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Personality traits' correlations with multiple indicators of obesity

Student work

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Comparison of indicators for obesity & personality

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Personality traits' correlations with multiple indicators of obesity**Abstract**

We investigated how personality traits and personality profiles are associated with different anthropometric indicators for obesity. Previous studies have mainly used Body Mass Index (BMI) to assess obesity, but associations with other indicators may be different. We correlated five indicators with the domains and 29 items of the Big Five Inventory from 3340 participants from the Wisconsin Longitudinal Study. BMI, Waist Circumference (WC) and Waist-to-Height-Ratio (WHtR) had the strongest relations with personality traits. The personality profiles of WC, WHtR and Relative Fat Mass were the most alike. However, personality traits explained the highest proportions of variance in WC and WHtR. Altogether, WC appears to be the simplest and most suitable indicator to use in research in body weight and personality.

Keywords: personality, anthropometric indicators, BMI, obesity, body weight

Isiksuse seos erinevate ülekaalulisuse indikaatoritega

Kokkuvõte

Uurisime, kuidas isiksuse omadused ja isiksuse profiilid on seotud erinevate antropomeetriliste ülekaalulisuse indikaatoritega. Eelnevad uuringud on peamiselt kehamassiindeksit (KMI) ülekaalulisuse hindamiseks kasutanud, aga seosed teiste indikaatoritega võivad olla teistsugused. Korreleerisime viis indikaatorit domeenide ja 29 küsimusega Suurest Viisikust 3340lt osalejalt Wisconsin longituuduuringust. KMII, puusaümberrõõdul (WC) ja puusa-pikkuse-suhtel (WHtR) olid kõige tugevamad seosed isiksusega. WC, WHtR ja suhtelise rahvamassi (RFM) isiksuse profiilid olid kõige sarnasemad. Siiski selgitasid isiksuse omadused WCs ja WHtRs suurimat dispersiooni. Kokkuvõtvalt näib olevat WC lihtsaim ja sobivaim indikaator kehakaalu ja isiksuse uurimisel.

Märksõnad: isiksus, antropomeetiline indikaator, KMI, ülekaalulisus, kehakaal

Introduction

In 2008 35% of adults were overweight and 11% were obese; it is the 5th leading risk of global deaths (World Health Organization, 2008). Obesity leads to diseases like type 2 diabetes, cardiovascular disease, several cancers and it also shortens life expectancy (Haslam & James, 2005). Not only new food possibilities in quality, quantity and availability influence the recent increase in obesity but also other aspects affect the weight control. Since personality traits sum up solid patterns in how people think, act, feel, and behave (Ozer & Benet-Martínez, 2006) they may help to understand how people with obesity differ from people with normal weight. Since the objective measurement of obesity is difficult, researchers often use simpler body weight measures like body mass index (BMI), Waist circumference (WC) and Waist-to-Hip Ratio (WHR) which are inevitably less accurate. However, studies aiming to describe the associations between personality traits and obesity have relied almost exclusively on BMI as an indicator of obesity or body weight. Therefore, the aim of the current student work is to compare how personality traits and personality profiles are associated with different easily calculated anthropometric indicators for obesity.

Relation of Obesity and Personality

In this student work we focus on the Five Factor Model (FFM) of personality. According to this model characteristic ways that people think, feel and behave are operationalized along five domains: Conscientiousness, Neuroticism, Extraversion, Openness and Agreeableness (McCrae & Costa, 2005). From those five traits, Conscientiousness is the most consistently associated with BMI and obesity. Individuals who are more conscientious tend to have a lower BMI and lower adiposity. Especially the self-discipline and order facets of Conscientiousness are strongly related with weight (Terracciano et al., 2009). On the other hand Sutin and Terracciano (2017) also mention that there might be cultural differences in these associations since Conscientiousness has a weaker relation with BMI in Asia and Neuroticism has weaker associations in America.

Thus, the relation of Neuroticism and body weight is not very clear. On the one hand there are some studies that show the association of Neuroticism with a higher BMI and higher risk of obesity (Armon et al., 2013; Sutin et al., 2011), on the other hand not all studies can confirm these findings (Chapman et al., 2009; Möttus et al., 2013). The differences might be explained by sex since the relation tends to be stronger among women than among men (Sutin & Terracciano, 2016) and constructs conceptually associated to Neuroticism like depressive

symptoms (Sutin & Zonderman, 2012). Further Neuroticism also increases risk for eating disorders (Ferguson et al., 2012) which means that individuals with either underweight or obesity may be higher in Neuroticism which leads to a nonlinear relation between Neuroticism and BMI. Nonetheless, most population-based studies propose a positive relation of Neuroticism with obesity.

