January 2016

Perceived Discrimination Correlates With Poor Angina Outcomes Among Patients With Acute Myocardial Infarction

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Master of Public Health Thesis

Yale University

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Abstract

Background: Perceived discrimination (PD) have been previously linked with multiple physiological and behavioral health risks. However, limited data is available on the association between PD and clinically relevant outcomes, such as the frequency and severity of angina.

Method: This thesis explores the association between PD and angina outcomes using data from the Examining Heart Attacks in Young Women (VIRGO) study, which enrolled 2,670 patients with prior acute myocardial infarction (AMI). The Detroit Area Scale and the Seattle Angina Questionnaire (SAQ) were employed to assess perceived discrimination and angina-related outcomes, including its onset frequency and related physical limitation, treatment dissatisfaction and disease perception. I used logistic regression model to examine the effect of PD on the above outcomes at both 1-month and 12-month post AMI.

Results: The analysis revealed a robust association between PD and increased risk for angina occurrence at 1-month (OR 1.57, 95% CI 1.14-2.15 for high PD) and angina-related physical limitation at 12-month (OR 1.66, 95% CI 1.14-2.42 for high PD). This association remained statistically significant after adjusting for socio-demographic, psychophysical and medical access factors, and appeared to be dose-responsive for the degree of discrimination. Furthermore, PD was associated with a higher risk of depression, which in turn is a strong predictor for worsened angina outcomes. Interestingly, only a small number of participants indicated that the discriminatory cases were of gender or race reason. And the largest proportion of participants did not know the cause for their discriminatory experience.

Conclusions: In AMI survivors sample analyzed in this study, PD is associated with increased risk of angina, and with worsened angina-related outcomes in all domains. This data supports programs for reducing PD as preventative measures for angina in AMI survivors.

Acknowledgement

This work is made possible by the VIRGO study (NCT00597922), which was funded by National Heart, Lung, and Blood Institute (NHLBI) R01HL081153-01A1. I would like to thank Drs. Judith Lichtman and Harlan M. Krumholz for kindly granting access to the dataset and Dr. Erica C. Leifheit-Limson for her help in preparing the data file. In addition, I am grateful for the guidance from Drs. Judith Lichtman and Rachel Dreyer in this work; and the support from Yale School of Public Health in accommodating my timeline. Finally, I appreciate the support from my husband Peng Yuan and my mother Zhenyuan Ji throughout my study at Yale.

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Introduction

Specific Objective

The primary goal of this thesis is to examine the association between PD on angina symptoms in patients over the first year after an AMI.

General problem

PD can be detrimental for one's health. For example, a statistically significant correlation exist between PD and hypertension (1–3). Similarly, using computerized tomography, it has been shown that life-time discrimination is correlated with an increased volume of fat content (4,5). These detrimental physiological changes may be driven by an unhealthy life-style that is associated with PD. Specifically, PD has been associated with increased tobacco use in several independent datasets, including the Behavior Risk Factor Surveillance System cohort study (6) and the CARDIA study (7). Furthermore, binge eating has been shown to be a result of PD (8,9). In addition, PD is consistently associated with insufficient sleep, measured both objectively (10–12) and through patient self-report (13,14), which could contribute to risks for a wide range of diseases. Therefore, identifying specific clinical outcomes associated with PD may provide clinically relevant evidence justifying the promotion of equality in the society, thus having important implications for improving preventative care and recovery management for diseases.

Rationale and Hypothesis

Based on the general framework outlined above, this thesis specifically explores the association between PD and angina and its related outcomes in patients with prior Acute myocardial infarction (AMI). AMI is a serious disease where the heart muscle fails to get enough blood supply for its normal pumping function, leading to insufficient blood flow for the whole body. Left untreated, AMI can lead to a very high mortality rate. Fortunately, with timely

hospitalization and treatment, AMI patients have a 95% survival rate over the first year after their AMI (15). However, in patients who survive the AMI, they are at high risk of developing various cardiovascular complications, limiting their life quality and mounting additional costs for the family and society. One common complication of patients who have experienced an AMI is angina – which is triggered by reduced blood flow to the heart. Angina produces chest pain in the patients which can be debilitating and in serious conditions it may also lead to life-threatening ischemic heart damage.

