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Running Head: PHYSICAL ACTIVITY AND PERSONALITY CHANGES

Physical Activity and Personality Development over Twenty Years: Evidence from Three Longitudinal Samples

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Author Contributions

Yannick Stephan, Angelina Sutin and Antonio Terracciano contributed to study conceptualization. Yannick Stephan and Antonio Terracciano contributed to data preparation. Yannick Stephan, Martina Luchetti and Grégoire Bosselut contributed to data analysis. All authors contributed to report writing.

Abstract

A physically inactive lifestyle is associated with maladaptive patterns of personality development over relatively short follow-up periods. The present study extends existing research by examining whether this association persists over 20 years. Participants (total *N* = 8,723) were drawn from the Wisconsin Longitudinal Study Graduates and Siblings samples and the Midlife in the United States Study. Controlling for demographic factors and disease burden, baseline physical inactivity was related to steeper declines in conscientiousness in all three samples and a meta-analysis (β=-.06). The meta-analysis further showed that lower physical activity was associated with declines in openness (β=-.05), extraversion (β=-.03), and agreeableness (β=-.03). These findings provide evidence that a physically inactive lifestyle is associated with long-term detrimental personality trajectories.

Key-words: Personality development; physical inactivity; adulthood

1. Introduction

Physical activity has major health-related implications across adulthood. A physically active lifestyle reduces risk of chronic disease (Koolhaas et al., 2016; Lee et al., 2012), depressive symptoms (Pereira, Geoffroy, & Power, 2014), cognitive decline and Alzheimer's disease (Stephen et al., 2017) and is related to lower risk of all-cause mortality (Ekelund et al., 2016; Samitz, Egger, & Zwahlen, 2011). In addition to physical and mental health outcomes, several studies and meta-analyses have found that a physically (in)active lifestyle is associated with concurrent personality traits (e.g., Rhodes & Smith, 2006; Sutin et al., 2016) and longitudinal research has shown that physical inactivity is associated with patterns of personality development across adulthood (Allen & Laborde, 2014; Allen, Magee, Vella, & Laborde, 2017; Allen, Vella, & Laborde, 2015; Stephan, Sutin, & Terracciano, 2014). Specifically, physical inactivity is associated with steeper declines in extraversion, openness, agreeableness and conscientiousness (Allen et al., 2015, 2017; Stephan et al., 2014). Surprisingly, no association has been found between physical activity and change in neuroticism (Allen et al., 2015, 2017; Stephan et al., 2014).

Recent models of personality and health recognize multiple pathways, including both behavioral and physiological mechanisms, through which personality contributes to long-term health outcomes (Friedman, Kern, Hampson, & Duckworth, 2014). There is growing recognition that these same mechanisms may also contribute to changes in personality across adulthood. Early theories of personality development implicated genetics as the chief biological antecedent of trait development (McCrae et al., 2000), and most other theories of personality development focus on major life events in adulthood as drivers of personality change (Luhmann, Orth, Specht, Kandler, & Lucas, 2014). In addition to genetics and life events, there is evidence that other important factors in the individual's life, usually included as a covariate, are important predictors of change in and of themselves (Sutin, Luchetti, Stephan, Robins, & Terracciano, 2017). Physical activity is one such factor.

A physically inactive lifestyle may weaken personality stability and lead to non-desirable personality changes through its link with disease burden, functional limitations, cognitive impairment, and depressive symptoms. Indeed, higher disease burden, biological dysfunction, depressive symptoms, and worsening cognition are related to higher neuroticism, and lower extraversion, openness, agreeableness and conscientiousness over time (Hakulinen et al., 2015; Jokela, Hakulinen, Singh-Manoux, & Kivimaki, 2014; Stephan, Sutin, Luchetti, & Terracciano, 2016; Wettstein et al., 2017). Worsening functional status, such as higher frailty over time is also related to maladaptive personality changes (Stephan, Sutin, Canada, & Terracciano, 2017). Biological mechanisms are also likely to operate. Indeed, physical inactivity is related to higher risk of physiological dysregulation (Hamer et al., 2012), which has been associated with lower conscientiousness, extraversion, openness and agreeableness over time (Stephan, Sutin, Luchetti, & Terracciano, 2016). Finally, physical inactivity may be related to worsening sleep quality (Kredlow, Capozzoli, Hearon, Calkins, & Otto, 2015), which has also been associated with higher neuroticism, and lower extraversion, agreeableness and conscientiousness (Stephan, Sutin, Bayard, Križan, & Terracciano, in press). In addition to health and cognition, there are social pathways through which physical inactivity may be associated with personality development. Physical inactivity, for example, may result in lower self-efficacy and fewer social interactions and support (McAuley, Jerome, Marquez, Elavsky, & Blissmer, 2003) that over time can lead to changes in characteristic ways of thinking, feeling, and behaving.

