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Self-reported fraud victimization and objectively measured blood pressure: Sex differences in post-fraud cardiovascular health

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Abstract

Background: Over 5 million older Americans are victims of financial exploitation, schemes, and/or scams per year. Such victimization is associated with increased hospitalizations, admittance to skilled nursing facilities, and lower 5-year all-cause mortality survival rates. Despite this, associations with medical comorbidities like elevated blood pressure (BP) have not been examined.

Methods: We investigated the association of self-reported fraud victimization (presence/absence) with objectively measured BP metrics leveraging cross-sectional and longitudinal data from over 1200 non-demented adults (75% female; age ~81 years) from the Rush Memory and Aging Project. We first examined cross-sectional associations between baseline fraud victimization and BP, then used longitudinal data to test the hypothesis that fraud victimization is associated with increases in BP after incident fraud. During up to 11 years of annual observation, participants were queried for fraud victimization and underwent serial BP measurements to calculate per visit averages of systolic and diastolic BP, mean arterial pressure (MAP), and pulse pressure.

Results: Cross-sectional analyses established that fraud victimization at baseline was associated with higher BP values. Next, using longitudinal change-point analyses, we showed that fraud victimization was associated with elevations in BP among men but not women. Specifically, men who reported incident fraud exhibited increases in all BP metrics post-fraud.

Conclusion: Results suggest an important link between fraud victimization and BP, particularly among men. Older men showed significant elevations in BP after incident fraud that, compounded over time, may portend other adverse health outcomes.

KEYWORDS

aging, blood pressure, fraud victimization

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INTRODUCTION

Adults 65 and older hold the vast majority of the nation's household wealth, and are among the most likely to become victims of financial fraud and other forms of exploitation. This fact has only been exacerbated by the COVID-19 pandemic. Recent evidence suggests that >5 million older Americans are victims of financial exploitation, schemes, and/or scams per year, including 1 in 18 cognitively intact individuals.[1] Annual financial losses exceed $35 billion/year.[1,2] Financial losses are difficult, if not impossible, for older adults to recover due to limited earning opportunities and shorter time horizons.

In addition to economic consequences, prospective population-based studies have shown that elder fraud and exploitation are associated with increased hospitalizations,[3] admittance to skilled nursing facilities (particularly for men),[4] and lower 5-year all-cause mortality survival rates.[5,6] They are also associated with poorer subjective health ratings[7–11] and higher self-reported medical comorbidities including high blood pressure.[9,12] Some evidence suggests that fraud victims are more likely to have diagnoses of cardiovascular disease including hypertension[13,14]; however, prior research has neither examined the association of fraud victimization with objective measures of cardiovascular disease such as elevations in blood pressure nor investigated blood pressure levels after incident fraud victimization.

This study investigated fraud victimization (self-reported presence/absence) and objectively measured systolic and diastolic blood pressure (BP), pulse pressure, and mean arterial pressure (MAP) cross-sectionally and longitudinally in a community-based cohort of older adults with and without hypertension. Specifically, we first established cross-sectional relationships between fraud victimization and the four BP measures, testing the hypothesis that fraud victimization at study baseline is associated with higher BP when compared to non-victimization after controlling for age and other relevant confounders. Then, using longitudinal changepoint models, we tested our central hypothesis that of those individuals not reporting fraud at baseline, BP levels increase post-fraud among victims of incident fraud. Given documented sex differences in fraud victimization[7] and blood pressure,[15] and the fact that some consequences of fraud and other forms of exploitation occur more often in men than women,[4] we paid particular attention to the role of sex as a biological variable in longitudinal analyses.

Key points

- Approximately 5 million older Americans experience fraud victimization, that is, financial exploitation, fraudulent schemes, and/or scams per year.
- We established cross-sectional associations of prevalent fraud victimization (self-reported presence/absence) with objectively measured blood pressure in non-demented older adults (75% female; age ~81 years) from the Rush Memory and Aging Project and determined if blood pressure increases following incident fraud.
- Results suggest an important link between fraud victimization and BP, with longitudinal changepoint models showing that older men experience significant elevations in BP after incident fraud victimization.