Many biological factors that are associated with cardiovascular diseases are also associated with a high occurrence for angina, including high blood pressure, obesity, high cholesterol and metabolic syndrome. Recent studies have linked psychological stressors with a significant increase for the risk of cardiovascular diseases (16). One such stressor is PD (17). Using the Center for Epidemiologic Studies Depression Scale, studies have consistently demonstrated an association between PD and reduced psychological well-being (18–21). In addition to the daily well-being, PD has also shown to be correlated with increased risks for more severe form of psychological disorders, including generalized anxiety disorder (22–24), post-traumatic stress disorder (25,26) and psychosis (27). This thesis tested the hypothesis that PD is associated with increased risk for angina and worsened outcomes in angina-related domains, among patients with prior AMI.

There is limited data examining the relationship between PD and angina. This study fills this gap of knowledge, investigating such association among young patients with prior AMI. This analysis is particularly important, considering that angina occurrence in AMI patients is associated with severe prognosis and reducing angina has been a primary goal in post-AMI management (28). The VIRGO study provides a unique opportunity to investigate outcome of 2,670 AMI survivors,

with PD and other AMI risk factors recorded in comprehensive surveys within the first year of recovery.

Review of Previous Studies

Lewis et al. systematically reviewed studies on the association between PD and health issues(17,29). People suffer from high PD also show increased risks for a myriad of diseases, including hypertension, carotid intima media thickness and coronary artery calcification. Importantly, Lewis et al. also summarized two potential causal pathways though which PD could affect risks for developing diseases, by triggering unhealthy behaviors or leading to depression.

Specifically related to this study, Arnold et al. (30) examined factors related to increased risk for angina in surviving AMI patients with diabetes and showed that non-white race is a strong predictor, along with history of prior angina, history of prior coronary bypass graft surgery and young age. In addition, Maddox et al. followed 2498 patients after AMI for 1 year and found that angina is also associated with non-white race (31). These studies did not directly examine discrimination. Although plenty of studies showed that non-white races are targets of racial discrimination, certain genetic factors may also be a confounding factor for this effect (32).

In a Chinese population, Zhang et al. (33) identified discrimination against women in the 20th century and found that this discrimination is the major explanatory factor for various health risks in Chinese women. The health risks included high odds ratio for developing angina.

Using the same data set as the present thesis, Xu et al. (34) showed that women experience more psychological stress than men and at the same time, worsened recovery outcome for angina-related quality of life. The study did not directly examine discrimination. As indicated in the literature (reviewed in (29), psychological variables are important factors for the

effect of perceived discrimination. Therefore, psychological stress due to discrimination could be a mediator for angina-related effect.

Research Design

Study design and participants

The VIRGO study is the largest prospective observational study of young patients with AMI (18-55 years). VIRGO enrolled 2000 women and a comparison cohort of 1000 men with AMI from more than 100 participating U.S. hospitals. Baseline, 1-month and 12-month data were collected by medical chart abstraction and standardized in-person patient interviews. The primary aims of the VIRGO study are to determine sex differences in the distribution and prognostic importance of biological, demographic, clinical, and psychosocial risk factors; to determine whether there are sex differences in the quality of care received by young AMI patients; and to determine how these factors contribute to sex differences in outcomes (including mortality, hospitalization, and health status).

Detroit Area Scale

The Detroit Area Scale assessed everyday occurrences of unfair treatment at baseline. Respondents indicate the frequency of certain experiences of unfair treatment that occur in their day-to-day life. Response options are scaled to 4-point scale: 1=never, 2=rarely, 3=sometimes, 4=often. Discrimination was assessed at baseline (during hospitalization) and each time point thereafter (1-month and 12-month). The PD data collected at baseline were used in this study. Based on the construct defined by Essed (35), this 10-item scale asked participants to indicate the frequency with which they experienced various forms of interpersonal mistreatment in their day-to-day lives.

Previous studies used two different methods in analyzing this scale. One method is to treat this scale as a continuous variable (36). Alternatively, levels of PD can be regarded as a categorical variable, based on threshold of points (37). In this thesis, the second approach has been adapted in defining three groups based on the sum of the scores from the 10 items, representing levels of reported everyday unfair treatment: none (N=1351, score=10), low (N=1079, score >10 and <=20), or high (N=240, score >20 and <=40).

