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Optimism predicts sustained vigorous physical activity in postmenopausal women☆

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ABSTRACT

Optimism and cynical hostility are associated with health behaviors and health outcomes, including morbidity and mortality. This analysis assesses their association with longitudinal vigorous physical activity (PA) in postmenopausal women of the Women's Health Initiative (WHI). Subjects include 73,485 women nationwide without history of cancer or cardiovascular disease (CVD), and no missing baseline optimism, cynical hostility, or PA data. The Life Orientation Test-Revised Scale measured optimism. A Cook Medley questionnaire subscale measured cynical hostility. Scale scores were divided into quartiles. Vigorous PA three times or more per week was assessed via self-report at study baseline (1994–1998) and through follow-up year 6. Descriptive analysis mapped lifetime trajectories of vigorous PA (recalled at ages 18, 25, 50; prospectively assessed at baseline, and 3 and 6 years later). Hierarchical generalized linear mixed models examined the prospective association between optimism, cynical hostility, and vigorous PA over 6 years. Models adjusted for baseline sociodemographic variables, psychosocial characteristics, and health conditions and behaviors. Vigorous PA rates were highest for most optimistic women, but fell for all women by approximately 60% between age 50 and study baseline. In adjusted models from baseline through year 6, most vs. least optimistic women were 15% more likely to exercise vigorously ($p < 0.001$). Cynical hostility was not associated with lower odds of longitudinal vigorous PA after adjustment. Results did not differ by race/ethnicity or socioeconomic status. Higher optimism is associated with maintaining vigorous PA over time in post-menopausal women, and may protect women's health over the lifespan.

1. Introduction

For adults ages 18–65, the American Heart Association (AHA) recommends vigorous or moderate intensity physical activity (PA) (Haskell et al., 2007; Mosca et al., 2011). PA levels decline with age (Nelson et al., 2007), and particularly around menopause in women (Champagne et al., 2008; Martin et al., 2014) even though PA improves cardiorespiratory fitness (Church et al., 2007), mood (Elavsky and

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McAuley, 2007), prevents weight gain (Champagne et al., 2008), and menopausal symptoms (Elavsky and McAuley, 2005). Aging women are at risk for osteoporotic fractures, which are associated with deteriorating health and increased mortality (Office of the Surgeon General, 2004), and cost $22B annually in the U.S. (Blume and Curtis, 2011). While either moderate or vigorous PA helps prevent cardiovascular disease (Manson et al., 2002), vigorous PA may be especially helpful for reducing osteoporotic fracture risk (Gutin and Kasper, 1992; Korpelainen et al., 2006). Older adults who maintain their PA levels typically have higher socioeconomic status (SES), better self-reported health, lower BMI, and do not smoke (Evenson et al., 2002). Uncovering psychological factors associated with age-related decline in vigorous PA may help risk-stratify older females. Optimism and cynical hostility may influence health outcomes via direct (e.g., psycho-physiologic processes) (Demaree and Harrison, 1997; Räikkönen et al., 1999a; Räikkönen and Matthews, 2008; Räikkönen et al., 1999b; Räikkönen et al., 2003; Räikkönen et al., 1999c) and indirect pathways (Scheier et al., 1986; Srivastava et al., 2006) (such as PA and other health behaviors (Giltay et al., 2007)), yet little is known about the relationship between these psychological attitudes and vigorous PA in older women.

Higher optimism (positive future expectation) (Scheier et al., 1994) is independently associated with lower incident coronary heart disease (CHD), CHD-related mortality, and total mortality in post-menopausal women of the Women's Health Initiative (WHI) (Tindle et al., 2009), as well lower mortality after myocardial infarction (Weiss-Faratci et al., 2017). Optimists typically practice more health-promoting behaviors, while pessimists often exhibit “less persistence, more avoidance coping, [and] more health-damaging behavior.” (Carver et al., 2010) Optimism in the WHI was also associated with better baseline diet quality and dietary improvement after intervention (Hingle et al., 2014). After coronary artery bypass surgery, higher optimism predicts faster recovery milestones including walking and resuming vigorous PA (Scheier et al., 1989), as well as decreased risk of re-hospitalization (Tindle et al., 2012). In older men and women, optimism is cross-sectionally associated with greater brisk walking and vigorous PA (Steptoe et al., 2006). Yet, other larger studies of older men do not find this association in multivariable models (Smagula et al., 2015), and studies on the relationship between psychological attitudes and PA are inconclusive (Hingle et al., 2014; Tindle et al., 2009), particularly for older women. Optimists are typically more confident in their ability to reach goals (Carver et al., 2010), which could reinforce goal-driven PA behaviors even in the face of physical, socioeconomic, or emotional limitations (Zaslavsky et al., 2015).