Previous studies have examined the association between physical activity and personality development over relatively short periods, ranging from 4 years (Allen et al., 2015, 2017; Stephan et al., 2014) to 10 years (Stephan et al., 2014). It is unknown whether this association persists or dissipates over longer periods. Long-term longitudinal studies indicate that the harmful effects of physical inactivity on physical and mental health and cognition continue over several decades (Chang et al., 2016; Pereira et al., 2014 ; Salvela et al., 2010). For example, lower physical activity at midlife has been associated with worsening executive function and memory twenty years later (Chang et al., 2010), higher depressive symptoms (Pereira et al., 2014), lower physical function (Chang et al., 2016; Salvela et al., 2013), and incident cardiovascular and respiratory diseases almost two decades later (Salvela et al., 2010). Given that health-related factors and cognitive functioning are associated with personality changes (Sutin et al., 2013; Wettstein et al., 2017), there are reasons to expect that the level of physical activity may be related to long-term personality development.

The present study examined the association between physical activity and personality change over two decades. Consistent with previous research on physical activity and personality development (Allen et al., 2015, 2017, Stephan et al., 2014) and the long-term negative outcomes of physical inactivity (Chang et al., 2016; Salvela et al., 2010), it was hypothesized that physical inactivity would be related to steeper declines in extraversion, openness, agreeableness and conscientiousness over two decades. Consistent with past findings, no association with neuroticism was expected. The relation between physical activity and personality change was tested in three large longitudinal studies of middle-aged and older adults and results were meta-analytically combined to provide a quantitative summary.

2. Method

2.1. Participants

Participants were drawn from the Wisconsin Longitudinal Study graduate (WLSG) sample, the Wisconsin Longitudinal Study Sibling (WLSS) sample, and the Midlife in the United States (MIDUS) survey. The present study included participants from the three samples who had complete data on personality, physical activity, demographic factors (age, sex, education, and race), and disease burden at baseline and personality at follow-up. Given that the items used to assess physical activity across the two waves of each survey were different, we only examined baseline physical activity.

2.1.1. WLS. The WLS followed a random sample of 10,317 participants who were born between 1937 and 1940 and who graduated from Wisconsin high schools in 1957. In addition to this main sample, the WLS also collected data on a selected sibling of some of the graduates. The WLS sample is broadly representative of older, white, non-Hispanic Americans who completed at least a high school education. Since 1991, the WLS has been supported principally by the National Institute on Aging (AG-9775, AG-21079, AG-033285, and AG-041868), with additional support from the Vilas Estate Trust, the National Science Foundation, the Spencer Foundation, and the Graduate School of the University of Wisconsin-Madison. Since 1992, data have been collected by the University of Wisconsin Survey Center. Information about how to access the WLS data can be found here: http://www.ssc.wisc.edu/wlsresearch/.

Baseline personality data, physical activity, disease burden, and demographic factors were obtained in 1992-1993 from a sample of 6462 graduates and in 1993-1994 from 3327 siblings. Follow-up personality data were collected in 2011. Complete data at baseline and follow-up were obtained from 4218 individuals in the WLSG and from 1934 participants in the WLSS (see Table 1). In the WLSG, participants with complete personality data at follow-up were younger (d= .14), more likely to be female, more educated (d= .22), more emotionally stable (d= .11), extraverted (d=.06), open (d= .10), more physically active (d= .18), and had lower disease burden (d= .13) than those without follow-up data. In the WLSS, participants with complete data at follow-up were on average younger (d=.29), more educated (d= .27), more physically active (d= .11), more extraverted (d= .11), and more open (d= .09), and had less disease burden (d= .09) than those with incomplete data at follow-up.