Seattle Angina Questionnaire

Data was utilized from the Seattle Angina Questionnaire (SAQ), collected during the 1-month and 12-month follow-up interview. The 4 domains of the SAQ include: physical limitation (SAQ PL, Q.1), angina frequency (SAQ AF, Q.3 & 4), treatment dissatisfaction (SAQ TS, Q.5-8), and disease perception (SAQ DP, Q.9-11). Each domain scores a range of 0 to 100 points, and higher scores indicating higher levels of functioning. To calculate the score for each domain, we assigned each response an ordinal value, starting with 1 for the response that implied the lowest level of functioning. Sum across items within each of the 4 scales. We will transform the scale score to a 0 to 100 range by subtracting the lowest possible scale score from the sum score of the items; divide the number by range of the scale; then multiply by 100 (38). Given the large percentage of patients without angina(39), and in accordance with previous studies, SAQ scores were dichotomized into score<100 (with angina, angina-related physical limitation, treatment dissatisfaction or disease perception) or score=100 (no above outcomes).

Statistical Analysis

Data from total 2986 participants were recorded. If any of the variables used in this study, as described below, contained missing data, then the participate was excluded from the analysis. This clearance resulted in a remaining 2670 included in the analysis. Participants were classified

into three groups for different levels of perceived discrimination. A general Linear Model and Chi-square tests were used to examine the distribution of sociodemographics, health care access and medical history variables in three groups.

A Cox proportional hazards regression was used to calculate the adjusted hazard ratios and 95% confidence intervals for the associations of discrimination and angina outcomes for each model. Models vary by different covariates (potential confounders). In the simple model, the PD group was the only independent variable and SAQ scores were dependent variables. In the fully-adjusted model, in addition to PD group, age, gender, race, marriage, college education, health insurance, primary care access, prior cardiac disease, hypertension, hyperlipidemia, diabetes, smoking, obesity and depression were included as independent variables. All statistical analyses will be performed using SAS, version 9.3 (SAS Institute, Inc., Cary, North Carolina).

Results

Baseline characteristics

A total of 2670 participants were included in the current study.

Participants were classified into three groups for different levels of perceived discrimination (**Table 1**). In this sample, black race, hypertension, hyperlipidemia, obesity and depression were positively correlated with PD, while marriage, high education and prior cardiac disease were negatively correlated with PD. These correlations are in general consistent with previous reports, except for high education (40).

Table 1 Descriptive statistics for participants stratified by level of perceived discrimination

	Level of perceived discrimination			P value
	None	**Low**	**High**	
Sample size	1351	1079	240	
Sociodemographic Characteristics				
Age, yrs (mean,SD)	47.14(6.28)	47.22(5.94)	47.84(5.94)	0.2605
Gender (Female, %)	66.25	67.93	71.67	0.2293
Race				0.0020*
Black	17.18	17.59	21.37	
White	78.98	78.20	73.50	
American Indian	0.90	2.39	3.85	
Asian/ Pacific Islander/ East Indian	2.94	1.82	1.28	
Married/cohabitating	61.03	55.67	44.30	<0.0001*
College education	58.92	57.65	49.58	0.0263*
Health Care Access				
Health insurance	73.50	72.84	71.25	0.7576
Has a primary care clinician	79.29	77.44	71.01	0.0169*
Medical History				
Prior cardiac disease[#]	63.29	58.02	47.37	<0.0001*
Hypertension	33.60	36.24	42.50	0.0234*
Hyperlipidemia	62.84	68.30	70.42	0.0052*
Diabetes	86.31	86.47	87.92	0.7959
Smoking status				0.0765
Current smoker	17.93	16.77	16.67	
Past smoker	50.30	53.01	59.58	
Obesity	50.70	53.57	58.75	0.0499*
Depression	11.54	20.94	42.36	<0.0001*

Have at least one of the following disease before entering the study: Prior MI, Prior angina, Prior cardiac catheterization, Prior PCI, Prior CABG, Congestive heart failure, Prior Stroke, Prior TIA, Prior PAD.

Level of perceived discrimination: None, score=10; Low, 10<score<=20; High, 20<score<=40.

p-values results from Chi-square tests or general linear model (for age). *: p<0.05.

Perceived discrimination and angina outcomes

Logistic regression was applied for perceived discrimination and four different aspects of angina outcomes: angina frequency (AF), angina-related physical limitation (PL), angina-related disease perception (DP) and angina-related treatment dissatisfaction (TD). Perceived discrimination was correlated with increased odds for worsened outcomes in all four aspects at 1-month post-AMI (**Table 2**). In addition, at 12-month post-AMI, all the aspects except for DP still showed increased odds for worsened outcomes in groups with PD, though to lesser degrees compared to the 1-month time point.

