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Facets of Conscientiousness and Objective Markers of Health Status

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Abstract

Objective: To examine the association between six facets of Conscientiousness (self-control, order, industriousness, traditionalism, virtue, responsibility) and objective markers of health status, including adiposity, blood markers, and physical performance.

Design: Cross-sectional analysis of participants from the Health and Retirement Study (*N*=12,188).

Main Outcome Measures: Adiposity (body mass index, waist circumference), blood markers (A1c, HDL cholesterol, total cholesterol, cystatin c, c-reactive protein) and physical performance (lung function, grip strength, walking speed).

Results: Four of the six facets of Conscientiousness were associated with nearly all of the health markers: Self-control, organization, industriousness, and responsibility were related to lower adiposity, healthier metabolic, cardiovascular, and inflammatory markers, and better performance on physical assessments. Traditionalism and virtue had fewer associations with these objective markers.

Conclusion: This research took a facet-level approach to the association between Conscientiousness and objective markers of health status. This research builds on models of Conscientiousness and health to suggest that, in addition to health-risk behaviors, facets of Conscientiousness are associated with more favorable biomedical markers of health status.

Keywords

Responsibility; Industriousness; Self-control; Conscientiousness; Biomarkers; Health Status; Facets

Conscientiousness, a personality trait defined as the general tendency to be organized, disciplined, and hard working, has long been implicated in positive health outcomes (Friedman, Kern, Hampson, & Duckworth, 2014; Roberts, Walton, & Bogg, 2005). Individuals who score higher on this trait, for example, are more likely to live longer (Kern & Friedman, 2008), have lower risk of Alzheimer's disease (Terracciano et al., 2014), and

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carry a lower burden of chronic disease (Weston, Hill, & Jackson, 2015). Conscientiousness is thought to promote better health, in part, through behavioral (Turiano, Chapman, Gruenewald, & Mroczek, 2015) and physiological (Friedman et al., 2014; Hampson, Edmonds, Goldberg, Dubanoski, & Hillier, 2013) mechanisms that contribute to these better outcomes.

As operationalized by the five-factor model (FFM), personality traits, including Conscientiousness, are hierarchically organized, with each higher-order trait formed from more specific components, or facets of the broad domain (Goldberg et al., 2006; McCrae & John, 1992; Soto & John, 2016). Facets contribute to the overall trait but also represent unique parts of it (Costa & McCrae, 1992). In fact, the greater specificity at the facet level can have stronger predictive power for consequential outcomes than the broad trait (Paunonen, 1998; Paunonen, Haddock, Forsterling, & Keinonen, 2003). As such, there has been interest in identifying facet-level associations with health-related outcomes and processes to gain a more nuanced understanding of the relation between personality and health. It is also possible that not all conscientiousness facets are related to health, and specific facets might be responsible for the associations observed for the broader Conscientiousness domain.

Although there is recognition that the broad Conscientiousness domain is composed of several specific facets of psychological functioning, there is not yet consensus on the exact facets that make up this domain (Costa & McCrae, 1992; Roberts, Chernyshenko, Strark, & Goldberg, 2005; Watson, Nus, & Wu, 2017). There are, however, some core facets of Conscientiousness that tend to be identified across different conceptualizations. First, Conscientiousness is defined in part by an individual's ability to control their behavior; this facet is sometimes referred to as self-control (Roberts et al., 2005) and sometimes referred to as self-discipline (Costa & McCrae, 1992). Second, the general tendency to be organized and to plan is also recognized across multiple models of Conscientiousness; this tendency is referred to as order (Costa & McCrae, 1992; Roberts et al., 2005). Third, Conscientiousness tends to be defined, in part, by a need to work hard and strive hard to accomplish one's goals; this tendency is sometimes referred to as industriousness (Roberts et al., 2005) and sometimes referred to as achievement striving (Costa & McCrae, 1992). Fourth, there is an interpersonal component to Conscientiousness that encompasses following through on one's commitments and being accountable to others. This tendency is sometimes referred to as responsibility (Roberts et al., 2005) and sometimes referred to as dutifulness (Costa & McCrae, 1992), although the latter also refers to a broader adherence to ethical principles. Other facets of Conscientiousness that are included in some models but not others include beliefs in one's own abilities (competence), thinking through the consequences of one's actions before acting (deliberation) (Costa & McCrae, 1992), and adhering to the social norms of society (traditionalism) and moral behavior (virtue) (Roberts et al., 2005).