2.1.2. MIDUS. The MIDUS is a longitudinal study of 7,108 non-institutionalized English-speaking adults in the United States, aged 20–75 years. The association between physical activity and change in personality has been previously reported using the first (1995-1996, MIDUS I) and the second waves (2004-2005, MIDUS II) of the MIDUS survey (Stephan et al., 2014). In the present study, we used data from the first and third waves (2013-2014, MIDUS III). The Midlife in the United States study 1 (MIDUS 1) was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development. The MIDUS 2 and MIDUS 3 research was supported by grants from the National Institute on Aging (P01AG020166, R37AG027343). Additional grants were obtained from grants from the General Clinical Research Centers Program (M01-RR023942, M01-RR00865) and the National Center for Advancing Translational Sciences (UL1TR000427). Information about how to access the MIDUS data can be found here: http://www.midus.wisc.edu/.

Complete data on demographic factors, physical activity, disease burden and personality traits were obtained from a total of 6,015 participants at baseline. Among this sample, 2,571 participants also provided data on personality at follow-up in 2013-2014 in MIDUS III (See Table 1). Attrition analysis revealed that participants with complete data at follow-up were more physically active (d= .19), more likely to be female and white, more emotionally stable (d= .04) and more conscientious (d= .18), and had lower disease burden (d= .13).

2.2. Measures

2.2.1. Personality. In the MIDUS, personality traits were assessed using the Midlife Development Inventory (MIDI; Lachman & Weaver, 1997). Participants were asked how much 25 adjectives that assessed neuroticism, conscientiousness, extraversion, openness, and agreeableness described themselves on a scale ranging from 1 (*not at all*) to 4 (*a lot*). The WLSG and WLSS used a 29-item version of the Big Five Inventory (John, Donahue, & Kentle, 1991). Participants were asked whether they agreed or disagreed with descriptive statements using a scale ranging from 1 (*disagree strongly*) to 6 (*agree strongly*). Cronbach alphas ranged from .56 to .81 across the three samples at baseline, and from .56 to .78 at follow-up. Measurement equivalence across time was observed in the three samples (see Supplementary Material and Table S1). As detailed in the Supplemental Material, comparisons of the different models demonstrate metric invariance, meaning that the strength of the relation between items and their underlying constructs are the same across time. Invariance across time is necessary to ensure that a construct can be reliably measured at different time points. However, if measurement invariance was not established, differences across time may be due to measurement artifacts rather than true change over time.

2.2.2. Physical activity. At baseline, WLSS and WLSG participants answered two items that asked how often they participated in light physical activity such as walking, dancing, gardening, golfing, and bowling, and how often they participated in vigorous physical activity such as aerobics, running, swimming, and bicycling. For both items, participants answered on a scale from 1 (three or more times per week) to 4 (less than once a month). In the MIDUS, participants reported how frequently they participated in moderate leisure (e.g. slow or light swimming, brisk walking) and vigorous physical activity (e.g., running or lifting heavy objects) during both the summer and the winter months. A scale ranging from 1 (several times per week or more) to 6 (never) was used. In the three samples, answers to the physical activity items were averaged, with higher score representing overall physical inactivity. The correlation between items for light and vigorous physical activity was r=.34, p<.001 in both the WLSG and the WLSS, and the correlation for moderate and vigorous physical activity items was r= .46, p<.001 in the MIDUS.