Why does this paper matter?

Results suggest an important link between incident fraud and BP, with men showing post-fraud elevations in BP that, compounded over time, may portend other adverse outcomes.

METHODS

Participants

Participants were from the Rush Memory and Aging Project (1997–present), an ongoing clinical-pathologic cohort study of aging.[16–18] An Institutional Review Board of Rush University Medical Center approved all study procedures and participants gave written informed consent in accordance with the Declaration of Helsinki.

The Rush Memory and Aging Project started in 1997 with a decision-making sub-study introduced in 2010 that included an annual assessment of fraud victimization.[19] At the time of the current analyses, 1273 had completed their initial decision-making sub-study visit. We excluded 62 participants who were determined to have dementia at the time of this visit based on a uniform structured clinical evaluation[17] by experienced clinicians following the diagnostic criteria set forth by the National Institute of Neurologic and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association.[20] The remaining 1211 participants had complete data on fraud victimization and contributed to analyses. Participants were approximately 80 years of age, primarily female (75%), had, on average, 15 years of education. We should note that cross-sectional and longitudinal analytic sample sizes varied and are noted below, and

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"baseline" as described in this manuscript refers to the first decision-making sub-study visit.

Assessment of self-reported fraud victimization

The decision-making assessment included a question asking participants if, in the past year, they were a victim of financial fraud or were told they were a victim of financial fraud (yes/no). As in our[21,22] and others'[7,8,11,12,14] prior publications, participants who answered in the affirmative were considered fraud victims, those that answered in the negative were non-victims.

Objective blood pressure assessment and value determinations

As previously described,[23,24] and in keeping with scientific statements from the American Heart Association regarding BP measurement in older adults,[25] two seated readings and a third standing BP were taken using an Omron automated blood pressure machine. Systolic and diastolic BP were calculated separately by averaging all three readings. Additional BP indices included pulse pressure, an index of the discrepancy between the maximum pressure applied during a heartbeat (i.e., systolic BP) and the pressure in the arteries between heartbeats (i.e., diastolic BP) and MAP, an index of the steady component or average of pressure in the arteries during a single cardiac cycle, approximated using the following formula: [systolic BP + (2 * diastolic BP)]/3. We included pulse pressure and MAP as they consider both systolic and diastolic BP, and are related to other BP indicators including cerebral blood flow,[26] end-organ damage and stroke,[27] and death.[28] Given that definitions of hypertension have varied since the initiation of the decision-making sub-study in 2010,[29] we used participants' history of being told by a doctor, nurse, or therapist that they had high BP to determine the presence (1) or absence (0) of hypertension across all study visits.[18]

Covariables

In addition to age, sex, and years of education (shown to be related to fraud victimization[7] and BP[15]), we also adjusted for additional metrics that may be associated with our predictor and outcomes including:

Anti-hypertension medication use—documented by visual inspection and coding via the Medi-Span Drug Data Base system[30] of participant-supplied medication containers.

Diabetes status—defined by the America Diabetes Association[31] and also by verified use of medication for diabetes (insulin and non-insulin related).[30]

Cumulative vascular disease burden[32]—derived using self-report questions probing the presence/absence of 1-claudication symptoms, 2-stroke (also based on neurological exam), 3-heart conditions, and 4-congestive heart failure. Each condition was given a value of 0 (absent) or 1 (present) with the final score ranging from 0 (none) to 4 (all) conditions.

Global cognitive functioning—all participants underwent an annual cognitive evaluation detailed elsewhere,[16–18] with a person's standardized scores across 19 neuropsychological tests averaged to yield a single composite score (higher = better performance).

Indicators of health and lifestyle behaviors—given health and lifestyle indicators may play an important role in the association of fraud and BP, we measured body mass index (BMI) using the formula kg/m^2 and smoking history to determine whether participants never smoked (coded as 0) or were former/current smokers (coded as 1).