The benefit of taking a facet-level approach is that it helps to identify which specific components of this trait are implicated in the relation between Conscientiousness and important outcomes (Paunonen, 1998; Paunonen et al., 2003). Perhaps not surprisingly, the strongest evidence for a specific facet of Conscientiousness is for self-control (Duckworth, 2011; Duckworth & Seligman, 2017; Moffitt et al., 2011). Although self-control is

conceptualized in different ways across models of psychological functioning (sometimes referred to broadly as impulsivity (Sharma, Markon, & Clark, 2014), and often conceptualized as its own trait and/or process and not necessarily part of Conscientiousness (Baumeister, Vohs, & Tice, 2007; Duckworth & Kern, 2011), it is associated consistently with better health outcomes (Duckworth, Tsukayama, & Geier, 2010; Moffitt et al., 2011), in part through better regulation of behavior. Individuals who score high in self-control, for example, are less likely to smoke (Daly, Egan, Quigley, Delaney, & Baumeister, 2016), overeat (Tangney, Baumeister, & Boone, 2004), or engage in risky sexual behaviors (Quinn & Fromme, 2010).

Other facets of Conscientiousness have likewise been implicated in more positive health-related behaviors. Individuals who are achievement oriented, disciplined, deliberate and organized tend to have healthier eating habits, measured either in general (Mõttus et al., 2012) or daily over a specific period of time (O'Connor, Conner, Jones, McMillan, & Ferguson, 2009). And, although all facets of Conscientiousness have been associated with less illicit substance use, the strongest associations tend to be for dutifulness, achievement striving, and competence (Sutin, Evans, & Zonderman, 2013).

In addition to health-related behaviors, individuals who score higher in order, industriousness, and responsibility report having better subjective physical health and fewer chronic conditions (Chopik, 2016). Less research, however, has addressed how the facets of Conscientiousness are associated with objective markers of health status. Initial evidence suggests that specific facets are related to some biological markers. Order, for example, is associated with less chronic inflammation (Sutin, Terracciano, et al., 2010) and both order and responsibility have been associated with less risk of metabolic syndrome, a constellation of cardiometabolic risk factors (Sutin, Costa, et al., 2010). Facets related to self-control/self-discipline have also been linked with healthier physiological profiles (Moffitt et al., 2011) and lower risk of mortality (Weiss & Costa Jr, 2005). Further, the meta-analysis from Kern and Friedman (2008) also provided evidence that achievement/order, and, to a lesser extent responsibility/control, are associated with reduced risk of mortality.

The present research builds on this preliminary evidence base by examining the association between the facets and a broad battery of objective health markers in a large US sample of older adults. Specifically, we test for associations with two markers of adiposity (body mass index [BMI], waist circumference), biomarkers of metabolic (hemoglobin A1c), cardiovascular (HDL and total cholesterol), liver (cystatin C), and inflammatory (c-reactive protein) health, and performance measures of fitness (lung function, grip strength, walking speed). By testing multiple facets and biomarkers in a single sample and a consistent analytic approach it is possible to examine patterns of associations that are otherwise difficult to discern by comparing findings across articles. Given the initial research on the facets of Conscientiousness and subjective and objective markers of health (Chopik, 2016; Sutin, Costa, et al., 2010) as well as findings on related constructs, we expect that among the Conscientiousness facets, self-control, order, and dutifulness will have the strongest and most consistent associations with the objective health markers and performance measures. We further consider whether these associations are independent of domain-level Conscientiousness. Due to age and sex differences in both the facets and the markers of

health, we also address whether the associations between the facets and the objective health markers are moderated by age and sex.