As well as about Neuroticism it is difficult to make any clear conclusions about Extraversion. There is some evidence in population-based studies that a greater tendency to Extraversion is associated with higher BMI and risk of obesity (Kakizaki et al., 2008; Magee & Heaven, 2011; Sutin et al., 2011) while some research has found no association (Chapman et al., 2009; Terracciano et al., 2009). Several factors may contribute to this complexity. There are gender differences and cultural differences (Jokela et al., 2013) as well as differences in the facets of domain-level Extraversion (Vainik et al., 2019).

Agreeableness and Openness has not been in too much focus, but the research so far gave different conclusions. Jokela et al (2013) found no significant association with Openness and obesity. This result was confirmed in two other population-based studies (Magee & Heaven, 2011; Sutin et al., 2011). Other research shows a relation only in women (Armon et al., 2013) or in men (Brummett et al., 2006). The correlation between Agreeableness and obesity is similarly unclear. Armon et al (2013) and Sutin et al (2011) observed a negative correlation, thus McCann (2011) saw a positive relation between Agreeableness and obesity.

To sum up, Conscientiousness seems to have a negative and Neuroticism a positive relation with obesity while it is less clear for Extraversion, Agreeableness and Openness.

Anthropometric Indicators for Measuring Obesity

Most of the previous research on personality and obesity have focused only on one body weight measure, especially BMI. However, growing evidence suggests that BMI might not be the best measure of the effects of obesity on health outcomes since it is a measure of excess weight rather than excess body fatness. It is simple to calculate using height and weight but it cannot directly address the aspects of body composition like visceral fat or fat distribution (Ashwell et al., 2012; Böhm & Heitmann, 2013; Britton et al., 2013). Therefore, BMI might not be the ideal measure to indicate the association of personality traits and obesity. Thus, we look at other indicators of obesity as well that can be similarly calculated using body measurements like height, weight, and waist circumference.

WC is related the strongest with health risk indicators like metabolic syndrome (Shen et al., 2006). It is an easy and practical indicator to assess visceral fat (Lemieux et al., 1996) which relates well with the objectively measure Body Fat Percentage (Heo et al., 2013). However, there is currently no common measurement protocol (Ross et al., 2008): some consider the waist level to be at the approximate midpoint between lower margin of the last palpable rib and the top of the iliac crest; some consider it to be at the top of the iliac crest or at the level of the navel.

Another indicator of visceral fat is the WHR (Piqueras et al., 2021). Apparently it describes fat distribution better than WC (Armon et al., 2013) and was found to be related with cardiovascular disease, increased risk of death and type 2 diabetes (Dalton et al., 2003; Motamed et al., 2015; Ross et al., 2020). On the other hand ratios like WHR might lose some information and might not be the most suitable to evaluate visceral fat (van der Kooy et al., 1993).

One measure of body fat distribution is the Waist-to-Height-Ratio (WHtR) which is also called Index of Central Obesity. This measure corrects the WC according to the individual's height and it is suggested that the main advantage of WHtR is its universal cut-offs for obesity (Browning et al., 2010). According to Browning et al. (2010) and Ashwell et al., (2012) WHtR is an even better predictor of metabolic risk than BMI and WC. However, since it has not been included in a lot of studies, its use is still controversial.

A relatively new indicator was developed by Woolcott & Bergman (2018): relative fat mass (RFM). It is based on the WHtR and found as an alternative indicator to predict whole-body fat percentage. According to Woolcott & Bergman (2018) it has better accuracy than BMI and decreases total obesity misclassification among women and men. Fedewa et al. (2020) confirm these finding that it can be a simple measurement to estimate obesity for large-scale epidemiological studies. However, since it is relatively new there is some more validation needed to see if it is suitable for clinical use to predict disease risk and track changes in body composition over time (Fedewa et al., 2020). Further it has not been confirmed for other ethnicities than Mexican-American, European-American, and African-American and athletes or individuals with specific diseases (Woolcott & Bergman, 2018).