2.2.3. Covariates. In the three samples, covariates included age, age squared, sex, education, and disease burden. Race (coded as 1 for white and 0 for other) was also controlled for in the MIDUS. Age squared was included as a covariate because personality development is non-linear (Lucas & Donnellan, 2011; Terracciano, McCrae, Brant, & Costa, 2005). Education was reported in years in the WLSG and WLSS, and on a scale ranging from 1 (*no grade school*) to 12 (*doctoral level degree*) in the MIDUS. Disease burden was included as a covariate because it has been related to changes in the five personality traits (Jokela et al.2014). Specifically, higher disease burden was related to higher neuroticism and lower extraversion, openness, agreeableness and conscientiousness over time (Jokela et al., 2014). Controlling for disease burden allowed a test of whether physical activity predicts personality change independent of one's health status. The sum of diagnosed conditions was computed in the three samples to obtain a measure of disease burden. In the WLSG and WLSS, the following conditions were summed: anemia, asthma, arthritis or rheumatism, bronchitis or emphysema, cancer, chronic liver trouble, diabetes, serious back trouble, heart trouble, high blood pressure, circulation problems, kidney or bladder problems, ulcer, allergies, multiple sclerosis, and colitis. In the WLSS, high cholesterol was also added. In the MIDUS, the following conditions were summed: anemia, bronchitis or emphysema, tuberculosis, lung problems, bone or joint diseases, skin trouble, thyroid disease, hay fever, stomach trouble, urinary or bladder problems, being constipated, gall blader trouble, foot trouble, varicose veins requiring treatment, AIDS or HIV, autoimmune disorders, trouble with gums or mouth, trouble with teeth, high blood pressure, emotional disorders, alcohol or drug problems, migraine headaches, chronic sleep problems, diabetes or high blood sugar, neurological disorders, stroke, ulcer, hernia or rupture, piles or hemorrhoids, and sciatica, lumbago or recurrent backache.

2.3. Data analysis

To test whether baseline physical inactivity was associated with change in personality traits, multiple regression analysis was used to predict each personality trait at follow-up from baseline physical activity, controlling for age, age squared, sex, education, race, disease burden, and baseline personality. Results from the three samples were pooled using a random-effect meta-analysis based on the t-value and sample size. Heterogeneity was quantified using the Q statistic. The meta-analysis was performed using the Comprehensive Meta-Analysis software. Latent change score models were conducted as a complementary method to examine the relation between physical inactivity and personality change using Mplus 8 (Muthén & Muthén, 1998-2017). Five models were tested, modeling each personality trait at baseline and follow-up, and change in personality (i.e. Δ Neuroticism), as latent variables. This approach has several advantages, including the examination of intra-individual change and potential individual differences in within-individual change (e.g., Allen et al., 2017), as well as the minimization of measurement error by fixing latent factor loadings and item intercepts to be invariant over time (Meredith, 1993). We included fixed-unit-value coefficients (i.e. Neuroticism at T2 regressed on Neuroticism at T1 and Δ Neuroticism = 1), so that the latent factor at follow-up is defined by the sum of the latent factor at baseline and its change (i.e. Δ Neuroticism). As proposed by McArdle (2009), and Selig and Preacher (2009), the latent change score was controlled for the intercept or initial level of each trait. The Δ mean captures the mean-level change; that is, whether individuals increased (if the Δ mean is positive) or decreased (if negative) over time. The Δ variance captures inter-individual differences around the mean change. To examine whether physical inactivity was associated with individual differences in within-individual change, we regressed the physical inactivity total score on the initial level and change of each trait. All models controlled for age, age squared, sex, education, disease burden and race (only for MIDUS).

Additional analyses were conducted to test whether age, sex, education, and race moderated the association between physical activity and personality change in each sample. Complementary regression analyses were also conducted with the specific types of physical activity (light, moderate, vigorous) as predictors of personality change. In the WLSG and the WLSS, the two items assessing light and vigorous physical activity were simultaneously included in the analysis. In the MIDUS, the analysis included the two items measuring vigorous and moderate physical activity.

3. Results

Descriptive statistics for the three samples are presented in Table 1. Higher physical inactivity at baseline was related to steeper declines in conscientiousness in the WLSG, the WLSS, and the MIDUS (Table 2). In each sample, physical activity was as strong as demographic factors and disease burden in predicting conscientiousness change. Consistent with past research (Sutin, et al., 2017), among the demographic factors, educational attainment was a strong predictor of personality change. In particular, the associations between education and change in openness are among the largest effects observed (see Table 2).