Method

Participants and Procedure

Participants were drawn from the Health and Retirement Study (HRS). HRS is a nationally representative longitudinal study of Americans ages 50 and older and their spouses (Health and Retirement Study, 2012). HRS data are available from here: http://hrsonline.isr.umich.edu. In 2006, HRS implemented an enhanced face-to-face interview that included an assessment of biological makers, physical measurements, and a leave-behind questionnaire to assess psychological functioning. A random half of the HRS sample first completed this enhanced interview in 2006; the other half completed it in 2008. Since then, participants have completed the enhanced measures every four years. The facet measure of Conscientiousness was included in the Leave-Behind Questionnaire. The Leave-Behind Questionnaire is left with the participant after completion of the main assessment. Participants completed the questionnaire and returned it by mail to the University of Michigan. It included a comprehensive assessment of the participant's psychosocial functioning with measures of constructs that can be grouped broadly (as defined by HRS) into the categories of well-being, personality, self-related beliefs, lifestyle, work, and social relationships (Smith, Ryan, Fisher, Sonnega, & Weir, 2017). The facet measure was first included in HRS in 2008; the other half of the sample first received it in 2010; these two subsamples were combined as the analytic sample. The response rate was 83.7% in 2008 and 73.1% in 2010. There were 194 participants who did not have complete information on the facets. Compared to participants with complete information on the six facets (n=15,007), participants without full data were older (F(1,15199)=64.80), had fewer years of education (F(1,15199)=77.86), and more likely to be African American (χ^2=16.03) or Hispanic (χ^2=27.17; all ps<.01); there were no differences in sex (χ^2=.88). Of the participants with facet data, a total of 10,082 participants (60% female) had complete data on the blood markers. Compared to these participants, participants who did not have complete biomarker data (n=4,925) were older (F(1,15005)=6.12), had fewer years of education (F(1,15005)=12.51), and were more likely to be African American (χ^2=25.46; all ps<.01); there were no differences in sex (χ^2=2.92) or Hispanic ethnicity (χ^2=.69). Of participants with full facet data, a total of 12,188 participants (59% female) had complete data on the adiposity and performance measurements. Compared to these participants, participants who did not have complete adiposity and performance data (n=2,819) were older (F(1,15005)=26.79), had fewer years of education (F(1,15005)=53.01), and were more likely to be African American (χ^2= 13.92; all ps<.01); there were no differences in sex (χ^2=3.80) or Hispanic ethnicity (χ^2=3.74).

Measures

Facets of Conscientiousness.—The facets of Conscientiousness were measured with a 24-item measure (Roberts et al., 2005) that was included in the Leave-Behind Questionnaire. Each of six facets was measured with four items: self-control (e.g., "I am easily talked into doing silly things." [reverse scored]; alpha=.52), order (e.g., "I hardly ever lose or misplace

things."; alpha=.46), industriousness (e.g., "I have high standards and work toward them."; alpha=.63), traditionalism (e.g., "I support long-established rules and traditions."; alpha=.44), virtue (e.g., "If the cashier forgot to charge me for an item, I would tell him/her."; alpha=.50), and responsibility (e.g., "I carry out my obligations to the best of my ability."; alpha=.54). Participants rated each item on a scale from 1 (*strongly agree*) to 6 (*strongly disagree*). Facets were scored in the direction of higher Conscientiousness. Correlations among the facets ranged from .18 (between order and virtue) to .40 (between industriousness and responsibility and between virtue and responsibility; Supplemental Table 1). The alpha reliabilities were relatively low because the items tapped the breadth of each facet with few items (i.e., content coverage was maximized over redundant items). Further, previous research has shown that test-retest reliability is a better indicator of validity than internal consistency (McCrae, Kurtz, Yamagata, & Terracciano, 2011). The test-retest reliability is high for these facets: r=.85 for self-control, r=.90 for order, r=.86 for industriousness and traditionalism, r=.80 for virtue, and r=.81 for responsibility (Green, O'Connor, Gartland, & Roberts, 2016).

Domain-level Conscientiousness.—Participants completed the Midlife Development Inventory (MIDI; Lachman & Weaver, 1997), a measure of domain-level personality, that was included in the Leave-Behind Questionnaire. Conscientiousness was measured with four items (e.g., organized; alpha=.66) on a scale from 1 (*a lot*) to 6 (*not at all*). Items were scored in the direction of higher Conscientiousness.

Adiposity.—Height was measured without shoes and recorded to the nearest quarter inch. Weight was measured without shoes and with light clothing using a Healthometer 830 kiloliter scale and recorded to the nearest half pound. BMI (kg/m^2) was considered both as a continuous variable and as standard categories[1]: normal weight (BMI between 18.50 and 24.99), overweight (BMI between 25 and 29.99), and obese (BMI ≥30). Waist circumference was assessed with a tape measure around the waist at the level of participants' navel.