By contrast, cynical hostility, defined as a deep-seated mistrust of other people (Cook and Medley, 1954), is associated with higher incident CHD and related mortality, as well as all-cause mortality in the WHI (Tindle et al., 2009). In men, this association is partly mediated by PA and other behaviors (Everson et al., 1997). Higher cynical hostility predicts greater continued smoking over time in WHI participants observed over 6 years (Progovac et al., 2017). Greater cynical hostility has also been linked to higher BMI, a relationship that remained steady over 19 years of follow-up in adult women in the U.K. Whitehall cohort study (Nabi et al., 2009), and has also been linked with lower PA in college students with low social support (Maier and James, 2014). However, less is known about the relationship between hostility and PA in older women.

Sociodemographic factors may be proxies for barriers to vigorous PA, and may modify the relationship between attitudes and vigorous PA over the lifespan. Persons in lower-SES neighborhoods use recreational facilities less, even if these facilities are close by (Giles-Corti and Donovan, 2002). Reported leisure-time PA is lower for racial/ethnic minorities, regardless of SES (Crespo et al., 2000). Attitudes may influence aging women's PA habits as physical exertion becomes more challenging (Lazarus and DeLongis, 1983). For example, high cynical hostility is associated with failure to seek or accept social support (Houston and Vavak, 1991), possibly hindering some PA activities (Kinnunen, 2006), especially if PA activities are reliant on social ties. However, there is no research examining whether the relationship between these psychological attitudes and vigorous PA over time varies by sociodemographic characteristics.

Least optimistic and most cynically hostile women were less physically active at baseline in the WHI (Tindle et al., 2009). Self-reported PA in the WHI (Meyer et al., 2009) remains relatively stable over 8 years of follow-up (Nguyen et al., 2013). However, vigorous PA declines precipitously after age 50 in this cohort based on self-report and recall (Evenson et al., 2002). Whether attitudes are associated with longitudinal trajectories of vigorous PA in older women has not been characterized. We examine whether baseline optimism and cynical hostility are associated with rates of vigorous PA 3 times or more per week for WHI women at study baseline, and years 3 and 6 of follow-up (after covariate adjustment), and whether the relationship between attitudes and longitudinal vigorous PA depend on sociodemographic factors. To contextualize results against lifetime reports of vigorous PA from WHI PA trajectory studies (Evenson et al., 2002), we also map unadjusted rates of vigorous PA by attitude across the lifespan. We hypothesized that more optimistic and less cynically hostile women would have higher vigorous PA overtime, and this relationship would be stronger for sociodemographic groups who may face greater barriers to vigorous PA. Recent meta-analytic evidence indicates that optimism can be modified favorably with psychological intervention (Malouff and Schutte, 2017). Similarly, factors related to hostility, such as hostile cognitions in Type A behavior, may be modifiable, with resultant decreases in coronary risk (Friedman et al., 1982). Understanding the relationship between psychological attitudes and vigorous PA may have implications for cardiovascular risk stratification and, potentially, for behavior modification to augment the practice of healthy behaviors.

2. Methods

2.1. Study population

The Women's Health Initiative recruited 161,808 postmenopausal women ages 50–79 from 40 clinical centers nationwide from diverse racial, ethnic, and socioeconomic backgrounds into one of two longitudinal study branches between 1994 and 1998: the clinical trial (CT; n = 68,132) or the observational study (OS; n = 93,676) (Hays et al., 2003). WHI exclusion criteria relevant to the current study included: any substance abuse (aside from smoking or alcohol), severe depression, dementia, life expectancy less than three years, participation in other randomized trials, and plans to move from current area within 3 years (further restrictions for CT participants, described elsewhere (Hays et al., 2003)). Participants gave informed consent at each center and materials used were approved by each center's institutional review board.