Statistical analyses

We first examined the cross-sectional associations of fraud victimization (self-reported present vs. absent at baseline) with objectively measured BP values (continuous outcomes of systolic and diastolic BP, pulse pressure, and MAP, separately) using linear regression models. Of note, non-victims served as a reference to those participants reporting fraud victimization. Model 1 included terms (continuous unless otherwise noted) for age, sex (male vs. female), and education; fully-adjusted Model 2 added terms for anti-hypertension medication use (presence vs. absence), diabetes status (presence vs. absence), cumulative vascular disease burden, global cognitive functioning, as well as BMI and smoking (never vs. former/current).

Next, we used changepoint models[33] to test our central hypothesis that BP levels increase post-fraud victimization. In these models, annual BP values were continuous longitudinal outcomes, and we included a changepoint anchored at the visit when participants reported incident fraud victimization (if reported). The models further included a term for time in years since baseline and a term for time since fraud. The coefficient of time since baseline estimated the annual rate of change in BP pre-fraud victimization, and the coefficient of time since fraud estimated the additional annual rate of BP change post-fraud victimization. Changepoint models were adjusted for all the covariates as specified in Model 2 above. The interaction terms between time and covariates estimate the association of covariates with the rates of BP change pre- and post-fraud; thus, interaction terms with sex

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TABLE 1 Characteristics for participants contributing to the cross-sectional analyses establishing associations between baseline fraud and blood pressure

	Non-victims at baseline ($n = 1064$)	Fraud victims at baseline ($n = 83$)	Between-group differences
Participant characteristics			
Age (years)	81.4 ± 7.4	77.4 ± 8.2	**$t = 4.78$, $p < 0.0001$**
Education (years)	15.5 ± 3.0	16.0 ± 3.5	$t = -1.11$, $p = 0.26$
Mini-mental state examination	28.2 ± 1.7	28.5 ± 1.5	$Z = 1.54$, $p = 0.12$
Diabetes status (met criteria), n (%)	142 (13.3)	13 (15.6)	$\chi^2 = 0.60$, $p = 0.43$
Cumulative vascular disease burden	0.38 ± 0.67	0.26 ± 0.61	$\chi^2 = 3.35$, $p = 0.06$
Global cognitive functioning	0.20 ± 0.52	0.29 ± 0.51	$t = -1.63$, $p = 0.10$
Body mass index	27.3 ± 5.3	28.4 ± 5.3	$t = -1.51$, $p = 0.13$
Smoking (never:former/current)	597:467	47:36	$\chi^2 = 0.13$, $p = 0.71$
Baseline blood pressure values			
Systolic blood pressure (mmHg)	132.8 ± 18.8	136.0 ± 20.8	$t = -1.44$, $p = 0.15$
Diastolic blood pressure (mmHg)	76.9 ± 11.0	81.2 ± 12.7	**$t = -3.34$, $p = 0.001$**
Pulse pressure (mmHg)	55.8 ± 13.9	54.7 ± 15.0	$t = 0.69$, $p = 0.49$
Mean arterial pressure (mmHg)	95.5 ± 12.5	99.5 ± 13.9	**$t = -2.69$, $p = 0.007$**
Anti-hypertensive medication (use), n (%)	734 (68.9)	52 (74.7)	$\chi^2 = 1.12$, $p = 0.29$
Hypertension status (present), n (%)	619 (58.2)	55 (66.2)	$\chi^2 = 3.14$, $p = 0.07$

Note: All values are mean ± standard deviation unless otherwise noted; t = t-test value, Z = Wilcoxon score, χ^2 = chi-square. Bolded statistics signify significance at $p < 0.05$.