Biomarkers.—Participants provided a blood spot sample to be assayed for biomarkers. To obtain the sample, the participant's finger was cleansed with an alcohol swab, pricked with a sterile lancet, and the blood droplets were placed on specially treated filter paper. Blood samples were assayed for hemoglobin A1c, HDL cholesterol, total cholesterol, cystatin C (cysC), and c-reactive protein (CRP). Due to the skewed distribution of CRP, we took the natural log to normalize the distribution; all other markers were normally distributed. Detailed information about biomarkers in HRS can be found in Crimmins and colleagues (2013).

Performance.—Participants completed performance measures of lung function, grip strength, and walking speed. To measure peak expiratory flow (PEF), a measure of lung function, participants were asked to stand up, take a deep breath, blow as hard and fast as possible into a peak flow meter, and then given a 30 second rest. This procedure was repeated three times. Lung function was considered the best of the three measurements. Grip

[1]Underweight participants were excluded from the analysis of BMI categories because of the low prevalence (n=94; 0.8%). These participants were included in the analysis of BMI as a continuous measure.

strength was measured with a hand dynamometer. Participants stood with their arm at their side at a 90 degree angle and told to squeeze the meter as hard as they could for a couple of seconds and then let go. After a couple of practice attempts, four measurements were taken, two on each hand, starting with the non-dominant hand and alternating between the two hands. Grip strength was considered the best of the four measurements. Walking speed was measured as the time it took to walk 98.5 inches (250.19 cm). Participants were instructed to walk at their normal pace to just past the end of the course. The time it took for participants to walk the course to the end and then back to the beginning was recorded. Walking speed was considered the faster of the two attempts. Walking speed was only measured on participants aged 65 and older (n=6,562). Detailed information about the performance measures in HRS can be found in Crimmins and colleagues (2008).

Additional covariates.—Participants reported on their smoking history up through the baseline facet assessment; ever smoker (0) was contrasted against never smokers (1). Concurrent with the baseline facet assessment, participants were asked about their frequency of engaging in moderate physical activity. Response options ranged from (1) more than once a week to (4) never and were reverse scored to indicate greater frequency of moderate physical activity.

Analytic Strategy

We examined the association between the facets of Conscientiousness and the objective health markers in several ways. First, to examine the association with the continuous outcomes (waist circumference, BMI, A1c, HDL cholesterol, total cholesterol, CysC, CRP, PEF, grip strength, and walking speed), we used linear regression to predict the outcomes from each facet, entered separately, controlling for age, sex, race, ethnicity, and education (height was included as an additional covariate for analysis of lung function). For the BMI categories, we used multivariate analysis of covariance (MANCOVA) to test for mean-level differences in the facets across the three BMI categories (overweight and obese compared to normal weight). Second, we reran the regressions for the blood markers and performance measures controlling for BMI, smoking, and moderate physical activity as additional covariates to test whether the associations were independent of these shared risk factors. Third, we again reran the regressions controlling for domain-level Conscientiousness to test whether the associations between the facets and the outcomes were independent of the higher-order trait. Finally, we examined whether any of the associations were moderated by age or sex by testing for an interaction between each facet and age and sex on the outcomes. Due to the large sample and number of tests, significance was set to p<.01.

Results

Descriptive statistics for all study variables are shown in Table 1.

Adiposity.—Table 2 shows the associations between the six facets and the measures of adiposity. Self-control, order, industriousness, and responsibility were associated with both a lower waist circumference and lower BMI; traditionalism and virtue were associated with a lower waist circumference but were unrelated to BMI. In addition, participants with obesity scored lower in self-control (d=.10; 95% Confidence Interval [CI]=.05-.14), order (d=.23;

95% CI=18–28), industriousness (*d*=.07; 95% CI=.02-.12), and responsibility (*d*=.06; 95% CI=.01-.10) than participants with normal weight (all *p*s<.01); likewise, participants with obesity scored lower in domain-level Conscientiousness (*d*=.10, 95% CI=.05-.15). Participants with overweight did not differ from the normal weight on the facets except that they scored lower on order. Most of these associations remained significant when controlling for domain-level Conscientiousness (Table 2). There was evidence for age differences in some of the associations: The association between industriousness and both BMI and waist circumference (both $\beta_{interaction}$=.03, *p*s<.01) and between order and waist circumference ($\beta_{interaction}$=.02, *p*<.01) was stronger among relatively younger than older participants, whereas the opposite was true for traditionalism and BMI ($\beta_{interaction}$=−.03, *p*<.01). Likewise, the associations tended to be stronger for women than men for self-control and waist circumference ($\beta_{interaction}$=−.04, *p*<.01), order and BMI ($\beta_{interaction}$=−.07, *p*<.01) and waist circumference ($\beta_{interaction}$=−.06, *p*<.01), industriousness and BMI and waist circumference (both $\beta_{interaction}$=−.05, *p*<.01), virtue and BMI and waist circumference (both $\beta_{interaction}$=−.05, *p*<.01), and responsibility and BMI ($\beta_{interaction}$=−.07, *p*<.01) and waist circumference ($\beta_{interaction}$=−.09, *p*<.01). See Supplemental Figure 1 for example plots of the interactions.