The current analysis uses women from either the OS or CT control study arms, with no history of physician-diagnosed CVD or cancer at baseline, and who are not missing baseline data for optimism, cynical hostility, or PA (n = 73,485; see Fig. 1 details). Only control participants from the CT study arm were included to avoid any possible influence of interventions on PA or attitudes.

2.2. Optimism and cynical hostility

Optimism (positive future expectation) was assessed at baseline by the six-item Life Orientation Test-Revised (LOT-R) (Scheier et al., 1994) (scores from 6 to 30; higher scores indicate greater optimism and lower scores indicate greater pessimism). Consistent with prior studies, women were classified by quartiles of optimism score from the analysis sample (Tindle et al., 2009): low (6–21), mid-low (22–23), mid-high (24-26), and high (> 27).

Cynical hostility (mistrust of others) was assessed at baseline using the 13-item cynicism subscale of the Cook Medley hostility

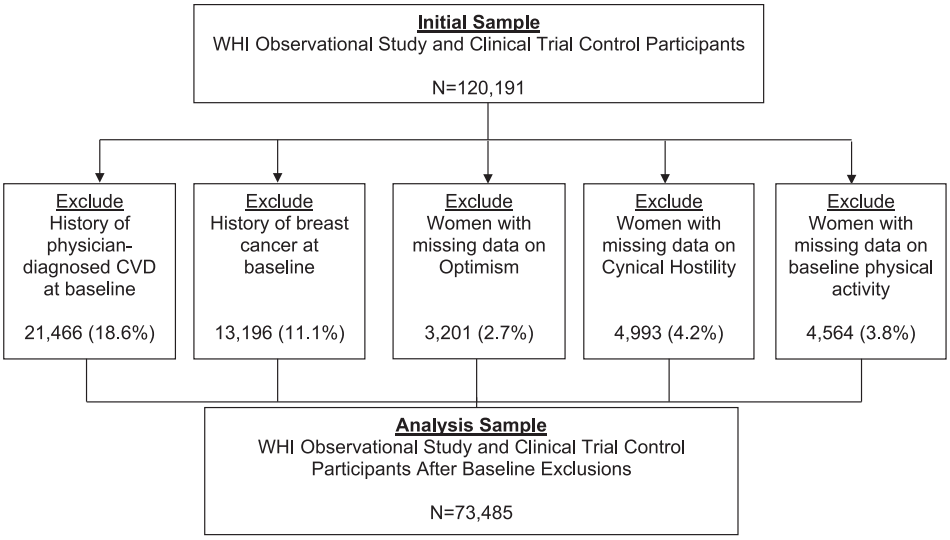

Fig. 1. Flowchart of cohort creation.

questionnaire (scores from 0 to 13, with higher scores indicating greater cynicism (Cook and Medley, 1954)). Women were classified by quartile of analysis sample score for cynical hostility consistent with prior work (Tindle et al., 2009): low (0–1), mid-low (2–3), mid-high (4–5), and high (6 and above).

Significant associations between psychological attitudes and important health outcomes have been documented (Progovac et al., 2017; Puig-Perez et al., 2017; Tindle et al., 2017). In this analysis we present findings based on quartile scores (Tindle et al., 2009; Hingle et al., 2014; Yan et al., 2003; Iribarren et al., 2000; Scherwitz et al., 1992) for optimism and cynical hostility. Presenting results in categories may be more interpretable in understanding the relationship between psychological profiles and health outcomes.