An association between physical inactivity and decline in openness was found in both the WLSG and the WLSS (Table 2). Physical inactivity was a stronger predictor of openness change than disease burden and most demographic factors in both samples. No other associations were found in the WLSG and the WLSS. In the MIDUS, physical inactivity was also related to a steeper decline in agreeableness (Table 2), and the effect size of this association was stronger than the effect size of most of the demographic factors and disease burden.

Overall, the effects across the three samples were similar. When the results were combined in a meta-analysis, physical inactivity was related to steeper declines in extraversion, openness, agreeableness and conscientiousness (Table 2). No association was found for neuroticism. Latent change analysis confirmed the association between physical inactivity and the decline in conscientiousness in the three samples, and with openness in the WLSG (see Table 3). However, there was less support for the relation with openness in the WLSS and agreeableness in the MIDUS (Table 3). Moderation analysis conducted individually in the three samples showed that none of the demographic factors (age, sex, education, and race) moderated the association between physical inactivity and personality change.

In follow-up analyses, we examined whether the intensity level of physical activity was differentially associated with personality change. In the WLSS, we found that lower vigorous physical activity was related to a steeper decline in conscientiousness (β= -.05, 95%CI : -0.089, -0.011, p<.05), openness (β= -.04, 95%CI : -0.074, -0.005, p<.05), and positively related to neuroticism (β= .04, 95%CI : 0.001, 0.075, p<.05). In the WLSG, lower light physical activity was associated with the decrease in conscientiousness (β = -.03, 95%CI : -0.060, -0.009, p<.05). Both low light (β = -.03, 95%CI : -0.050, -0.004, p<.05) and vigorous physical activity (β = -.03, 95%CI : -0.051, -0.005, p<.05) were related to decline in openness. In the MIDUS, lower moderate physical activity was related to lower extraversion (β= -.04, 95%CI : -0.075, -0.011, p<.01), agreeableness (β= -.08, 95%CI : -0.118, -0.050, p<.001), openness (β= -.06, 95%CI : -0.093, -0.026, p<.001), and conscientiousness (β= -.07, 95%CI : -0.104, -0.033, p<.001). In contrast, lower vigorous physical activity was related to higher openness over time (β= .04, 95%CI : 0.006, 0.077, p<.05).

4. Discussion

The present study revealed that physical inactivity was related to maladaptive personality trajectories over 20 years across three samples of middle-aged and older adults. These findings support the hypothesis that health-related behaviors and physical activity in particular are related to patterns of personality development (Allen et al., 2015, 2017, Stephan et al., 2014). Most important, this study indicates that the association between physical inactivity and personality change is not limited to a short follow-up but extends over two decades.

Physical inactivity was related to a steeper decline in conscientiousness across the three samples and in the meta-analysis. The supplemental analysis revealed that the link between physical inactivity and decline in conscientiousness was observed at three different intensities of activity. Even light physical activity was related to change in conscientiousness. Physical inactivity was also related to a decline in openness in the WLSG and the WLSS and the meta-analysis, and in the MIDUS when moderate physical activity was examined. This result extends past research that reported these associations over 4 to 10 years (Allen et al., 2015, 2017; Stephan et al., 2014). A physically inactive lifestyle has a range of long-term biological, health and cognitive outcomes, such as higher risk of frailty (Salvela et al., 2013), worse mental and physical health (Pereira et al., 2014; Salvela et al., 2010), and declines in memory and executive functions (Chang et al., 2010). Such outcomes, in turn, may have a long-term impact on personality, such as reductions in the tendency to be self-disciplined and organized or to be exploratory and curious. Indeed, cognitive decline, greater frailty, and more depressive symptoms and disease burden have been associated with reduced conscientiousness and openness over time (Hakulinen et al., 2015 ; Mõttus, Johnson, Starr, & Deary, 2012 ; Stephan et al., 2017 ; Sutin et al., 2013; Wettstein et al., 2017).

The meta-analysis also revealed an association between physical inactivity and steeper decline in extraversion and agreeableness. This finding adds to existing studies conducted over four to 10 years (Allen et al., 2015; Stephan et al., 2014). It is possible that the long-term functional limitations and depressive symptoms that result from a physically inactive lifestyle (Chang et al., 2016 ; Salvela et al., 2010, 2013) may be reflected in a lower tendency to experience positive emotions, be enthusiastic, and be agreeable (Hakulinen et al., 2015 ; Mueller et al., 2016). Furthermore, less physical activity may restrict social interactions, leading to lower propensity to be sociable and prosocially oriented. Results from the MIDUS revealed that low moderate physical inactivity in particular was related to steeper declines in extraversion and agreeableness more than vigorous physical inactivity.