The above analysis was not adjusted for any variables and thus the correlation between perceived discrimination and worsened angina outcomes may be explained by factors differentially present in different groups in this sample. As described in participants' characteristics, such factors include race, marriage college education, primary care availability, hypertension, hyperlipidemia, obesity and depression (**Table 1**). In order to examine the impact of these variables on the correlations described above, I next applied multiple variant logistic regression to the data set.

After controlling for all the variables available in the dataset, perceived discrimination remained to associate with significantly increased odds for angina frequency, treatment dissatisfaction and disease perception at one-month (**Table 3**), and for physical limitation and treatment dissatisfaction at 12-month (**Table 4**). Notably, in cases of physical limitation at 1-month and angina frequency at 12-month, there was a strong trend for an effect, in which the odds ratio is higher than 1 with lower limit of confidence interval approaching 0.97 to 0.99. Furthermore, similar to the results in non-adjusted model, the correlation appeared to be dose-responsive to the degree of perceived discrimination.

Table 2. Unadjusted regression for perceived discrimination and angina-related outcomes

Response	**Low vs No PD**	**High vs No PD**
Angina Frequency OR, 95% CI, 1month	1.59 (1.35, 1.88)*	2.05 (1.55, 2.71)*
Physical Limitation OR, 95% CI, 1month	1.29 (1.07, 1.56)*	1.91 (1.41, 2.58)*
Treatment Dissatisfaction OR, 95% CI, 1month	1.70 (1.44, 2.00)*	2.40 (1.81, 3.17)*
Disease perception OR, 95% CI, 1month	1.52 (1.20, 1.93)*	2.38 (1.44, 3.93)*
Angina Frequency OR, 95% CI, 12month	1.32 (1.09, 1.59)*	2.04 (1.50, 2.76)*
Physical Limitation OR, 95% CI, 12month	1.18 (0.95, 1.46)	2.27 (1.63, 3.17)*
Treatment Dissatisfaction OR, 95% CI, 12month	1.41 (1.18, 1.69)*	2.10 (1.55, 2.85)*
Disease perception OR, 95% CI, 12month	1.25 (0.98, 1.60)	1.50 (0.95, 2.38)

p-values result from logistic regression. *: $p<0.05$.

Table 3. Fully adjusted logistic regression model examining the association between PD and SAQ score (1 month).

Predictor	Angina Frequency OR, 95%CI	Physical Limitation OR, 95% CI	Treatment Satisfaction OR, 95% CI	Disease Perception OR, 95% CI
Low vs No PD	1.47 (1.23, 1.76)*	1.18 (0.97, 1.44)	1.60 (1.35, 1.90)*	1.43 (1.11, 1.85)*
High vs No PD	1.57 (1.14, 2.15)*	1.38 (0.98, 1.93)	1.94 (1.42, 2.65)*	1.98 (1.11, 3.53)*
Age	0.97 (0.96, 0.99)	0.99 (0.98, 1.01)	0.99 (0.98, 1.01)	0.97 (0.95, 0.99)
Female vs Male	1.42 (1.17, 1.73)*	1.26 (1.01, 1.57)*	1.24 (1.03, 1.49)*	1.72 (1.34, 2.22)*
Black vs White	1.32 (1.05, 1.66)*	1.45 (1.14, 1.85)*	1.10 (0.88, 1.38)	0.72 (0.52, 0.99)
Asian vs White	1.21 (0.62, 2.33)	1.12 (0.54, 2.31)	0.87 (0.45, 1.67)	1.65 (0.50, 5.50)
Other race vs White	1.24 (0.71, 2.16)	1.06 (0.55, 2.05)	1.30 (0.77, 2.22)	0.78 (0.39, 1.56)
Single vs Married	1.18 (0.99, 1.42)	1.12 (0.92, 1.37)	1.16 (0.97, 1.38)	1.07 (0.83, 1.39)
High school or less education	1.03 (0.86, 1.23)	0.99 (0.81, 1.21)	0.80 (0.67, 0.95)	0.89 (0.69, 1.15)
No primary care	1.12 (0.91, 1.38)	1.08 (0.85, 1.35)	1.12 (0.92, 1.37)	0.91 (0.75, 1.27)
No health insurance	1.34 (1.07, 1.68)*	1.22 (0.96, 1.55)	0.91 (0.74, 1.14)	0.81 (0.59, 1.10)
Have at least one previous heart problem	1.24 (1.03, 1.49)*	1.47 (1.21, 1.80)*	1.19 (0.99, 1.42)	0.97 (0.95, 0.99)
Diabetes	1.09 (0.90, 1.32)	1.03 (0.83, 1.27)	0.90 (0.75, 1.08)	0.98 (0.75, 1.29)
Hypertension	0.93 (0.76, 1.12)	1.01 (0.81, 1.27)	0.84 (0.69, 1.01)	0.92 (0.70, 1.22)
Hyperlipidemia	1.01 (0.78, 1.31)	1.00 (0.75, 1.35)	1.01 (0.79, 1.30)	0.93 (0.63, 1.36)
Past smoker vs None smoker	1.09 (0.84, 1.41)	1.25 (0.94, 1.68)	1.27 (0.99, 1.63)	1.38 (0.96, 1.98)
Current smoker vs None smoker	0.93 (0.76, 1.15)	1.19 (0.95, 1.50)	0.94 (0.77, 1.14)	1.19 (0.90, 1.58)
Obesity	0.87 (0.72, 1.04)	0.97 (0.79, 1.18)	0.87 (0.73, 1.04)	0.87 (0.68, 1.13)
Depression	2.64 (2.11, 3.30)*	2.21 (1.75, 2.79)*	2.01 (1.61, 2.52)*	4.03 (2.38, 6.81)*