2.3. Vigorous physical activity in the Women's Health Initiative

Women recalled at WHI baseline whether they participated in vigorous PA three times or more per week (Y/N) at ages 18, 35, 50 ("strenuous or very hard exercise long enough to work up a sweat and make your heart beat fast"). Women reported their vigorous recreational PA at baseline and at follow-up years 3 and 6 using a self-administered questionnaire with established reliability and validity (Meyer et al., 2009). This questionnaire included days per week of PA and duration of PA episodes, with intensity cues parallel to those provided for the past-recall PA. Vigorous PA responses at baseline, year 3, and year 6 were dichotomized to determine whether women participated in these activities for 20 min 3 times per week or more in line with 2007 AHA recommendations (Haskell et al., 2007).

2.4. Covariates and potential confounders

Individual characteristics associated with attitudes or PA measured by self-report at baseline include age (Evenson et al., 2002), U.S. region (Northeast, South, West, Midwest), race/ethnicity (White, Black, Hispanic, American Indian or Alaskan Native, Asian/Pacific Islander, Other/Unknown), annual gross family income (< $20,000 annually, $20,000–$49,999, $50,000–$74,999, or $75,000 and above), and high school or equivalent education (y/n). Models were adjusted for physical health conditions, including hypertension ever (y/n), diabetes ever (y/n), any cancer (y/n) or cardiovascular disease (y/n) during the WHI study period, arthritis ever (y/n), broken bone ever (y/n), obesity (BMI ≥ 30), and depressive symptoms (y/n, prevalent despite study exclusion for clinical depression). Depressive symptoms were measured using the Burnam Screening Algorithm (Burnam et al., 1988), a questionnaire that includes 6 items from the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977) and two from the Diagnostic Interview Scale (DIS) (Robins et al., 1981), with a cutoff of ≥ 0.06 indicating depression (Burnam et al., 1988; Goveas et al., 2011). Alcohol (y/n) and smoking (y/n) are associated with attitudes and also impact lung function and circulation (Anthonisen et al., 2002; Quillen et al., 1993) and metabolism (El-Sayed et al., 2005). Longitudinal models also adjust for past vigorous PA (y/n, ≥ 3 times per week) at age 18, 35, and 50 (Crespo et al., 2000). Longitudinal models also assess interactions between psychological attitudes and (1) race/ethnicity (Crespo et al., 2000), (2) income level (Giles-Corti and Donovan, 2002), and (3) education level (Giles-Corti and Donovan, 2002).

2.5. Statistical methods

2.5.1. Baseline characteristics

Baseline characteristics were compared across quartiles of score for optimism and cynical hostility using chi-square tests for categorical variables and analysis of variance (ANOVA) tests for continuous variables.

2.5.2. Vigorous PA over time, including past recall

Rates of vigorous PA were examined at each time point for all women (age 18, 35, 50, baseline, year 3, year 6), and then compared across quartiles of optimism and cynical hostility using chi-square tests.

2.5.3. Vigorous PA at baseline, year 3, and year 6

To characterize the role of optimism and cynical hostility on longitudinal vigorous PA from baseline through year 6, we conducted a series of hierarchical generalized linear mixed models (GLMM), adding covariates in batches and nesting multiple observations (Year 3 and Year 6 outcomes) within each subject to account for within-subject correlations (SAS 9.4 PROC GLIMMIX). Hierarchical modeling better captures the effect of subsequent covariate adjustment on the relationship between attitudes and vigorous PA over time. The GLIMMIX procedure is ideal for fitting generalized mixed models to non-normal data with repeated events (outcomes correlated at the individual unit of analysis): in this case, multiple years of observed response on reports of vigorous PA (Schaebenberger, 2005). Model 1 adjusted for age only. Model 2 added demographic characteristics (race/ethnicity, income, and education) to Model 1. Model 3 included variables in Model 2 and past vigorous PA ≥ 3 times weekly (binary y/n at each age 18, 35, and 50). Model 4 added health conditions (hypertension ever, diabetes ever, obesity at baseline, any cancer or CVD through follow-up, arthritis

history, fracture history, depressive symptoms). Model 5 added smoking and alcohol consumption. Model 6 also included interaction terms between psychological attitudes and (1) race/ethnicity, (2) income level, and (3) education level. Models include women from all four quartiles of the optimism and cynical hostility scales (most, mid-high, mid-low, least). For simplicity, ORs for women in the most vs. least quartiles are displayed in results tables. Significant ORs for women in mid-high and mid-low quartiles are reported in text only.