Blood markers.—Table 3 shows the associations between the facets and the five blood markers. Participants who scored higher in self-control, order, industriousness, or responsibility had generally healthier physiological profiles: they had lower A1c, higher HDL cholesterol, lower cystatin C, and lower CRP (except for responsibility). Responsibility was also associated with higher total cholesterol, which may be due, in part, to the inclusion of HDL cholesterol in the total cholesterol measurement. With the exception of the association between self-control and CRP, all of the associations remained significant with the inclusion of BMI, smoking, and physical activity as covariates. Further, the associations between self-control, order, and responsibility and A1c, the associations between industriousness and responsibility and cystatin C, and the association between industriousness and CRP remained significant when controlling for domain-level Conscientiousness (Table 3). Age moderated the associations such that the association between industriousness and A1c ($\beta_{interaction}$=.03, *p*<.01) and the association between order and CRP ($\beta_{interaction}$=.03, *p*<.01) was stronger among relatively younger than older participants. In addition, both virtue and responsibility were associated with healthier levels of HDL cholesterol for women but not men (both $\beta_{interaction}$=.05, *p*s<.01).

Performance measures.—Table 4 shows the associations between the facets and the three performance measures. All of the facets were associated with both lung function and walking speed: Participants who scored higher on self-control, order, industriousness, traditionalism, virtue, and responsibility had greater lung capacity and walked faster than participants who scored lower on these facets. Four of the six facets (self-control, order, industriousness, and responsibility) were also associated with greater grip strength. Further, the associations between industriousness and responsibility and these three outcomes remained significant after controlling for domain-level Conscientiousness (Table 4). Traditionalism was associated with worse grip strength among relatively older than younger participants ($\beta_{interaction}$=.02, *p*<.01), and although associated with better performance for

both sexes, industriousness was associated with better performance for men on grip strength ($\beta_{interaction}$=−.05, p<.01) and lung function ($\beta_{interaction}$=−.06, p<.01), responsibility was associated with better performance for men on grip strength and lung function (both $\beta_{interaction}$=−.05, p<.01), and virtue was associated with better performance for men on lung function ($\beta_{interaction}$=−.03, p<.01).

Discussion

The present study examined the association between six facets of Conscientiousness and objective markers of health status, including adiposity, common blood markers, and performance measures of fitness. We found a consistent pattern of results: Individuals who scored higher on industriousness, order, responsibility, and self-control were thinner, less inflamed, had healthier levels of glucose and cholesterol, had better kidney function, walked faster, and had stronger lung function and grip strength. Traditionalism and virtue, which are less central to Conscientiousness than industriousness, order, and self-control (Roberts et al., 2005), were mostly unrelated to these markers of health. The associations between the facets and the blood markers and performance measures were mostly independent of BMI, smoking, and physical activity.

We had hypothesized that self-control, order, and responsibility would be the facets of Conscientiousness most relevant for the objective outcomes. While this hypothesis was supported, the strongest associations emerged for industriousness, particularly on the performance-based measures. Those who score high on this facet describe themselves as hard-working, ambitious, and confident (Roberts et al., 2005). The strength and consistency of the associations were somewhat surprising because previous research has found this facet not to be highly correlated with health-risk behaviors (Artese, Ehley, Sutin, & Terracciano, 2017; Green et al., 2016), although there is some evidence that it is associated with healthier eating behavior (Mõttus et al., 2012; O'Connor et al., 2009), exercise (Hoyt, Rhodes, Hausenblas, & Giacobbi Jr, 2009), walking faster (Terracciano et al., 2013), and reduced risk of premature mortality (Kern & Friedman, 2008). Of note, industriousness was more strongly associated with the performance measures than with the blood markers. Individuals high on this trait strive for excellence and may want to achieve in any situation, including performance-related situations. To that end, it is of note that all of the performance measures required multiple trials and participants knew how well they performed on each trial. Industrious participants may have striven to beat their performance on each subsequent attempt.