TABLE 2 Cross-sectional associations of fraud victimization with blood pressure values alone and with hypertension status as an effect modifier

	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)	Mean arterial pressure (mmHg)	Pulse pressure (mmHg)
Alone				
Fraud victimization at baseline	4.23 (2.23, $p = 0.058$)	**3.15 (1.28, $p = 0.01$)**	**3.51 (1.48, $p = 0.01$)**	1.07 (1.57, $p = 0.49$)
With hypertension status as an effect modifier				
Fraud victimization at baseline	0.28 (3.82, $p = 0.94$)	0.48 (2.22, $p = 0.82$)	0.41 (2.55, $p = 0.87$)	−0.19 (2.70, $p = 0.94$)
Hypertension (HTN) at baseline	9.38 (1.46, $p < 0.00001$)	3.68 (0.85, $p = 0.00002$)	5.58 (0.98, $p < 0.00001$)	5.70 (1.03, $p < 0.00001$)
Fraud * HTN	4.79 (4.62, $p = 0.30$)	3.53 (2.69, $p = 0.19$)	3.95 (3.09, $p = 0.20$)	1.26 (3.27, $p = 0.70$)

Note: Values are unstandardized coefficient (SE, p-value) from fully-adjusted Model 2 which included terms for age, sex, education, anti-hypertensive medication use, diabetes status, cumulative vascular disease, global cognition, body mass index, and smoking; additional terms for hypertension status and its interaction with fraud victimization at baseline were added to test for effect modification. Bolded values represent significant results at $p < 0.05$ for predictors of interest.

allowed us to investigate sex-specific BP increases post-fraud victimization. We note that participants who reported fraud at baseline were excluded from change-point model analyses (as our interest in the longitudinal analyses relates to incident fraud), and data for participants who reported no victimization at any point during the study period contributed only to the estimation of changes in BP pre-fraud victimization.

All analyses were programed using SAS/STAT software, Version 9.4 of the SAS System for Linux (SAS Institute, Cary, NC); and statistical significance was set at $p < 0.05$.

RESULTS

Cross-sectional association of self-reported fraud and objectively measured BP

Table 1 outlines characteristics for participants contributing to the cross-sectional analytic sample stratified by baseline fraud victimization and delineates significant differences between the groups on age, diastolic BP, and MAP only (p-values < 0.007). Regression models adjusted for age, sex, and education established that fraud

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TABLE 3 Characteristics for participants contributing to the longitudinal changepoint analyses investigating rates of change in blood pressure pre- and post-fraud

	Non/never victims ($n = 720$)	Fraud victims after baseline ($n = 217$)	Between-group differences
Participant characteristics			
Age (years)	81.9 ± 7.1	78.6 ± 7.2	**$t = 5.89$, $p < 0.0001$**
Education (years)	15.4 ± 3.0	15.8 ± 3.0	$t = -1.58$, $p = 0.11$
Mini-mental state examination	28.2 ± 1.6	28.6 ± 1.4	**$Z = 4.20$, $p < 0.0001$**
Diabetes status (met criteria), n (%)	91 (12.6)	31 (14.3)	$\chi^2 = 0.40$, $p = 0.52$
Cumulative vascular disease burden	0.37 ± 0.67	0.29 ± 0.55	$\chi^2 = 2.11$, $p = 0.14$
Global cognitive functioning	0.18 ± 0.50	0.36 ± 0.51	**$t = -4.60$, $p < 0.0001$**
Body mass index	27.2 ± 5.2	28.0 ± 5.7	$t = -1.92$, $p = 0.055$
Smoking (never: former/current)	415:305	121:96	$\chi^2 = 0.24$, $p = 0.62$
Baseline blood pressure values			
Systolic blood pressure (mmHg)	132.6 ± 18.6	132.1 ± 18.7	$t = 0.29$, $p = 0.77$
Diastolic blood pressure (mmHg)	76.7 ± 10.7	77.5 ± 11.2	$t = -0.95$, $p = 0.34$
Pulse pressure (mmHg)	55.8 ± 14.1	54.6 ± 12.8	$t = 1.14$, $p = 0.25$
Mean arterial pressure (mmHg)	95.3 ± 12.2	95.7 ± 12.8	$t = -0.41$, $p = 0.68$
Anti-hypertensive medication (use), n (%)	502 (69.7)	140 (64.5)	$\chi^2 = 2.09$, $p = 0.14$
Hypertension status (present), n (%)	425 (59.0)	119 (54.8)	$\chi^2 = 1.20$, $p = 0.27$