Two sensitivity analyses were completed. First, to examine the extent to which optimism and cynical hostility jointly influence vigorous PA, a second set of GLMMs included both attitude variables jointly, and we examined changes in significance and magnitude of odds ratios. Second, we repeated hierarchical GLMM among women with complete data (n = 61,756), and compared effect estimates with those of the full sample. Missing data on any covariate was present in 16% of the sample, with greatest missingness for indicators of income.

3. Results

3.1. Baseline characteristics

Compared to all WHI Observational Study participants, the current sample was generally healthier, wealthier, and better educated, but had similar distribution of race/ethnicity groups (Langer et al., 2003). All baseline characteristics were statistically significant by quartiles of optimism or cynical hostility (Table 1, all $p < 0.05$). Most vs. least optimistic women had higher baseline vigorous PA (18.0% vs. 12.8%), and were younger (61.9 vs. 62.2 years old), more likely to be white, have higher income and education. They were less likely to have hypertension (24.8% vs. 32.6%), diabetes (3% vs. 5.9%), arthritis (38.3% vs. 48.3%), depressive symptoms (3.6% vs. 21.4%) or obesity (23.0% vs. 30.2%), report smoking at baseline (5.1% vs. 7.8%), or develop CVD after baseline (6.3% vs. 7.7%). However, they more often developed cancers after baseline (10.0% vs. 9.1%). Most cynically hostile women resembled least optimistic women on many baseline factors, although they were slightly less likely to develop cancer (8.9% vs. 10.0%).

Women with no missing data on any covariates (n = 61,756, or 84% of the study sample) differed modestly from the full sample at baseline: they tended to be younger (62.2 vs. 62.4 years old), were more likely to be white (84.6% vs. 82.9%), to have higher education (96.3 vs. 94.8 finishing high school), and higher incomes (22.5% vs. 20.5% in highest income bracket).

3.2. Vigorous PA at each time point (including past recall)

Unadjusted past vigorous PA rates at ages 18, 35, and 50 were comparable to reported prevalence for U.S. men and women (Haskell et al., 2007), and reflected the expected substantial drop off in vigorous PA after age 50. At each time point, rates of vigorous PA were higher for most (vs. least) optimistic women ($p < 0.0001$; results not shown). Compared to women reporting least cynical hostility at baseline, the most cynically hostile women recalled higher vigorous PA at age 18 and 35, and lower vigorous PA by age 50 that persisted through follow-up year 6 (all statistically significant).

3.3. Longitudinal analysis

3.3.1. Optimism

Most vs. least optimistic women were significantly more likely to report vigorous PA from baseline through year 6. Most optimistic women were 85% more likely to report vigorous PA after adjustment for age only (Model 1; OR for mid-high vs. least = 1.46; OR for mid-low vs. least = 1.18; all $p < 0.01$). Most vs. least optimistic women were more likely to report rigorous PA in each subsequent model. In Model 5, after adjusting for all other covariates including sociodemographic variables, health and depressive symptoms, and other health behaviors, most optimistic women were still 15% more likely to report vigorous PA compared to least optimistic women (OR 1.15 for most vs. least, $p < 0.001$; OR for mid-high vs. least not significant; OR 0.92 for mid-low vs. least, $p = 0.03$). There were no significant interactions between quartiles of optimism and race/ethnicity, income, or education. For simplicity, only ORs for women in the most vs. least optimism quartiles for Models 1–5 are displayed in Table 2. Significant ORs for women in mid-high and mid-low quartiles are reported in text only.