p-values result from logistic regression. *: $p<0.05$.

Table 4. Fully adjusted logistic regression model examining the Association between PD and SAQ score (12 month).

Predictor	Angina Frequency OR, 95%CI	Physical Limitation OR, 95% CI	Treatment Satisfaction OR, 95% CI	Disease Perception OR, 95% CI
Low vs No PD	1.19 (0.98, 1.46)	1.03 (0.81, 1.30)	1.33 (1.10, 1.60)*	1.20 (0.93, 1.56)
High vs No PD	1.40 (0.99, 1.98)	1.66 (1.14, 2.42)*	1.64 (1.17, 2.31)*	1.25 (0.75, 2.09)
Age	0.98 (0.97, 1.00)	0.99 (0.97, 1.01)	0.99 (0.81, 1.20)	0.99 (0.97, 1.01)
Female vs Male	1.20 (0.96, 1.49)	1.22 (0.95, 1.58)	1.11 (0.91, 1.36)	2.05 (1.58, 2.66)*
Black vs White	1.20 (0.93, 1.55)	1.44 (1.09, 1.90)*	1.29 (1.01, 1.65)*	0.69 (0.49, 0.97)
Asian vs White	0.92 (0.44, 1.92)	1.63 (0.75, 3.51)	0.39 (0.16, 0.91)	0.43 (0.19, 0.99)
Other race vs White	0.92 (0.46, 1.85)	1.04 (0.45, 2.40)	1.25 (0.70, 2.24)	0.51 (0.26, 0.97)
Single vs Married	1.21 (0.99, 1.47)	1.47 (1.17, 1.85)*	1.32 (1.09, 1.60)*	1.04 (0.79, 1.35)
High school or less education	0.98 (0.80, 1.20)	0.97 (0.77, 1.23)	0.91 (0.75, 1.10)	0.73 (0.57, 0.95)
No primary care	1.11 (0.87, 1.40)	1.07 (0.81, 1.40)	1.26 (1.01, 1.58)*	0.86 (0.64, 1.17)
No health insurance	1.60 (1.25, 2.04)*	1.75 (1.33, 2.30)*	1.34 (1.05, 1.71)*	1.39 (0.97, 1.98)
Have at least one previous heart problem	1.43 (1.16, 1.75)*	1.67 (1.32, 2.11)*	1.29 (1.06, 1.58)*	0.98 (0.75, 1.28)
Diabetes	1.15 (0.93, 1.43)	1.21 (0.95, 1.55)	1.18 (0.96,1.45)	0.90 (0.68, 1.19)
Hypertension	1.12 (0.89, 1.40)	1.05 (0.81, 1.36)	0.95 (0.77, 1.17)	1.10 (0.83, 1.45)
Hyperlipidemia	1.14 (0.85, 1.54)	1.10 (0.77, 1.55)	1.17 (0.89, 1.55)	1.56 (1.10, 2.22)*
Current smoker vs None smoker	1.06 (0.79, 1.42)	1.22 (0.87, 1,72)	0.94 (0.72, 1.23)	1.04 (0.74, 1,48)
Past smoker vs None smoker	1.43 (1.14, 1.81)*	1.43 (1.09, 1.88)*	1.03 (0.83, 1.28)	1.22 (0.92, 1.64)
Obesity	1.10 (0.90, 1.35)	0.99 (0.78, 1.25)	0.99 (0.81, 1.20)	0.90 (0.70, 1.17)
Depression	1.97 (1.54, 2.52)*	1.60 (1.21, 2.11)*	1.46 (1.14, 1.87)*	2.45 (1.54, 3.90)*

p-values result from logistic regression. *: $p<0.05$.