Note: All values are mean ± standard deviation unless otherwise noted; t = t-test value, Z = Wilcoxon score, χ^2 = chi-square. Bolded statistics signify significance at $p < 0.05$.

victimization was associated with increased systolic BP (unstandardized coefficient = 4.57 mmHg, SE = 2.22, $p = 0.04$), diastolic BP (unstandardized coefficient = 3.42 mmHg, SE = 1.28, $p = 0.007$), and MAP (unstandardized coefficient = 3.81 mmHg, SE = 1.48, $p = 0.010$) compared to non-victimization; victimization was not associated with pulse pressure ($p = 0.46$). All associations persisted after adjustments for additional covariates (Table 2). In separate analyses, we added a term for the interaction of baseline fraud victimization (presence/absence) and hypertension status (presence/absence) to Model 2; these analyses showed no evidence that results were modified by hypertension status (Table 2).

Longitudinal change in objectively measured BP After self-reported incident fraud

Next, we used longitudinal data to test our central hypothesis that incident fraud victimization is associated with an increase in BP levels over time. Thus, we restricted these analyses to persons who did not report fraud at baseline (to exclude prevalent fraud) and conducted changepoint analyses with an inflection point anchored at the time of incident fraud (for those who reported fraud) to examine sex-specific annual rates of change in BP before (i.e., pre-fraud) and after incident fraud (i.e., post-fraud).

Table 3 outlines characteristics for participants contributing to the longitudinal changepoint analytic sample stratified by incident fraud victimization and delineates significant between-group differences on select characteristics, that is, age, a cognitive screener, and global cognition (p-values < 0.0001). A total of 136 individuals in this analytic sample (23%) reported incident fraud victimization over the course of up to 11 years of observation; data from these persons contributed to the estimation of rates of change in BP before (pre-fraud) and after fraud victimization (post-fraud). Data from the remaining 77% of participants who did not report fraud, that is, non-victims, contributed to the estimation of the pre-fraud rate of change in BP only since they did not experience fraud victimization.

In analyses (Table 4), we observed statistically significant annual rates of decline in diastolic BP and MAP among women pre-fraud (p-values ≤ 0.004). Specifically, women showed a 0.57 mmHg yearly average decline in diastolic BP and a 0.47 decline in MAP. Notably, however, rates of change in BP were not significantly altered post-fraud when compared to pre-fraud levels (p-values ≥ 0.12); that is, among women reporting incident

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TABLE 4 Sex-specific annual rates of change in blood pressure pre- and post-incident fraud

	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)	Mean arterial pressure (mmHg)	Pulse pressure (mmHg)
Women ($n = 715$, 164 with incident fraud)				
Pre-fraud victimization[a]	−0.27 (0.25, $p = 0.29$)	**−0.57 (0.14, $p = 0.0001$)**	**−0.47 (0.16, $p = 0.004$)**	0.31 (0.19, $p = 0.10$)
Post-fraud victimization[b]	−0.85 (0.71, $p = 0.23$)	−0.01 (0.40, $p = 0.98$)	−0.27 (0.46, $p = 0.56$)	−0.83 (0.53, $p = 0.12$)
Men ($n = 222$, 53 with incident fraud)				
Pre-fraud victimization[c]	**−0.60 (0.29, $p = 0.04$)**	−0.23 (0.16, $p = 0.15$)	−0.35 (0.19, $p = 0.06$)	−0.37 (0.22, $p = 0.09$)
Post-fraud victimization[d]	**2.31 (0.85, $p = 0.007$)**	**0.96 (0.48, $p = 0.04$)**	**1.39 (0.55 $p = 0.01$)**	**1.31 (0.64, $p = 0.04$)**

Note: Values are unstandardized coefficient (SE, *p*-value) from fully-adjusted changepoint Model 2 which included terms for age, sex, education anti-hypertensive medication use, diabetes status, cumulative vascular disease burden, global cognition, body mass index, and smoking. Bolded values represent significant results at $p < 0.05$.