3.3.2. Cynical hostility

In age-adjusted models, most vs. least cynical hostility predicted lower odds of vigorous PA (Model 1, OR for most vs. least 0.80, 95% CL 0.74–0.86, $p < 0.001$; OR for mid-high vs. least 0.83 and OR for mid-low vs. least 0.86; both $p < 0.05$). This association became marginally significant after accounting for demographic characteristics (Model 2, OR for most vs. least 0.93, 95% CL 0.86–1.00, $p = 0.05$; OR for mid-high vs. least 0.82 and OR for mid-low vs. least 0.85 with $p < 0.01$ for both) and past vigorous PA (Model 3, OR 0.92 for most vs. least, 95% CL 0.86–0.99, $p = 0.02$; OR for mid-high vs. least is 0.88 and is significant at $p < 0.001$; OR for mid-low vs. least not significant), but was no longer significant after accounting for health-related covariates (Table 2). There were no significant interactions between cynical hostility and race/ethnicity, income, or education. For simplicity, only ORs for women in the most vs. least cynical hostility quartiles are displayed in Table 2. Significant ORs for women in mid-high and mid-low quartiles are reported in text only.

3.3.3. Sensitivity analyses

Results did not differ substantially when both optimism and cynical hostility were included in each model simultaneously. Sensitivity analyses including only women with complete data resulted in nearly identical results for both attitudes, except in Model 2, where most vs. least cynically hostile women demonstrated 15% lower odds of vigorous PA over time ($p < 0.001$), compared with 7% lower odds in the full sample (Supplemental Table 1).

4. Discussion

Women reporting highest (vs. lowest) levels of optimism were 15% more likely to report vigorous PA over six years of follow up, even after adjustment for important health, demographic, and socioeconomic factors that may influence ability to exercise vigorously. That optimism appears to predict sustained vigorous PA well into old age may in part explain WHI findings of optimistic women's lower risk of multiple falls (Cauley et al., 2017), incident CVD, and mortality (Tindle et al., 2009). Contrary to hypotheses, the observed association between optimism and vigorous PA was not modified by race/ethnicity, income, or education.

Most (vs. least) optimistic women also recalled higher vigorous PA across the life course. Most optimistic women also reported sharp declines in vigorous PA after age 50. But into older age, they maintained the highest levels of vigorous PA compared to least optimistic peers even after adjusting for these higher rates of earlier-life vigorous PA. Higher dispositional optimism has been associated with greater recall of personally-relevant health information (Abele and Gendolla, 2007), and most optimistic women may be more likely to recall vigorous PA earlier in life. However, the prospective longitudinal finding of persistently higher levels of vigorous PA is consistent with the general profile of greater physical health and healthier behaviors among individuals with high optimism (Rasmussen et al., 2009). In the context of recent evidence that depressive symptoms predict future PA (but PA does not predict depressive symptoms) (Sin et al., 2016), our work provides additional evidence for prospective directionality between psychological factors and PA.

In contrast to our hypotheses, cynical hostility was not independently associated with vigorous PA in prospective analyses after

Table 1
Baseline (1994–1998) characteristics by quartiles of optimism and cynical hostility.