All in all, the most widely used anthropometric indicators in clinical practice are BMI and WC. There are indicators that provide more information on the distribution of body fat but

these are more expensive, complex and technical (bioelectrical impedance analysis (BIA), dual-energy X-ray absorptiometry (DXA), computed tomography (CT), etc) (Duren et al., 2008), so these are not always suitable for clinical practice. Furthermore, only BMI, WC and WHR have well validated cut-off values for obesity. The indicators have different advantages and limitations as they relate differently to overweight and other health indicators. Therefore, BMI is not necessarily the most appropriate indicator to use in research. Thus, it is worth comparing the indicators.

Current study

To address the association between personality and different anthropometric indicators for obesity, we assessed FFM personality traits at the personality profile level. In addition to a more comprehensive approach to personality traits, we also take a more comprehensive approach to adiposity. Since most previous research only included BMI as an obesity indicator, we also tested whether personality shared similar relations with WC, WHR, WHtR and RFM.

This research uses data from the Wisconsin Longitudinal Study (WLS), funded by the National Institute on Aging (R01 AG009775; R01 AG033285) where we can find a 29-item questionnaire based on the FFM additionally to the needed body measurements. We look at the correlation of the anthropometric indicators for obesity with the FFM personality traits as well as with personality profile of the 29-item questionnaire. The personality profile refers to a pattern of relations that this indicator has with personality traits (Vainik et al., 2019). Further we research which indicator is associated with personality traits the most.

Therefore, the goal of the study is to investigate how personality traits and personality profiles are associated with different anthropometric indicators for obesity. It is important to mention that comparing the indicators is only informative. If all indicators are equally strongly related to the same personality traits and the personality profile, then it does not make much of a difference which indicator to use in studies and all indicators are probably equally correct and suitable, BMI as the easiest indicator is suitable. If any of the other indicators are more strongly related to personality, then this suggests that previous studies using BMI alone may have underestimated the relation between personality and body weight and that some indicators might be more accurate. Thus, we test whether other indicators correlate with the same personality traits as BMI. If so and the relationships are just as strong, studies can continue using the most common and simple indicator BMI. If not, this indicates that it is worth using other indicators in addition to BMI.

Methods

Participants

Valid personality and anthropometric data were obtained from 3340 subjects from the WLS, a study administered by the National Institute on Aging. The WLS is a data base of mainly White, non-Hispanic American men and women who were born primarily in 1939 and graduated from Wisconsin high schools in 1957. It is the first of the large longitudinal studies of American adolescents. The study gives researchers the opportunity to link family background, adolescent characteristics, educational experiences, employment experiences, income, wealth, family formation and social and religious engagement to midlife and late-life physical health, mental health, psychological well-being, cognition, end of life planning and mortality over a span of 60 years (Herd et al., 2014). The initial goal of the study was to get to know the demand for post-high school education and what contributed to their education plans. Over time the survey has changed as the participants got older. Researchers now wanted to cover relevant aspects of the participants' life course. Originally an in-person questionnaire was completed in 1957. It was then followed by a mail survey of parents in 1964, a phone survey in 1975, a phone and mail survey in 1993 and 2004 and a in person and mail survey in 2011.

In this research paper we use data from the wave in 2011 (except gender was ascertained in a spring 1957 survey of the graduates); all of the analyses are therefore cross-sectional. In this sample, age ranged from 70 to 74 ($M = 71$, $SD=0.92$) with 53.5% women. About 66% of participants had a high school degree, 20% undergraduate degree, 13% postgraduate and the remaining participants had a college certificate not classified elsewhere. The mean and standard deviation of the indicators can be found in Table 1. Details on the calculations are in the Anthropometric assessment section.

Table 1

Means and Standard Deviations of the Anthropometric Indicators and Age

Characteristics	All participants		
	All	Males	Females
Age (years)	71.22 (0.92)	71.26 (0.93)	71.18 (0.91)
BMI	29.73 (5.51)	30.05 (4.77)	29.44 (6.07)

Characteristics	All participants		
	All	Males	Females
WC	103.14 (14.97)	107.39 (12.28)	99.42 (16.08)
WHR	0.94 (0.08)	0.98 (0.054)	0.90 (0.07)
WHtR	0.62 (0.09)	0.62 (0.08)	0.62 (0.11)
RFM	37.31 (7.48)	31.06 (3.75)	42.79 (5.33)

Note. All values are means (SDs in brackets). BMI = Body Mass Index, WC = Waist Circumference, WHR = Waist-to-Hip Ratio, WHtR = Waist-to-Height-Ratio, RFM = Relative Fat Mass.