Consistent with prior research, there was no consistent association between physical activity and neuroticism (Allen et al., 2015; Stephan et al., 2014). This finding is surprising given that physical activity can help buffer stress and reduce negative emotional states (Pereira et al., 2014), but such effects seem to have limited impact on the long-term trajectories of neuroticism in these population-based cohorts of older adults. There was one exception with the finding that low vigorous physical activity was related to higher neuroticism over time. This result is consistent with evidence that vigorous exercise may have benefits for mental health (Hallgren et al., 2016).

In contrast to past research conducted over shorter time frames (Allen et al., 2017; Stephan et al., 2014), the relations between physical inactivity and personality change were not moderated by demographic factors. Specifically, physical activity was related to higher conscientiousness over a four-year period among individuals with less education (Stephan et al., 2014) and women (Allen et al., 2017). The present study suggests that these short-term demographic differences may dissipate over time. The long-term cumulative implications of physical (in)activity may manifest into conscientiousness changes irrespective of one’s demographic characteristics. For example, the deleterious effects of physical inactivity may cumulate over time up to a point where they may not be compensated by higher education or any other demographic characteristics.

The present study has several strengths including three large samples over a follow-up period of almost twenty years, the replication of some associations across three samples, and a meta-analysis. Further, the three samples had adequate power to detect the associations reported in the previous studies (Allen et al., 2015; Stephan et al., 2014). However, there are also limitations. First, we do not have personality and physical activity measured early in adulthood. The pattern of change observed in this study may reflect a selection effect, in which personality earlier in adulthood may be predictive of the level of physical activity in later adulthood and may drive personality change. For example, individuals low in conscientiousness are less likely to be physically active (Sutin et al., 2016), and may experience steeper decline in conscientiousness over time independently from the level of physical activity. However, our findings for change in personality are consistent with a broader literature, including experimental studies with human and animal models, which support the benefits of physical activity. Likewise, the assessment of the level of physical activity in adulthood may only give a partial picture of the role of a physically (in)active lifestyle for personality change. Indeed, it is possible that there are cumulative effects of physical activity earlier in the lifespan that may influential for patterns of personality change. In addition, third variables are also likely to operate in this association. For example, educational attainment is a predictor of personality development in the present study and is also associated with physical activity (Shaw & Spokane, 2008). A mediational process may operate, with physical activity mediating the association between educational attainment achieved earlier in life and personality development. In addition, both the adoption of a physically active lifestyle and personality development are in part genetically driven (Kandler, Kornadt, Hagemeyer, & Neyer, 2015; Karvinen et al., 2015). Therefore, shared genetic influences could also be a third variable explaining the link between physical activity and personality changes.

Second, the present study was characterized by a positive selection effect that may limit the generalizability of the results. Indeed, the attrition analyses revealed that participants with longitudinal data were healthier, more physically active and have more adaptive personality profiles than those without follow-up data. Third, the present study focused only on baseline level of physical activity and not changes in physical activity. Future research is needed to examine whether long-term changes in physical activity are related to long-term personality development. Fourth, this study used self-reported measures of physical activity. Additional research may examine whether the pattern of personality trajectories observed replicates using objective physical activity measures. A recent study, however, found that the pattern of cross-sectional associations between personality and physical activity are essentially the same when using either self-reports or activity monitors (Artese, Ehley, Sutin, & Terracciano, 2017). Finally, although small in absolute terms, the size of the association between physical activity and personality change over time was larger than the size of the contribution of other health variables implicated in personality development, such as disease burden (Sutin et al., 2013). The effect size should also be placed in the context of the long follow-up period of approximately 20 years.