[a]Estimates represent the annual rate of change in blood pressure (BP) over time for women pre-fraud.

[b]Estimates represent the additional rate of change in BP post-fraud for those women who reported incident fraud when compared to pre-fraud levels.

[c]Estimates represent the additional annual rate of change in BP pre-fraud for men relative to women pre-fraud.

[d]Estimates represent the additional annual rate of change in BP post-fraud for men who reported incident fraud relative to women who reported incident fraud.

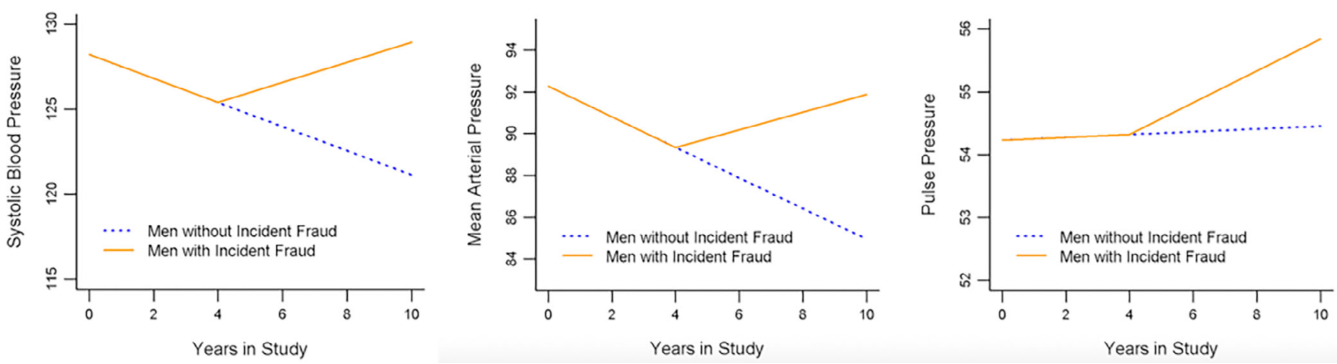

FIGURE 1 Rate of change in blood pressure in male participants pre- and post-fraud victimization (solid orange line with inflection point to signify rates of change before and after incident fraud in those reporting fraud; dotted blue line signifies the projected continual decline in blood pressure seen in men who did not report incident fraud). Lines based on relevant estimates for men taken from the fully-adjusted changepoint model including terms for age, sex, education, anti-hypertension medication use, diabetes status, cumulative vascular disease burden, global cognitive functioning, body mass index, and smoking. Panels reflect (from left to right) systolic blood pressure, mean arterial pressure, and pulse pressure; diastolic blood pressure is not shown given it was not significant.

fraud, we did not observe a significant change in any BP value following incident fraud.

In contrast, men showed greater declines in all BP values pre-fraud compared to women although only systolic BP met the threshold for significance (Table 4). Further, BP values increased significantly in men following victimization, with all measures showing significant elevations post-fraud (*p*-values < 0.04; Table 4). For example, compared to pre-fraud BP levels for women, men showed an additional annual pre-fraud decline in systolic BP of 0.60 mmHg resulting in a total estimated annual rate of decline of 0.87 mmHg (calculated using the following equation of estimates from Table 4: $-0.27 - 0.60 = 0.87$). In addition, the annual rate of change in BP increased by an estimated 1.46 mmHg post-fraud (calculated using the following equation of estimates from Table 4: $-0.85 + 2.31 = 1.46$). Similar post-fraud increases were seen for the other BP metrics (Table 4). For illustration purposes only, Figure 1 displays the change in BP slopes post-fraud victimization among men and shows that all metrics increased post-fraud.