Anthropometric assessment

Anthropometric traits were recorded by an interviewer during the physical examination of the WLS. In addition to height and weight, waist and hip circumference were assessed in the imperial system. WC was measured at the navel and hip circumference (HC) at the maximum circumference of the hips. For the height and weight measurements participants were asked to remove their shoes. WC, HC and height were measured with a retractable measuring tape.

Afterwards the measurements were converted to the metric system and the BMI (weight/ height²), RFM (64- (20 x height/waist circumference) + (12 x sex); sex= 0 for men and 1 for women), WHR (waist circumference/hip circumference) and WHtR (waist circumference/height) were calculated by the researcher herself.

Personality assessment

The WLS obtained self-reports for 29 items in John et al. (1991) Big Five Inventory, version 54 (BFI-54) to measure personality variables for graduates. A selection of the original questionnaire was made. The Extraversion (vs. Social Inhibition) scale captures gregarious, energetic, and expressive features of behavior; the Agreeableness (vs. Antagonism) scale reflects essentially prosocial characteristics, describing the person who is empathic and tries to establish positive relationships with others; the Conscientiousness (vs. Lack of Direction) scale captures the multiple elements of persistence and impulse control in task and achievement settings; the Neuroticism (vs. Emotional Stability) scale reflects multiple elements of negative emotionality, such as nervous tension, fearfulness, and brittleness under stress; and the Openness to experience (vs. Close Mindedness) scale refers to persons who are imaginative, curious, creative, and susceptible to absorbing experience. The 29 questions were answered on a six-point Likert scale, from *agree strongly* to *disagree strongly*. They also had the option to leave the question blank. The questionnaire was filled in via email.

The Extraversion subscale consisted of 6 items ($\alpha = 0,74$), the Agreeableness subscale consisted of 6 items ($\alpha = 0,68$), the Conscientiousness subscale consisted of 6 items ($\alpha = 0,67$),

the Openness subscale consisted of 6 items ($\alpha = 0,60$) and the Neuroticism subscale consisted of 5 items ($\alpha = 0,75$).

Statistical overview

All together three sets of analyses were conducted using JASP 0.13.1. As a first analysis we examined the correlations between each personality trait (i.e., each domain and each of the 29 items) and anthropometric indicator using linear regression, controlling for age, age² and sex. P values were corrected with the false discovery rate method, which reduces the likelihood of false-positive results. Through the 29 items' correlations with each indicator, we get the personality profile of each indicator. Secondly, we studied the correlation between these indicator profiles so we can examine how similar the personality profiles of the different indicators are.

Thirdly, using multiple regressions, the 29 personality items of the Big-Five Personality Scale were used as predictors of the different indicators (BMI, WC, WHR, WHtR and RFM). Herewith we get the variance explained R² statistics, which shows us how much of the variability of each indicator the personality items together can describe. For each indicator, we set the 29 personality items to predict the indicator while using age, age² and sex as covariates. We then compared the extent to which the personality profile allowed the prediction of the indicator.

Ethical aspect

In this research we use data of the Wisconsin Longitudinal Study which is supported by the Behavioral and Social Research Program of the National Institute on Aging. Because no new data were collected for the current work, review by the local ethics committee was not deemed necessary. Further work from other researchers have been cited accordingly. Hence, we believe it is in the accordance with all ethical aspects cited in APA.

Results

Personality Traits' Correlations with Anthropometric Indicators

The associations between personality and the anthropometric indicators are shown in Table 2. All items have been reversed in the same direction as their domain. At the broad domain level, controlling for demographic variables (sex, age and age squared), the highest negative correlation was between Conscientiousness and each of the anthropometric indicator (strongest relation: BMI, WC & WHtR $r = -.12$). This was also the only domain which was statistically significantly correlated with all indicators. In addition, Openness and Agreeableness had a negative association with most of the indicators. It was stronger with BMI, WC and WHtR (strongest relation: Openness: WHtR $r = -.06$; Agreeableness: BMI $r = -.06$).