Despite these limitations, the present study provides some initial evidence that physical inactivity is related to long-term personality change. Combined with recent evidence that personality traits are amenable to change through interventions (Roberts et al., 2017), it suggests that non-pharmacological interventions may be directed toward the promotion of physical activity in middle adulthood to increase physical activity and reduce maladaptive personality changes. It is likely that the benefits of even a small increase in physical activity may accumulate over time, resulting in significant personality change.

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Table 1.

Baseline Characteristics of the Samples

	WLSG		WLSS		MIDUS	
Variables	*M/%*	*SD*	*M/%*	*SD*	*M/%*	*SD*
Age (Years)	53.18	0.61	52.56	6.73	46.53	11.23
Sex (% Women)	55%	-	54%	-	55%	-
Race (% White)	100%	-	100%	-	95%	-
Education	13.88	2.38	14.06	2.55	7.34	2.43
Disease burden	0.99	1.20	2.08	1.99	2.21	2.23
Physical inactivity	2.39	0.83	2.31	0.81	2.17	1.12
Baseline Neuroticism	3.17	0.98	3.20	0.96	2.22	0.66
Baseline Extraversion	3.85	0.89	3.76	0.91	3.20	0.55
Baseline Openness	3.67	0.79	3.63	0.76	3.02	0.51
Baseline Agreeableness	4.76	0.73	4.72	0.73	3.47	0.49
Baseline Conscientiousness	4.88	0.68	4.78	0.70	3.47	0.43
Follow-up Neuroticism	3.03	0.92	3.02	0.92	2.05	0.62
Follow-up Extraversion	3.78	0.88	3.76	0.89	3.08	0.58
Follow-up Openness	3.47	0.76	3.45	0.74	2.89	0.54
Follow-up Agreeableness	4.80	0.70	4.79	0.71	3.43	0.50
Follow-up Conscientiousness	4.76	0.71	4.73	0.72	3.47	0.45

Note. WLSG: N= 4218; WLSS: N=1934; MIDUS: N= 2571

See method section for differences in assessments and coding of each variables in each sample. Given the differences in methodology, mean values in the MIDUS and WLS cohorts are not comparable.

Table 2.
Summary of Analysis Predicting Personality Change from Baseline Physical Inactivity in the Three Samples

	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness
WLSG					
Age	.02[-.005;.042]	-.02*[-.044;-.000]	-.00 [-.028;.017]	-.02[-.045;.006]	-.03*[-.052;-.001]
Age squared	-.02[-042;.005]	.01[-011;.032]	-.02[-.041;.004]	.00[-.025;.026]	-.00[-.030;.021]
Sex	-.03*[-.050;-.003]	-.03**[-.051;-.008]	-.03**[-.055;-.010]	-.12***[-.145;-.093]	-.04**[-.062;-.012]
Education	-.05***[-.078;-.032]	.00[-.018;.025]	.14***[.119;.166]	.01[-.013;.038]	.04***[.018;.068]
Disease burden	.02[-.006;.040]	-.01[-.034;.008]	.01[-.008;.035]	-.01[-.033;.017]	-.04**[-.064;-.015]
Baseline personality trait	.64***[.620;.667]	.71***[.693;.736]	.63***[.609;.656]	.55***[.521;.571]	.58***[.558;.607]
Physical Inactivity	.02[-.004;.042]	-.02[-.043;.000]	-.04***[-.067;-.023]	-.01[-.035;.015]	-.05***[-.074;-.024]
WLSS					
Age	.01[-.027;.042]	-.04**[-.073;-.011]	-.08***[-.111;-.046]	.00[-.034;.040]	-.08***[-.121;-.049]
Age squared	.03[-.002;.066]	-.03*[-.065;-.004]	-.01[-.046;.017]	-.03[-.070;.003]	-.05**[-.089;-.018]
Sex	-.01[-.045;.026]	-.01[-.043;.020]	-.03[-.061;.004]	-.11***[-.150;-.075]	-.05**[-.092;-.019]
Education	.-.04*[-.079;-.008]	.01[-.025;.038]	.16***[.127;.198]	.05*[.010;.085]	.07***[.037;.110]
Disease burden	.01[-.021;.049]	-.04*[-.067;-.005]	.03[-.007;.059]	-.02[-.061;.013]	-.04*[-.074;-.001]
Baseline personality trait	.62***[.590;.661]	.73***[.697;.758]	.61***[.574;.643]	.55***[.517;.591]	.59***[.550;.622]
Physical Inactivity	.03[-.003;.068]	-.01[-.046;.017]	-.06***[-.089;-.024]	-.03[-.070;.004]	-.06**[-.096;-.023]
MIDUS					
Age	-.06***[-.088;-.023]	.02[-.004;.054]	.01[-.017;.043]	.01[-.020;.042]	-.07***[-.106;-.040]
Age squared	.05***[.023;.085]	-.08***[-.111;-.054]	-.07***[-.099;-.039]	-.07***[-.105;-.045]	-.06***[-.092;-.028]
Sex	-.03*[-.066;-.001]	-.04*[-.068;-.009]	-.03[-.056;.005]	-.15***[-.180;-.116]	-.04*[-.073;-.007]
Education	-.06***[-.094;-.030]	.00[-.025;.032]	.07***[.037;.099]	-.01[-.041;.020]	.04**[.011;.075]
Race	.02[-.014;.048]	-.02[-.051;.005]	-.02[-.048;.011]	.01[-.023;.037]	-.02[-.050;.013]
Disease burden	.05**[.022;.089]	-.03[-.058;.000]	-.00[-.034;.027]	-.03[-.059;.002]	-.05**[-.084;-.019]
Baseline personality trait	.56***[.525;.592]	.67***[.646;.703]	.63***[.602;.663]	.58***[.549;.612]	.55***[.523;.587]
Physical Inactivity	-.00[-.033;.032]	-.03[-.059;.000]	-.01[-.041;.022]	-.04*[-.073;-.010]	-.06***[-.093;-.027]
Meta-analysis, random model	.02[-.000;.042]	-.03[-.051;-.009]**	-.05[-.087;-.013]**	-.03[-.055;-.006]*	-.06[-.086;-.044]***
Heterogeneity Q [p-value]	2.05 [.36]	0.33[.84]	5.85[.05]	2.60[.27]	.29[.86]