Order is defined as the ability to plan and organize one's tasks and activities (Costa & McCrae, 1992; Roberts et al., 2005). Of the facets of Conscientiousness, order emerges consistently as the strongest correlate of adiposity: Individuals who are organized have lower BMI, waist circumference, and gain less weight over time than individuals who are more disorganized (Sutin, Ferrucci, Zonderman, & Terracciano, 2011; Terracciano et al., 2009). These individuals tend to eat healthier (Mõttus et al., 2012) and have more regular meal rhythms (Sutin & Terracciano, 2016) that help maintain a healthier body weight, although they do not necessary exercise more (Hoyt et al., 2009). This healthier body weight, however, did not account for the association between order and the biomarkers and

performance measures of health status; order remained a significant correlate even after controlling for BMI. The overall healthier lifestyle (e.g., diet) of organized individuals may contribute to better blood markers and performance.

Previous research on self-control has shown consistently that individuals who score high on this facet have lower BMI (Koike, Hardy, & Richards, 2016), gain less weight over time (Schlam, Wilson, Shoda, Mischel, & Ayduk, 2013), especially across major developmental transitions (Duckworth et al., 2010). The present findings indicate that the negative relation between self-control and adiposity continues across adulthood. It also indicates that the healthier biomarker profiles and better physical functioning associated with this trait (Moffitt et al., 2011) also continue across middle and older adulthood and are mostly independent of the individual's body weight and supports previous research on the importance of this facet (Duckworth & Seligman, 2017).

Of the six facets of Conscientiousness, responsibility is the only facet that has a clear, explicit interpersonal component. Responsibility is defined as those who "like to be of service to others, frequently contribute their time and money to community projects, and tend to be cooperative and dependable" (p. 122; Roberts et al., 2005). The content of this facet is not as clearly linked to health outcomes as some of the other facets. And yet, it has previously emerged as a correlate of less substance use (Green et al., 2016), a healthier diet (Mõttus et al., 2012), and greater use of preventative health behaviors (Roberts et al., 2005). Ultimately, these healthier behaviors pay off in the form of fewer chronic diseases (Chopik, 2016) and less risk of dementia (Sutin, Stephan, & Terracciano, in press) in older adulthood. Individuals who score high on this facet may have stronger social relationships and support from others that help to bolster their physical health. Being responsible to others may also lead to more social and cognitive engagement that keep the individual active and healthier longer into old age.

Finally, of the six facets, the fewest associations emerged for traditionalism and value. These two facets are debated as to whether they belong within the domains of Conscientiousness or Openness (Costa & McCrae, 1992; Roberts et al., 2005). Traditionalism refers to the tendency to comply with the rules and norms of society and virtue refers to the tendency to act in a moral way and to set a good example for others (Roberts et al., 2005). Both facets have been associated with less substance use (Green et al., 2016) and greater consumption of fruits and vegetables (Wilson, O'Connor, Lawton, Hill, & Roberts, 2015). These behaviors, however, apparently do not transfer to healthier biomedical profiles.

Age and sex moderated some of the associations between the facets and the objective health markers. Most of the age interactions were found for adiposity and indicated that the Conscientiousness facets were protective among relatively younger participants but that the protective effect lessened at older ages. This pattern could be due to selective mortality, weight loss due to diseases in less conscientious individuals, and the relatively less detrimental effects of overweight on health among older individuals (Losonczy et al., 1995). Sex likewise had few significant interactions, with the exception of adiposity. Although protective for both sexes, the facets had stronger negative associations with BMI and waist circumference for women than for men. This pattern fits with previous research on domain-

level Conscientiousness that has found this trait to be protective for both sexes but with stronger negative associations for women (Sutin & Terracciano, 2016).