So those higher in Conscientiousness, Openness and Agreeableness had a smaller BMI, WC, WHR, WHtR and RFM.

The more circumscribed item-level analyses revealed which aspects of the traits were the most strongly related to the indicators. The strongest negative association was for E3: Energetic with all indicators (i.e., for WC, $r = -.23$). Those participants who are highly full of energy were the most likely to have lower scores in the indicators. The second strongest negative relation with all indicators was C4: Lazy. The lazier the participants were the higher the results for the indicators (for WC, $r = -.14$). Also, more talkative (E1: Talkative), less thorough (C1: Thorough), less disorganized (C3: Disorganized) and participants who do not prefer work that is routine and simple (O2: Routine) had a higher BMI, WC, WHtR and RFM (strongest relation: E1: Talkative: BMI $r = .10$; C1: Thorough: BMI $r = -.08$; C3: Disorganized: BMI $r = -.10$; O2: Routine BMI $r = -.07$; WHtR $r = -.07$). Also, ruder (A2: Rude) participant had higher scores in the anthropometric indicators (strongest relation: BMI $r = -.05$; WC $r = -.05$; WHtR $r = -.05$).

Table 2

Correlations Between Personality and Anthropometric Indicator, Controlling for Sex, Age, Age Squared

Personality	Anthropometric Indicator				
	BMI	WC	WHR	WHtR	RFM
Domains					
Extraversion	.00	-.03	-.03	-.02	-.02
Agreeableness	-.06*	-.05**	-.03	-.05*	-.03**
Conscientiousness	-.12***	-.12***	-.06***	-.12***	-.08***
Neuroticism	-.02	-.01	.02	.00	.00
Openness	-.05*	-.05**	-.04*	-.06***	-.04***

Personality	Anthropometric Indicator				
	BMI	WC	WHR	WHtR	RFM
Items					
E1: Talkative	.10***	.08***	.04*	.08***	.05***
E2: Reserved	.05**	.03	.00	.03	.02
E3: Energetic	-.21***	-.23***	-.13***	-.21***	-.13***
E4: Quiet	.04*	.02	.00	.02	.01
E5: Shy	.01	.00	.00	.00	.00
E6: Enthusiastic	-.02	-.03	-.02	-.03	-.02
A1: Fault-finding	-.02	-.01	.00	.00	.00
A2: Rude	-.05**	-.05*	-.04	-.05*	-.04**
A3: Trusting	-.02	-.01	-.00	-.01	-.01
A4: Cold	-.01	-.02	-.02	.01	-.01
A5: Considerate	-.03	-.01	-.01	.00	-.01
A6: Cooperative	-.05*	-.03	-.01	-.02	-.02
C1: Thorough	-.08***	-.07***	-.03*	-.07***	-.05***

Personality	Anthropometric Indicator				
	BMI	WC	WHR	WHtR	RFM
C2: Reliable	-.05*	-.05*	-.03	-.05*	-.03**
C3: Disorganized	-.10***	-.08***	-.03	-.08***	-.05***
C4: Lazy	-.13***	-.14***	-.08***	-.13***	-.09***
C5: Efficient	-.06***	-.04*	-.02	-.04*	-.03*
C6: Distracted	-.05*	-.05**	-.04	-.05*	-.03**
N1: Tense	-.02	.00	.03	.01	.00
N2: Stable	.01	.01	.02	.03	.01
N3: Worried	.00	.02	.03	.02	.01
N4: Calm	-.04	-.05*	-.02	-.05	-.03*
N5: Nervous	-.01	.01	.01	.01	.01
O1: Traditional	-.02*	-.02	-.00	-.02	-.02
O2: Routine	-.07***	-.05*	-.03	-.07	-.04***
O3: Aesthetic	-.03	-.04	-.04	-.04	-.03*
O4: Imaginative	.01	.00	-.01	.00	.00

Personality	Anthropometric Indicator				
	BMI	WC	WHR	WHtR	RFM
O5: Simple	-.03	-.02	-.02	-.03	-.02
O6: Arty	-.01	-.02	-.03	-.03	-.02

Note. * $p < .05$. ** $p < .01$. *** $p < .001$. All items have been reversed in the same direction as their domain. BMI = Body Mass Index, WC = Waist Circumference, WHR = Waist-to-Hip Ratio, WHtR = Waist-to-Height-Ratio, RFM = Relative Fat Mass.