Note. **p*<.05, ** *p*<.01, *** *p*<.001. Coefficients are standardized regression coefficients. 95% confidence intervals are in brackets

Table 3. Results from Latent Change Models

	Δ N	Δ E	Δ O	Δ A	Δ C
WLSG					
Mean	0.007	0.074	-0.624**	-0.219	-0.835**
Variance	0.802**	0.868**	0.812**	0.788**	0.923**
T1 -> Δ	-0.454**	-0.360**	-0.478**	-0.470**	-0.246**
PA -> Δ	0.023	-0.024	-0.074*	-0.005	-0.069**
SRMR	0.043	0.069	0.094	0.046	0.057
RMSEA	0.063	0.083	0.093	0.065	0.055
CFI	0.902	0.836	0.714	0.816	0.86
WLSS					
Mean	-0.163	0.119	-0.593	-0.376	-0.728**
Variance	0.827**	0.869**	0.790**	0.788**	0.806**
T1 -> Δ	-0.422**	-0.359**	-0.484 **	-0.453**	-0.355**
PA -> Δ	0.041	0.017	-0.059	-0.067	-0.093*
SRMR	0.046	0.074	0.091	0.048	0.044
RMSEA	0.062	0.085	0.088	0.066	0.053
CFI	0.905	0.837	0.746	0.81	0.882
MIDUS					
Mean	-0.096	-0.308	-0.355*	-0.025	0.18
Variance	0.723**	0.896**	0.891**	0.81**	0.871**
T1 -> Δ	-0.544**	-0.285**	-0.307**	-0.431**	-0.277 **
PA -> Δ	-0.012	-0.009	-0.003	-0.036	-0.056*
SRMR	0.035	0.05	0.053	0.031	0.042
RMSEA	0.053	0.071	0.071	0.044	0.052
CFI	0.936	0.884	0.843	0.952	0.894

Note. Standardized coefficients are reported.
* $p < .05$, ** $p < .01$

Highlights

- Physical activity is related to personality change over 20 years in three samples
- Physical inactivity was related to declines in conscientiousness in three samples
- A physically inactive lifestyle is associated with detrimental personality trajectories