*, 2, 409–419.
- Bluman, L.G., Rimer, B.K., Berry, D.A., Borstelmann, N., Iglehart, J.D., Regan, K., . . . , Winer, E.P. (1999). Attitudes, knowledge, and risk perceptions of women with breast and/or ovarian cancer considering testing for BRCA1 and BRCA2. *Journal of Clinical Oncology*, 17, 1040–1046.
- Brewer, N.T., Chapman, G.B., Gibbons, F.X., Gerrard, M., McCaul, K.D., & Weinstein, N.D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology*, 26, 136–145.
- Butler, G., & Mathews, A. (1987). Anticipatory anxiety and risk perception. *Cognitive Therapy and Research*, 11, 551–565.
- Center for Disease Control and Prevention (2008). *Hypertension awareness, treatment, and control – Continued disparities in adults: United States, 2005–2006*. Retrieved from <http://www.cdc.gov/nchs/data/databriefs/db03.pdf>
- Center for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division for Heart Disease and Stroke Prevention (2011). *High blood pressure fact sheet*. Retrieved from <http://www.cdc.gov/Features/HighBloodPressure/>
- Emanuel, E.J., Wendler, D., & Grady, C. (2000). What makes clinical research ethical? *Journal of the American Medical Association*, 283, 2701–2711.
- Frijling, B.D., Lobo, C.M., Keus, I.M., Jenks, K.M., Akkermans, R.P., Hulscher, M.E.J.L., . . . , Grol, R.P.T.M. (2004). Perceptions of cardiovascular risk among patients with hypertension or diabetes. *Patient Education and Counseling*, 52, 47–53.
- Gibbons, F.X., Gerrard, M., & Lane, D.J. (2003). A social reaction model of adolescent health risk. In J. Suls & K.A. Wallston (Eds.), *Social psychological foundations of health and illness* (pp. 107–136). Malden, MA: Blackwell Publishing.
- Gordan, W.J., Polansky, J.M., Boscardin, W.J., Fung, K.Z., & Steinman, M.A. (2010). Coronary risk assessment by point-based vs. equation-based Framingham models: Significant implications for clinical care. *Journal of General Internal Medicine*, 11, 1145–1151.
- Gurmankin, A.D., Polsky, D., & Volpp, K.G. (2004). Accounting for apparent “reverse” racial disparities in department of veterans affairs (VA)-based medical care: Influence of out-of-VA care. *American Journal of Public Health*, 94, 2076–2078.
- Harris, P.R., Griffin, D.W., & Murray, S. (2008). Testing the limits of optimistic bias: Event and person moderators in a multilevel framework. *Journal of Personality and Social Psychology*, 95, 1225–1237.
- Helweg-Larsen, M., & Shepperd, J.A. (2001). Do moderators of the optimistic bias affect personal or target risk estimates? A review of the literature. *Personality and Social Psychology Review*, 5, 74–95.
- Klein, W.M.P. (2003). Self-prescriptive, perceived, and actual attention to comparative risk information. *Psychology and Health*, 18, 625–643.
- Klein, W.M.P., Zajac, L.E., & Monin, M.M. (2009). Worry as a moderator of the association between risk perceptions and quitting intentions in young adult and adult smokers. *Annals of Behavioral Medicine*, 38, 256–261.
- Kreuter, M.W., & Strecher, V.J. (1995). Changing inaccurate perceptions of health risk: Results from a randomized trial. *Health Psychology*, 14, 56–63.
- Lipkus, I.M., Klein, W.M.P., Skinner, C.S., & Rimer, B.K. (2005). Breast cancer risk perceptions and breast cancer worry: What predicts what? *Journal of Risk Research*, 8, 439–452.
- National Heart, Lung, and Blood Institute. Risk assessment tool for estimating your 10-year risk of having a heart attack. Retrieved from <http://hin.nhlbi.nih.gov/atpiiii/calculator.asp?usertype=pub>

- Pickering, T. (1999). Cardiovascular pathways: Socioeconomic status and stress effects on hypertension and cardiovascular function. *The Annals of the New York Academy of Sciences*, 896, 262–277.
- Preacher, K.J., & Hayes, A.F. (2008). Asymptomatic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 40, 879–891.
- Radcliffe, N.M., & Klein, W.M.P. (2002). Dispositional, unrealistic, and comparative optimism: Differential relations with the knowledge and processing of risk information and beliefs about personal risk. *Personality and Social Psychology Bulletin*, 28, 836–846.
- Reimer, R.A., Gerrard, M., & Gibbons, F.X. (2010). Racial disparities in smoking knowledge among current smokers: Data from the Health Information National Trends Surveys. *Psychology and Health*, 25, 943–959.
- Rogers, R.W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J.T. Cacioppo & R.E. Petty (Eds.), *Social psychophysiology: A course book* (pp. 163–176). New York: Guilford Press.
- Simon, A.E., Steptoe, A., & Wardle, J. (2005). Socioeconomic status differences in coping with a stressful medical procedure. *Psychosomatic Medicine*, 67, 270–276.
- Sjoberg, L. (1998). Worry and risk perception. *Risk Analysis*, 18, 85–93.
- Skinner, C.S., Kreuter, M.W., Kobrin, S., & Strecher, V.J. (1998). Perceived and actual breast cancer risk: Optimistic and pessimistic biases. *Journal of Health Psychology*, 3, 181–193.
- van der Weijden, T., van Steenkiste, B., Stoffers, H.E.J.H., Timmermans, D.R.M., & Grol, R. (2007). Primary prevention of cardiovascular diseases in general practice: Mismatch between cardiovascular risk and patients' risk perceptions. *Medical Decision Making*, 27, 754–761.
- Volpp, K.G., Troxel, A.B., Long, J., Ibrahim, S., Appleby, D., Smith, J.O., . . . , Kimmel, S.E. (2011). *Randomized controlled trial of blood pressure medication copayment reduction: The Collaboration in Hypertension to Reduce Disparities (CHORD) Trial*. Unpublished manuscript.
- Waters, E.A., Klein, W.M.P., Moser, R.P., Yu, M., Waldron, W.R., McNeel, T.S., & Freedman, A.N. (2011). Correlates of unrealistic risk beliefs in a nationally representative sample. *Journal of Behavioral Medicine*, 34, 225–235.
- Weinstein, N.D. (2000). Perceived probability, perceived severity, and health-protective behavior. *Health Psychology*, 19, 65–74.
- Weinstein, N.D. (1987). Unrealistic optimism about susceptibility to health problems: Conclusions from a community-wide sample. *Journal of Behavioral Medicine*, 10, 481–500.
- Weinstein, N.D., Kwitel, A., McCaul, K.D., Magnan, R.E., Gerrard, M., & Gibbons, F.X. (2007). Risk perceptions: Assessment and relationship to influenza vaccination. *Health Psychology*, 26, 146–151.
- Wright, N.D., Barnhart, J., & Freeman, K. (2010). Coronary heart disease risk underestimation in a minority population: The Bronx Coronary Risk Perception Study. *Preventive Medicine*, 51, 434–454.
- Zajac, L.E., Klein, W.M.P., & McCaul, K.D. (2006). Absolute and comparative risk perceptions as predictors of cancer worry: Moderating effects of gender and psychological distress. *Journal of Health Communication*, 11, 37–49.