Taken together, these results indicate that in the surviving AMI patients examined in this study, perceived discrimination is associated with higher odds for angina frequency, disease perception and treatment dissatisfaction at one-month post AMI, and higher odds for angina-related physical limitation and treatment dissatisfaction at twelve-month post AMI. This association remains robust after adjusting for all the additional information collected on the patients.

Involvement of depression

Previous studies have shown that psychological variables may be mediators of the effect of PD (29). In the present dataset, depression was increased as the degree of perceived discrimination ($p<0.0001$, **Table 1**). Furthermore, depression was associated with higher odds for worsened angina outcomes in all four aspects at both one-month and twelve-month in the fully adjusted model (**Table 3 and 4**). This indicates that depression could partially contribute to the apparent association between perceived discrimination and worsened angina outcomes in the unadjusted model (**Table 2**). While it is plausible that perceived discrimination is a cause for depression, other possibilities exist and can explain the covariance between the two. For example, it is possible that depressive personality could be a target for, or extra sensitive to, discrimination. In addition, the discrimination and depression may have a third common cause. This current dataset did not allow untangling among these possibilities.

Importantly, perceived discrimination remained to correlation with higher odds for worsened angina outcomes after adjusted for depression (**Table 3 and 4**), indicating that the effect of perceived discrimination is at least partially independent from depression. Therefore, additional psychological variables may at play in these cases. Transient emotional reaction to discrimination, such as angriness, could trigger unhealthy cardiovascular load and have long-

lasting effect in patients previously have AMI. It will be interesting to test whether the emotional response to perceived discrimination is a variable correlated with angina outcomes.

Causes for perceived discrimination

The above analyses suggest that PD may contribute to the high risk for worsened angina outcomes in surviving AMI patients. Understanding the causes for such perceived discrimination could, therefore, be the first step in eliminating such health risk. I next examined the self-reported primary causes for discrimination from the same participants. The survey inquired this information by letting the participants choose from one of the eight common themes for discrimination, or supply their own reason if they chose "Other". The distribution of themes did not differ between the low and high perceived discrimination groups, indicating that there were no intrinsic differences in the treatment in these two groups (Yate's Chi-Square test, p=0.08, **Figure 1**). Interestingly, only small number of participants reported the ostensibly common causes are the primary reason for discrimination in their cases, such as race, ethnicity, gender and sex orientation (7.6%, 1.8%, 4.1% and 1.1% in low perceived discrimination group and 7.7%, 1.3%, 5.1% and 0.3% in high perceived discrimination group, respectively). This is consistent with our finding that women were not preferentially present in the groups with perceived discrimination (**Table 1**). On the other hand, income level and physical appearance appeared to be more prevalent causes for perceived discrimination (11.9% and 12.2% in low perceived discrimination group and 12.5% and 17.3% in high perceived discrimination group, respectively).