The present research contributes to further development of models of personality and health. These models hypothesize that Conscientiousness contributes to better health outcomes through both behavioral and physiological pathways (Friedman et al., 2014; Hampson, 2012; Hampson et al., 2013). There is a great deal of evidence that individuals who score high in Conscientiousness tend to make healthier behavioral choices (Bogg & Roberts, 2004) and that these behaviors are one mechanism toward better health (Turiano et al., 2015). There is also growing evidence that biological factors are an additional pathway in this process (Hampson et al., 2013; Luchetti, Barkley, Stephan, Terracciano, & Sutin, 2014). The present research extends this support to objective measures of both physiological markers and physical performance and further suggests that different components of Conscientiousness are differentially associated with these markers. That is, not every facet of Conscientiousness is associated with health. Identifying the differential associations between the facets of markers of health will facilitate work into the processes and mechanisms responsible for why Conscientious individuals stay healthier longer into older adulthood. For example, self-discipline/self-control have been associated with lower risk of mortality (Weiss & Costa , 2005) and dementia (Sutin et al., in press), associations that cannot be explained completely by standard behavioral and clinical risk factors. The present work suggests that an additional pathway may be through physiological and performance markers of health. Future research is needed to test whether these markers mediate the relation between the facets and health outcomes, such as mortality.

The present study had several strengths, including a large sample of older adults, a detailed measure of the facets of Conscientiousness, and biological and performance markers of physical health. This study also has limitations that could be addressed in future research. The data, for example, were cross-sectional. Such data are important for establishing relations between the facets and objective markers of health, but it would be worthwhile to examine the longitudinal associations in future research to determine whether the facets predict long-term change in these markers over time and, likewise, whether the markers are associated with change in the facets. In addition, the present study did not consider all of the factors that could account for the associations between the facets and healthier markers. In addition to BMI, smoking, and physical activity, health-risk/protective behaviors (e.g., diet and medication adherence) may account for the associations. There are also less obvious factors, such as social engagement, social integration, and stress reactivity that may also account for the relation between the facets and the health markers. Individuals high on self-discipline and order experience of fewer daily hassles (O'Connor et al., 2009), for example, which could contribute to the associations with health. Finally, this research was hypothesis-driven based on a strong foundation in the literature on Conscientiousness and health. As such, a Bonferroni correction would be overly conservative (Perneger, 1998). Still, it should also be noted that we set a relatively stringent level for significance but did not correct for multiple testing.

Since Conscientiousness was first recognized as a consistent predictor of longevity (Friedman et al., 1993), there has been great interest in understanding why more organized

and disciplined individuals live longer. One pathway is certainly through engagement in health protective behaviors, such as physical activity, and avoidance of health-risk behaviors, such as smoking (Turiano et al., 2015). This research provides a deep dive into the relations between six specific facets of Conscientiousness and many biomarkers and performance measures that are common markers of health status. The results suggest that several facets, not just one, drive the relation between Conscientiousness and these markers. It also suggests that there is a robust association between Conscientiousness and physiological and performance markers of health because several facets are implicated in these outcomes. The present research builds on evidence for the association between Conscientiousness and physiological pathways (Hampson et al., 2013) and suggests that specific facets of Conscientiousness are associated with objective markers of health status.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1:

Descriptive Statistics For All Study Variables

Variable	Biomarker	Performance
Age (years)	67.75 (10.42; 26−100)	67.37 (10.87; 26−100)
Sex (female)	60%	59%
Race (African American)	14%	14%
Race (other)	4%	4%
Ethnicity (Hispanic)	10%	10%
Education (years)	12.81 (3.01; 0−17)	12.83 (2.99; 0−17)
Facets		
Self-control	4.69 (.93; 1−6)	4.70 (.93; 1−6)
Order	4.29 (.96; 1−6)	4.31 (.96; 1−6)
Industriousness	4.69 (1.00; 1−6)	4.70 (1.00; 1−6)
Traditionalism	4.31 (.94; 1−6)	4.30 (.94; 1−6)
Virtue	4.97 (.97; 1−6)	4.97 (.96; 1−6)
Responsibility	5.18 (.84; 1−6)	5.18 (.83; 1−6)
Conscientiousness	3.37 (.49; 1−4)	3.37 (.48; 1−4)
Adiposity		
Body mass index	29.65 (6.12; 10.01−76.49)	29.41 (5.96; 10.01−76.49)
Waist Circumference	39.76 (5.70; 23.25−74.25)	39.90 (5.99; 22.00−81.00)
Biomarkers		
A1c	5.86 (.95; 4.08−17.26)	--
HDL cholesterol	54.54 (16.06; 12.11−130.04)	--
Total cholesterol	198.16 (43.05; 89.04−414.59)	--
Cystatin C	1.10 (.51; .05−10.15)	--
C-reactive protein (raw)	3.88 (7.25; .02−185.36)	--
Performance measures		
Lung function	--	368.59 (1.33; 20−900)
Grip strength	--	31.48 (11.33; .80−350.00)
Walking speed	--	3.55 (1.98; .02−35.54)
Smoking (ever)	52%	52%
Physical Activity	3.03 (1.18; 1−4)	3.04 (1.18; 1−4)

Note. N=10,082 for the biomarker subsample and N=12,188 for the performance subsample. n=6,562 for walking speed only. Numbers are either percentages or means (standard deviations; range).