DISCUSSION

In this study of older non-demented adults with and without hypertension, we investigated the association of self-reported fraud victimization with BP using multiple objectively-measured indices. We first established cross-sectional associations between baseline fraud victimization and higher BP values, and showed that these associations did not differ by hypertension status. Then, in longitudinal analyses, we tested our central hypothesis that fraud victimization is associated with increases in BP over time. Using changepoint analyses, we found that both men and women showed declines in BP pre-fraud; notably, however, men reporting incident fraud showed significant increases in BP post-fraud, whereas women did not. Results suggest an important link between fraud victimization and BP in old age, with men reporting incident fraud showing significant elevations in BP in the years following victimization. Our findings suggest that fraud prevention may be beneficial for blood pressure and possibly cardiovascular health, particularly in men. Furthermore, the finding that fraud victimization is associated with subsequent and steadily increasing BP among men, when considered compounded over time, may even portend other more adverse health outcomes known to be associated with fraud victimization.

This study expands the emerging literature on fraud victimization and health outcomes in several important ways. First, the majority of work to date investigating fraud victimization and physical health has relied on subjective health ratings[7–11] and/or self-reported symptom checklists.[9,12] By contrast, our study included objective measures of physical health, specifically, systolic and diastolic BP, pulse pressure, and MAP, that, if chronically elevated, contribute to end organ damage including stroke,[27,34] cardiovascular disease morbidity,[35] and mortality.[36] Furthermore, we compared these objective measures of physical health between fraud victims and non-victims. Additionally, beyond establishing cross-sectional associations of self-reported baseline fraud victimization and objectively measured BP that existed even among individuals not being monitored and/or treated for hypertension-related issues, we used longitudinal changepoint models to determine if BP increased after incident fraud.

This study is the first to demonstrate increases in BP after incident fraud victimization. This may be due, in part, to the fact that most studies lack information about victims' health status prior to incident fraud, whereas we knew about pre-exposure BP values, the timing of the exposure, and post-exposure BP values. Elevations in BP, particularly systolic BP, are predictors of cardiovascular disease morbidity and mortality in the population generally,[37,38] and in older men specifically.[35,36] When coupled with the fact that older men are more likely to be victimized by fraud,[7] and more likely to suffer other adverse health consequences of fraud and other forms of financial exploitation,[4] our work points toward the need to consider whether more stringent BP monitoring in older men after incident fraud victimization [and/or a closer review of systems including other cardiovascular disease risk factors and their treatment (e.g., cholesterol) often triggered by annual increases in BP] should become standard clinical practice in affected individuals.

The underlying mechanisms of the association between fraud victimization and BP in affected older adults generally, and the link between changes in BP post fraud victimization in men more specifically, have not been elucidated; however, there are several possibilities. Older adults who are victims of fraud may develop elevations in BP either directly or indirectly due, in part, to the concomitant emotional dysregulation shown to be associated with fraud victimization including increased stress, anger, and anxiety.[5,9,12,39] In fact, more than half of financial fraud victims (53%) report experiencing socioemotional problems involving moderate to severe levels of distress.[40] Higher BP has been associated with higher levels of stress, anger, and anxiety,[41,42] particularly anger and hostility experienced in older men.[42] Elevations in BP, either alone or in conjunction with emotional dysregulation, may exacerbate cardiac stiffness, hypertension, and hypoperfusion[41–44] leading to the known adverse outcomes associated with fraud victimization outlined above.[3–6] Future studies are needed to determine the underlying mechanisms linking fraud victimization and BP, particularly in men, and to determine whether emotional processing of victimization post fraud may be useful in lowering BP and ensuring optimal long-term outcomes in affected men. In addition to these relationships, it is plausible that other physical/health and/or nutritional factors more generally, may indirectly exacerbate cardiac health and contribute to the adverse outcomes associated with fraud victimization. While we did control for some of these factors, for example, BMI, and our groups did not differ on this metric, more work is needed to examine whether these or other indirect factors may play a role.