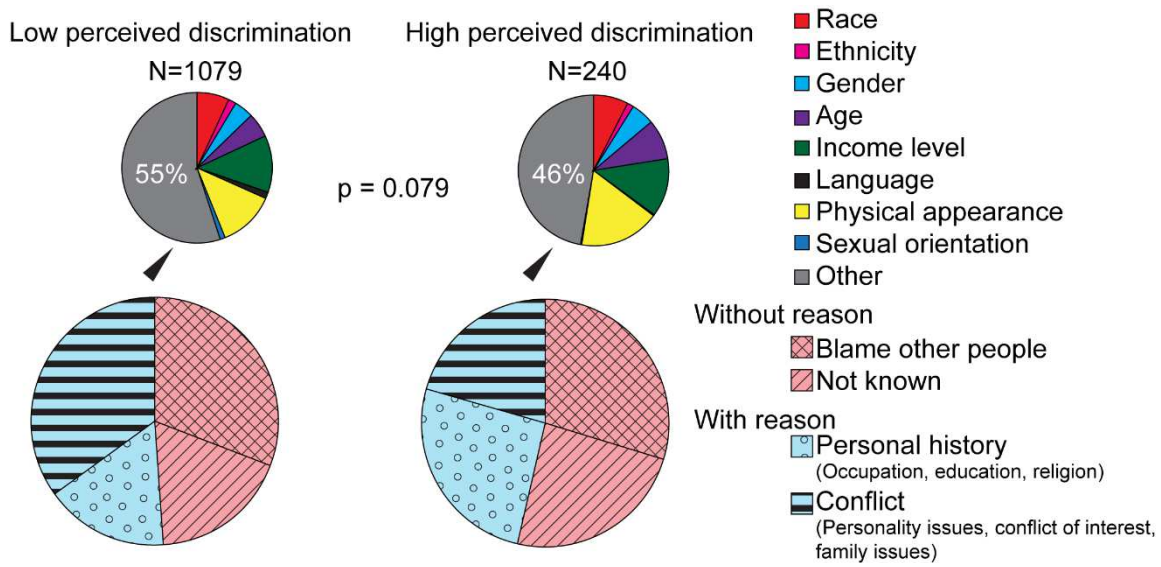

Figure 1 Self-reported causes for discrimination in participants.

Interestingly, more than half of the participants chose “other” category and supplied their own causes. Examining these answers revealed that about half among these “other” causes were related to personal history (related to occupation, personality, education or religion) and conflict between people (competition between co-workers, or family issues, etc.), and the remaining half essentially had no reasons. The participants either blamed other people or simply admitted they did not know the reason (**Figure 4**).

Discussion

Present Results in the context of previous studies

This study extends prior literature in 2 important ways. First, it demonstrates a correlation between PD and poor angina-related outcomes. In a previous study by Xu and colleagues (34), it has been shown that psychological stress is negatively associated with AMI recovery among patients 18 to 55 years of age. The present study indicates that PD could be a potential source of psychological stress. In addition, previous studies have identified PD as a risk factor for a series of psychological and physical illnesses (17), such as breast cancer and asthma. The present study contributes to this growing literature and identifies PD as a risk factor for angina. This finding is of particular importance in the field of cardiovascular diseases, since PD has been associated with many preclinical endpoints, including hypertension, carotid intima thickness and coronary artery calcification, but not yet with an actual disease endpoint. The results in the present study fills this gap of knowledge. Importantly, the association between PD and angina remains significant after controlling for hypertension, hyperlipidemia, smoking status and depression, indicating that PD is an independent risk factor for angina occurrence and related poor outcomes. Therefore, the results from this study provide strong support for developing interventions for PD as a potential risk management in AMI patients.

Second, the present study suggests that many people experience PD without a clear understanding for its reason. Such finding may seem to be at odds with the recent report that 56% of African Americans believe that there is "a lot" of discrimination, while only 16% of whites do (41). There are two important points can be made about this discrepancy. A), Discrimination of race or gender origin may not be explicit. And B), Program aims at reducing perceived discrimination can be more effective by not only targeting discriminatory behavior, but also providing mental health and social support. Discrimination is a complex behavior that may have certain evolutionary root in human history (42). Like many innate emotions of mankind, such feeling is difficult to control. The social norms and pressure of "correctness" may have only limited impact and will not fundamentally change the prejudice existed in the society. Perhaps when all the unnecessary costs and loss of growth opportunities identified, such as the small step taken in this study, the society will finally choose to treat everyone equally.

Limitations of the study

Causal relationship. This study supports the hypothesis that perceived discrimination leads to worsened angina outcomes after AMI. Although previous research has provided potential biological mechanisms (29), this study does not provide direct evidence for a causal relationship. Nevertheless, the dose-responsive relationship between PD and the degree of worsened angina outcomes strongly suggests a causal relationship is at play. The consistency in the correlation at 1-month and 12-months indicates that the association between perceived discrimination and worsened angina outcomes is robust and likely represents some long-lasting effects on patients. Importantly, the odds ratio for worsened outcomes are higher in high perceived discrimination compared to modest perceived discrimination. This dose-responsive relationship suggests a causal link between perceived discrimination and worsened angina outcomes.

Interestingly, results from this thesis indicate a co-variance between PD, depression, and worsened angina outcomes. And perceived discrimination remains to be a risk for worsened angina outcomes after we controlled for depression. These results suggest that there is at least one additional mechanism other than depression that is the mediator for the effect of perceived discrimination.

Psychological adjustment. Previous research suggested that one's psychological attitude towards the perceived discrimination stratifies the related health risks (17,29). This is consistent with the hypothesis that perceived discrimination may trigger acute negative emotions and thus produces hormonal or neural changes to damage cardiovascular system. In present study, the psychological status of the participants or related copping method was not available. Including this information may help identify the group of patients that are truly affected by perceived discrimination, and assess the related risk changes accordingly.