% or mean (SD)	All	Optimism (quartiles of LOT-R score)					Cynical hostility (quartiles of Cook-Medley score)				
	n = 73,485	Most (27–30)	Mid-high (24–26)	Mid-low (22–23)	Least (6–21)	p-Value[a]	Most (6–13)	Mid-high (4–5)	Mid-low (2–3)	Least (0–1)	p-Value
		n = 14,126	n = 22,257	n = 18,038	n = 19,064		n = 17,259	n = 16,651	n = 20,118	n = 19,457	
Age at screening	62.4 (7.1)	61.9 (7.0)	62.4 (7.0)	62.7 (7.1)	62.4 (7.2)	< 0.001	62.5 (7.2)	62.4 (7.0)	62.3 (7.0)	62.3 (7.0)	0.003
Race/ethnicity											
White	82.9	86.1	84.9	83.6	77.4		74	83.1	86.1	87.2	
Black	8.1	8.2	8.0	7.3	9.0		13.8	8.8	6.3	4.4	
Hispanic	4.0	2.8	3.1	3.8	6.2		6.4	3.7	3.2	3.0	
Other (American Indian, Asian/Pacific Islander, Other)	4.8	2.8	3.7	5.2	7.1	< 0.001	5.5	4.3	4.1	5.2	< 0.001
U.S. region											
Northeast	23.4	19.9	22.2	24.3	26.4		24.1	24.2	23.3	22.0	
South	25.3	25.9	25.7	24.9	25		28.9	25.4	24.4	23.1	
Midwest	21.8	22	22.1	22.2	21		20.4	21.2	22.3	23.0	
West	29.5	32.3	30.1	28.7	27.6	< 0.001	26.6	29.1	30.0	31.9	< 0.001
Education: ≥ HS	94.8	97.5	96.4	94.9	90.8	< 0.001	90.2	95.2	96.4	96.8	< 0.001
Annual family income											
Less than $20,000	12.8	8.4	10.4	12	19.7		20.1	13	10.4	8.6	
$20,000–$49,999	40.3	35.9	39.8	42.4	42.1		41.4	41.5	40.4	38.2	
$50,000–$74,999	19.8	22.3	20.6	20	16.7		16.1	20.2	20.8	21.7	
$75,000 or greater	20.5	27.6	22.9	19	13.8	< 0.001	14.4	19.1	22.1	25.3	< 0.001
Hypertension ever (Yes)	29.1	24.8	28.2	29.9	32.6	< 0.001	33.3	29.9	27.9	25.9	< 0.001
Diabetes ever (Yes)	4.2	3	3.6	4.3	5.9	< 0.001	6.5	4.4	3.4	2.9	< 0.001
Depressive symptoms (Yes)	10.1	3.6	5.7	8.8	21.4	< 0.001	17.1	10.8	7.9	5.6	< 0.001
Obesity (BMI ≥ 30)	25.9	23.0	24.3	25.5	30.2	< 0.001	32.4	27.3	23.9	20.9	< 0.001
Cancer during study (Yes)	9.7	10.0	9.9	9.8	9.1	0.01	8.9	9.9	9.8	10	< 0.001
CVD during study (Yes)	7.2	6.3	7.2	7.3	7.7	< 0.001	7.7	7.4	7.2	6.5	< 0.001
Arthritis ever (Yes)	43.6	38.3	41.8	44.9	48.3	< 0.001	47.8	45.4	42.9	38.9	< 0.001
Broke bone ever (Yes)	36.4	38.0	36.9	36.2	34.9	< 0.001	34.5	36.7	37.7	36.6	< 0.001
Any alcohol at baseline (Yes)	71.8	74.7	74	72.3	66.7	< 0.001	64.5	72.6	74.3	75.1	< 0.001
Smoked at baseline (Yes)	6	5.1	5.3	5.5	7.8	< 0.001	7.2	6.1	5.7	4.9	< 0.001
Baseline vigorous exercise 3 times or more per week (Yes)	15.1	18.0	15.9	14.3	12.8	< 0.001	13.9	14.8	15.3	16.3	< 0.001

[a] Significance tests conducted using chi-square for categorical variables and ANOVA for continuous variables.

Table 2
Optimism, cynical hostility, and vigorous physical activity over 6 years of follow up (baseline in 1994–1998, year 3, year 6) in the full sample.

Model[a,b]	Covariates added[d]	Optimism (most vs. least)[c]		Cynical hostility (most vs. least)	
		OR (95% CL)	p-Value	OR (95% CL)	p-Value
Model 1 n = 73,485	Age	1.85 (1.72–2.00)	< 0.001	0.80 (0.74–0.86)	< 0.001
Model 2 n = 67,962	Age, **region**, **race/ethnicity**, **income**, **education**	1.48 (1.37–1.61)	< 0.001	0.93 (0.86–1.00)	0.05
Model 3 n = 64,945	Age, region, race/ethnicity, income, education, **past vigorous exercise**	1.27 (1.18–1.37)	< 0.001	0.92 (0.86–0.99)	0.02
Model 4 n = 62,461	Age, region, race/ethnicity, income, education, past vigorous exercise, **health covariates including depressive symptoms**	1.16 (1.07–1.25)	< 0.001	1.02 (0.95–1.10)	0.52
Model 5 n = 61,756	Age, region, race/ethnicity, income, education, past vigorous exercise, health covariates including depressive symptoms, **alcohol and smoking**	1.15 (1.06–1.24)	< 0.001	1.03 (0.94–1.10)	0.51
Model 6 n = 61,756	Age, region, race/ethnicity, income, education, past vigorous exercise, health covariates including depressive symptoms, alcohol and smoking, and **interaction terms**:	Type III fixed effects Interaction terms:		Type III fixed effects Interaction terms:	
	Attitude ∗ race/ethnicity	Attitude ∗ race/ethnicity	0.788	Attitude ∗ race/ethnicity	0.695
	Attitude ∗ income	Attitude ∗ income	0.721	Attitude ∗ income	0.603
	Attitude ∗ education	Attitude ∗ education	0.163	Attitude ∗ education	0.942