Personality profiles

In Table 3 the correlations between the personality profiles of BMI, WC, WHR, WHtR and RFM are depicted below the diagonal. All the profiles have a very strong correlation. The strongest correlation was between RFM with WC ($r = .99$, $p < .001$) and WHtR ($r = .99$, $p < .001$). The weakest correlation was between BMI and WHR ($r = .87$, $p < .001$), still being a very strong correlation. On average WHR had the lowest correlation with the other indicators ($r = .92$, $p < .001$), whereas WC and RFM had the strongest correlation with the other indicators ($r = .97$, $p < .001$).

The correlations between the indicators themselves are found in Table 3 above the diagonal. They are mostly very strong and positive as well. Exceptions are the correlation between BMI and WHR ($r = .35$, $p < .001$), BMI and RFM ($r = .48$, $p < .001$), RFM and WC ($r = .36$, $p < .001$) and RFM and WHR ($r = -.09$, $p < .001$), which is even the only negative and the weakest correlation as well.

Table 3

Personality Profiles of the Anthropometric Indicators and the Correlation between the Anthropometric Indicators

Variable	BMI	WC	WHR	WHtR	RFM
BMI	—	0.83	0.35	0.82	0.48
WC	0.97	—	0.68	0.88	0.36
WHR	0.87	0.95	—	0.52	-0.09

Table 3

Personality Profiles of the Anthropometric Indicators and the Correlation between the Anthropometric Indicators

Variable	BMI	WC	WHR	WHtR	RFM
WHtR	0.96	0.98	0.94	—	0.59
RFM	0.97	0.99	0.93	0.99	—

Note. All p-values are < .001. BMI = Body Mass Index, WC = Waist Circumference, WHR = Waist-to-Hip Ratio, WHtR = Waist-to-Height-Ratio, RFM = Relative Fat Mass. Above the diagonal are the correlations between the indicators (Pearson's r). Below the diagonal are the personality profile correlations (Pearson's r).

Personality profile prediction of the indicator

In Table 4 is the explained variance from item and covariate models and their difference. In the Item Model all 29 items were included except E3: Energetic. This item was excluded from the model since this question probably reflects not only the personality but also the general state of health of the elderly individuals included in the sample and may thus inflate the indicators' correlations with personality. Thus, the resulting R^2 would not purely reflect the personality-indicator relation but also the relation of the indicator to the state of health. The covariate models include the covariates (age, age² and sex) and is subtracted from the item models to control for the covariates and not take them into account in the result. After subtraction the variance explained by the covariates, the 28 personality items explained the highest proportion of variance in WC ($R^2 = 0.043$). The second highest which had a similar variance explained was with WHtR and the personality profile ($R^2 = 0.040$). WHR and RFM had a surprisingly small variance explained ($R^2 = 0.015$ and $R^2 = 0.008$).

Table 4

Explained variance (R^2) from item and covariate models

	Item models	Covariate models	Δ
BMI	0.042	0.007	0.035
WC	0.114	0.071	0.043
WHR	0.339	0.324	0.015
WHtR	0.041	0.001	0.040
RFM	0.620	0.612	0.008

Note. Item model is a multiple regression model of covariates (age, age² and sex) and the 29-items excluding E3: Energetic inserted together as predictors with the indicator of adiposity as

the dependent variable. Covariate model is a multiple regression model of covariates (age, age² and sex) inserted together with the indicator of adiposity as the dependent variable. Δ is the difference in the R^2 of item and covariates models. For all regression models, $p < 0.001$ for the variables reported. BMI = Body Mass Index, WC = Waist Circumference, WHR = Waist-to-Hip Ratio, WHtR = Waist-to-Height-Ratio, RFM = Relative Fat Mass.

Discussion

The aim of the current research was to compare indicators of obesity and analyse which anthropometric indicator has the strongest relation to personality traits and therefore and suits best for research purpose on body weight (obesity) and personality traits. Using a sample of over 3300 participants, we built upon the literature on the relation between personality and weight in several ways. Previous research has focused primarily on one anthropometric indicator (BMI); we extended the association between personality and weight to other indicators like WHR, WHtR and RFM that have not been used much in research in relation to personality traits. At the domain level, the indicators were negatively associated with Conscientiousness, Openness and Agreeableness. At the item level, the strongest negative association was for E3: Energetic and the strongest positive with C4: Lazy. We also found that all the personality profiles of the indicators had a very strong correlation whereas not all the indicators between each other had a strong positive relation (e.g., most correlations with RFM). Personality items collectively explained the highest proportion of variance in WC and WHtR. Therefore, there is no clear conclusion which indicator is best for research like this but there is a tendency towards WC and WHtR since they had the strongest association with the personality traits.