Self-report causes. The study utilized self-report questionnaires to ask patients about the primary causes for their perceived discrimination. This may not be an accurate measurement since naturally, in order to examine the reason for one's discriminatory behavior, one would need to ask not the participant, but the people whose behavior the participants interpret as discrimination. However, this survey is extremely difficult to accomplish, if possible. Therefore, the results related to the causes for discrimination should be interpreted as the participants' perception, not the true underlying reason for discrimination. For example, the small percentage of gender discrimination in this study does not indicate a lack of discrimination towards females, but rather that people do not perceive the discrimination to be of gender origin.

It is also worth noting that gender did not correlated with perceived discrimination in this dataset, in contrast to previous studies (33). Although gender and racial discrimination is only

perceived by a small number of participants, female gender and African American race still showed increased risks for worsened angina outcomes (**Table 3 and 4**). This effect is independent of discrimination and could be due to the physiological features of these groups, such as a genetic risk factor for angina, consistent with previous research (43).

Broader impact of the study

The association between PD and poor angina outcomes reported in this study has implications in patient management post AMI. Since angina elicits pain in patients and can lead to physical limitation, poor angina outcome is indicative of reduced quality of life in patients. Furthermore, the transient ischemia that happens during the angina attack further damages heart muscle cells and could lead to re-occurring of a full-blown heart attack. Therefore, reducing the frequency and severity has been a major goal in managing post AMI patients (28). As revealed by the present study, PD positively correlates with poor angina outcomes, including increased occurrence. Although it is not clear whether PD causes the increased risk for angina, alternatively maybe the population with increased risk for angina is pre-disposed with higher tendency to perceive discriminatory behaviors, the information can be instructive in patient management. For example, a survey in post AMI patients on the level of perceived discrimination could be an additional measure to identify the group with high risk for angina. These patients can be given education material on angina, and related medication in case it happens, in order to minimize the pain caused by it. In addition, consoling services on these patients may be effective in providing psychological adjustment techniques in these patients.

Perceived discrimination also correlates with higher risk for depression. The feeling of exclusion from discriminatory behavior, or ostracism, has been shown to lead to depression in the long term (44). The present results are consistent with previous literature. In addition to

psychological dissonance, depression can also affect one's physical health, including increased risk for heart diseases and poor prognosis (45). Furthermore, depression has recently been recognized to potentially be a cause for many other diseases, such as stroke (46). Such causal relationship is perhaps mediated through the release of harmful hormones like cortisol that are induced by chronic depression (47). Therefore, it is possible that the association between perceived discrimination and poor health outcomes can be extended into other diseases.

Future Areas of Research

This thesis contributes to the literature that perceived discrimination imposes a health risk for worsened angina outcomes in surviving AMI patients. This is consistent with many previous studies on perceived discrimination. Therefore, developing a program in reducing the impact of perceived discrimination could have several benefits: First, such an intervention program could allow a more direct measurement for the causal effect of perceived discrimination on health. Second, such a program could help lower the discrimination-associated risks for angina and improve AMI patient outcomes.

This thesis also provides some insights in devising such a program. The fact that gender and racial related causes for perceived discrimination only represented a small number of participants, suggests that focusing on the elimination of gender and racial discrimination will have limited impact in terms of reducing risks for worsened angina outcomes. On the other hand, general psychological guidance on coping with negative emotions and/or depression could be more efficient in reducing perceived discrimination-associated health risks.

Conclusions

This thesis presents the following findings:

1. Perceived discrimination in surviving young AMI patients is associated with worsened angina outcomes, including increased angina frequency, increased physical limitation, increased treatment dissatisfaction and increased disease perception at both 1-month and 12-months.

2. The degree of worsened angina outcomes correlates with the degree of perceived discrimination.

3. After controlling for a list of potential confounding factors, the association between perceived discrimination and worsened angina outcomes remains obvious in the dataset. Angina frequency at 1-month, physical limitation at 12-month, treatment dissatisfaction at 1- and 12-months and disease perception at 1-month are statistically significant ($p<0.05$ level).

4. Depression is strongly correlated with worsened angina outcomes as well as perceived discrimination.

5. The gender and racial discrimination are a small portion for the causes of perceived discrimination in this dataset. The largest proportion of people do not know the cause for their discrimination experience.

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