Table 2:

Association between the Facets of Conscientiousness and Measures of Adiposity

Facet	Waist Circumference	BMI	BMI Category		
			Normal	Overweight	Obese
Self-control	−.06 *a	−.05 *a	4.74 (.02)	4.73 (.01)	4.65 (.01) *
Order	−.11 *a	−.10 *a	4.43 (.02)	4.36 (.02) *a	4.21 (.01) *a
Industriousness	−.09 *a	−.06 *a	4.72 (.02)	4.74 (.02)	4.65 (.01) *
Traditionalism	−.03 *	−.01	4.31 (.02)	4.32 (.01)	4.30 (.01)
Virtue	−.04 *	−.02	5.00 (.02)	4.99 (.01)	4.95 (.01)
Responsibility	−.06 *a	−.04 *	5.19 (.02)	5.22 (.01)	5.14 (.01) *
Conscientiousness	−.09 *	−.06 *	3.39 (.01)	3.39 (.01)	3.34 (.01) *

Note. *N*=12,188. Coefficients are standardized beta coefficients from linear regression or estimated marginal means (standard errors) from MANCOVA, controlling for age, sex, race, ethnicity, and education. For the MANCOVA, the reference group is normal weight.

[a]Remains significant controlling for domain-level Conscientiousness.

*p<.01.

Table 3:

Association Between the Facets of Conscientiousness and Blood Markers

Facet	Biomarker				
	A1c	HDL	TotC	CysC	CRP (ln)
Self-control	−.03 *b	.03 *	.01	−.03 *	−.03 *
Order	−.05 *a,b	.03 *	.01	−.05 *a,	−.05 *
Industriousness	−.03 *	.04 *	.01	−.08 *a,,b	−.05 *b
Traditionalism	−.01	.01	−.01	−.01	−.02
Virtue	−.03 *	.00	.00	−.01	−.01
Responsibility	−.04 *a,,b	.03 *	.03 *a,	−.05 *a,,b	−.02
Conscientiousness	−.04 *a,	.06 *a,	.04 *	−.06 *a,	−.04 *

Note. *N*=10,082. Coefficients are standardized beta coefficients from linear regression, controlling for age, sex, race, ethnicity, and education. The HDL and TotC regressions also controlled for cholesterol-lowering medication. A1C=hemoglobin A1C. HDL=High-density lipoprotein. TotC=total cholesterol. CysC=cystatin C. CRP (ln)=c-reactive protein log transformed to normalize the distribution.

[a] Remains significant controlling for body mass index, smoking, and physical activity.

[b] Remains significant controlling for domain-level Conscientiousness.

* $p<.01$.

Table 4:

Associations Between the Facets of Conscientiousness and Performance Measures of Physical Functioning

Facet	Performance Measures		
	PEF	Grip	Walking speed[c]
Self-control	.04 *[a]	.03 *[a]	−.03 *[a]
Order	.02 *[a]	.03 *[a]	−.04 *[a]
Industriousness	.09 *[a,b]	.07 *[a,b]	−.10 *[a,b]
Traditionalism	.03 *[a]	−.01	−.04 *[a]
Virtue	.03 *[a,b]	.01	−.04 *[a]
Responsibility	.08 *[a,b]	.06 *[a,b]	−.08 *[a,b]
Conscientiousness	.06 *[a]	.05 *[a]	−.10 *[a]

Note. *N*=12,188. Coefficients are standardized beta coefficients from linear regression, controlling for age, sex, race, ethnicity, and education. PEF=Peak Expiratory Flow. Grip=grip strength.

[a]Remains significant controlling for body mass index, smoking, and physical activity.

[b]Remains significant when controlling for domain-level Conscientiousness.

[c]*n*=6,562 because only participants 65 and older were asked to complete this task.

*p<.01.