OR = Odds Ratio; CL = Confidence Limit.
[a] Modeled using SAS 9.4 Proc GLIMMIX (logit link), nesting observations within subjects.
[b] Results were similar in sensitivity analyses which included only women with no missing data for covariates (n = 61,756).
[c] Models include women from all 4 quartiles of the optimism and cynical hostility scales (most, mid-high, mid-low, least). For simplicity, only ORs for women in the most vs. least quartiles are displayed in results tables. Significant ORs for women in mid-high and mid-low quartiles are reported in text only.
[d] Bold terms indicate covariates newly added to model.

health factors were considered. Therefore, cynical hostility may not explain differences in vigorous PA beyond physical limitations in older women. This result is consistent with a recent WHI study showing that high cynical hostility is associated with an increased risk of falls and modest increase in fracture risk (Cauley et al., 2017). That study adjusted for baseline PA but did not test whether repeated measures of vigorous PA were a key mediator of the relationship between cynical hostility, falls and fractures. These findings add important data to existing literature showing a strong relationship between higher hostility and higher BMI over time for women (Nabi et al., 2009). Higher hostility is also associated with lower PA levels for college students who lack social support (Maier and James, 2014). Nonetheless, existing literature lacked published information on the relationship between cynical hostility and PA in older women.

Understanding the role that attitudes such as optimism play in vigorous PA behavior over time may be critical for health practitioners caring for aging women. Woman at higher risk of reduced activity, such as those with lower optimistic attitudes, may need additional resources or support to maintain PA levels. Physicians who are aware of patients' attitudes over time may be able to direct the most vulnerable women to health-maintaining resources such as group exercise programs. At present, the LOT-R is strictly used as a research tool. However, a recent meta-analysis has shown that optimism may be modifiable with targeted psychological interventions (Malouff and Schutte, 2017), and more research is needed to determine whether a change in LOT-R score or level may be associated with subsequent changes in CVD risk.

5. Limitations

WHI women were typically healthier than post-menopausal women on average. Though missing covariate data in fully adjusted longitudinal models was somewhat high (16%), sensitivity analyses using only women with complete data available were nearly identical to results for the full analysis sample. Optimism and hostility were also not measured between baseline and 6 year follow up. Nonetheless, these psychological attitudes are considered trait-like after early adulthood: optimism test-retest scores are correlated at rates of 0.58 to 0.79 over a 3–10 year period (Carver et al., 2010; Matthews et al., 2004) while hostility scores over 4 years are correlated at rates of 0.56, even for youths and young adults (Woodall and Matthews, 1993). Optimism can remain stable even in the face of health shocks (Schou et al., 2005), although it may wane in aging men (Giltay et al., 2006). Observational data may have residual confounding. This study lacks measures of objective energy expenditure (available on a tiny subset of WHI participants) which may better predict CVD, chronic disease, and mortality (Zheng et al., 2014; Manini et al., 2006) than self-reported PA; and on "optimistic bias," a type of unrealistic optimism (Shepperd et al., 2015) associated with poor health (Radcliffe and Klein, 2002) which was beyond the scope of this study.

6. Conclusion

Although vigorous PA declined sharply after menopause in this large cohort of community-dwelling older women, high optimism was independently associated with persistently-high levels of vigorous PA, and this relationship was consistent by race/ethnicity, income, and education. Future studies should examine the extent to which interventions aimed at sustaining PA levels for women with low optimism, or those that help preserve optimistic attitudes as women age, could potentially improve postmenopausal women's health.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2017.10.008.

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