Strengths of this study include the comprehensive analytic approach that included the establishment of a cross-sectional relationship of fraud victimization and BP in participants with and without a history of hypertension, then more in-depth longitudinal analyses in participants without baseline fraud to understand the impact of incident fraud victimization on BP and potential directionality of cross-sectional associations. Our study leveraged over 10 years of data to examine how fraud victimization affects subsequent BP values. By using changepoint models, we were not only able to include non-victims as a control group to document longitudinal outcomes for BP in the absence of fraud, but participants reporting incident fraud victimization also served as their own control contributing information about BP both before and after fraud victimization. Additional strengths included our use of multiple objectively measured BP

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values and a comprehensive set of covariates including anti-hypertension medication use, diabetes, cumulative vascular disease burden, a metric of global cognition comprised of 19 tests, and important lifestyle factors of BMI and smoking. Furthermore, our study contributes to the small literature showing that fraud victimization associates with objective[7] (as opposed to subjective[8–12]) health outcomes.

Limitations include the fact that we lacked measures assessing other forms of elder abuse or details regarding the fraud victimization event itself including its economic consequences and/or its perpetrator; however, despite this, we were able to detect increases in BP post fraud victimization in men. Furthermore, while we lacked data on the type of fraud victimization reported and/or legal documentation of fraud victimization, in related analyses (not shown) we found that it was the self-reported experience of fraud victimization and subsequent loss, not merely vulnerability to fraud more generally, that is associated with elevations in BP values. Furthermore, and as outlined in our previous work,[21,22] self-report likely underestimates the burden of fraud secondary to unawareness and/or embarrassment; it is likely, however, that those who report victimization actually were victimized. Although we did not adjust for prior history or duration of hypertension and/or types of anti-hypertensive treatment, we did investigate whether hypertension (inclusive of those on anti-hypertensives) modified our primary results (it did not). Furthermore, we adjusted for cumulative vascular disease burden including heart conditions, congestive heart failure, and stroke, all of which may be present secondary to chronic hypertension.[34] Although it would have been interesting to also include clinical cardiovascular events as outcomes in longitudinal models, incident myocardial infarction and/or incident stroke were not sufficiently present in the current relatively healthy sample and thus, we did not have power for such analyses. In addition, less obvious changes that may occur post-fraud victimization including the optimal interventions for elevated BP in the eighth decade of life (e.g., a review of systems and/or subtle lifestyle modifications) are difficult to ascertain and moved beyond the focus of our current study establishing the important link between fraud victimization and BP.

Lastly, this study was conducted in an almost exclusively non-Latino White population of fraud victims and non-victims. In addition to being primarily White, our cohort reported high levels of education (a proxy for socioeconomic status). Thus, other potential factors that may increase vulnerability to fraud victimization and/or high blood pressure including neighborhood-level deprivation and other select social determinants of health (SDOH), while important to consider, may be less applicable in the current cohort than other SDOH (e.g., neighborhood-level fraud victimization crime rates and/or individual-level economic fragility). Work is ongoing using geographic information systems mapping to determine neighborhood-level SDOH that may relate to fraud victimization. Future work will consider them in relation to our individual-level variables of interest as little is known about this important area of research. Furthermore, fraud as a crime in and of itself should be considered a SDOH, particularly for older adults; more work is needed systematically detailing these events within this important context.

Our findings associating self-reported prevalent as well as incident fraud victimization with objectively measured BP values may have important public health practice implications by providing targets for interventions to help reduce the burden of adverse health outcomes associated with fraud victimization, particularly in men.

AUTHOR CONTRIBUTIONS

Study concept and design: Melissa Lamar and Patricia Boyle. *Acquisition of subjects and/or data*: David A. Bennett and Patricia Boyle. *Analysis and interpretation of data*: Melissa Lamar, Lei Yu, Sue Leurgans, Neelum T. Aggarwal, Robert S. Wilson, and Patricia Boyle. *Preparation of manuscript*: Melissa Lamar, Lei Yu, Sue Leurgans, Neelum T. Aggarwal, Robert S. Wilson, S. Duke Han, David A. Bennett, and Patricia Boyle.

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CONFLICT OF INTEREST

The authors have no conflicts of interest.

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