The domain-level associations of the anthropometric indicators with lower Conscientiousness may indicate a role of decreased self-control capabilities in obesity (Sutin & Terracciano, 2017). Conscientiousness has also been linked to longevity (Wilson et al., 2004), and has become an important trait in health-related behaviours (Booth-Kewley & Vickers, 1994), including physical activity (Rhodes & Smith, 2006), and the use of tobacco and other drugs (Terracciano et al., 2008). This is supported by our results as in the item level analysis the item Energetic and Lazy had a very strong correlation with all indicators. Since participants who tend to be full of energy are probably also more physically active whereas lazy participants are not.

Less organized and thorough participants as well as those who prefer routine had a higher body weight as correlations with most of the indicators suggested. So those who have a difficult time following regular meal rhythms may find it more difficult to maintain a healthy weight (Terracciano et al., 2009). Previous research has shown that individuals that are organized and methodical have a natural tendency to exercise routines, a healthy diet, and regular meal rhythms, while avoiding unplanned food consumption and over-eating which are all key behaviours for weight maintenance (Elfhag & Rössner, 2005). Neither the relation of talkative nor rude has been discussed in previous research although in this research we found relatively strong associations between these traits and body weight. So, including narrower personality traits is beneficial since they help to specify which aspects of each domain most strongly relate to outcomes like body weight.

Unexpectedly, the domains Openness and Agreeableness had negative associations with body weight. Both domains have shown rather no, a very weak or even positive associations with body weight (Jokela et al., 2013; McCann, 2011; Sutin et al., 2011). It is unclear if these traits relate to body weight but Brummet et al (2006) argues that it is possible that more agreeable people tend to trust the suggested guidelines from physicians and relatives with respect to diet and exercise more. This might be a similar reason for Openness as well. As well as there is some evidence that Openness is positively related with healthy dietary practice which in turn may result in lower weight measurements (Goldberg & Strycker, 2002).

The correlations with individual domains and items suggest that personality traits most strongly relate to BMI, WC and WHtR. BMI and WC had positive associations in previous research as well (Sutin et al., 2011; Terracciano et al., 2009). Sutin & Terracciano ((Sutin & Terracciano, 2017) say that it is important to establish a relation between personality and the health outcome of interest (e.g. anthropometric indicator). Thus, BMI, WC and WHtR are best to use in relation to bodyweight and personality. WHR is the least suitable since it has the weakest probability that an effect exists in the population.

The variance explained in the indicators by personality traits shows which indicator is most strongly correlated with personality traits in general and therefore helps us to predict which indicator is best to use. Previous research (Seeboth & Möttus, 2018) used a similar method to predict BMI from 50 personality items and got similar results for the variance explained in BMI (about 4%). Although BMI has been used a lot in previous research it does not have the strongest variance explained in this study. While RFM and WHR associate the

least with the personality traits WC and WHtR have a higher relation. Thus, we can assume that according to this analysis WC and WHtR are better to use in relation with personality than RFM and WHR because the personality traits predict WC and WHtR better than RFM and WHR, they have a higher correlation.

Beyond individual traits, the indicators' personality profiles were correlated and the anthropometric indicators themselves. As previous research (Revelle et al., 2021) suggests, the indicator correlations are smaller than the profile correlations. There are no big differences in the personality profile correlations hence we can assume that there is no big difference which indicator we use to study personality traits' associations with body weight. Although the correlation between BMI and WHR is alarmingly low considering BMI is used a lot in research and the correlation is considerably lower than the others. The strong relation between RFM with WC and RFM with WHtR can be explained that for calculating RFM we use the height and waist circumference which are both used for WHtR and waist circumference is used for WC as well. WC has been used in some previous research and has been found to correlate with largely the same personality traits as BMI (Sutin et al., 2011; Terracciano et al., 2009), but the current results suggest that these two indicators are the most different in terms of which personality traits they correlate with. Therefore, RFM and WHtR can be used the same way because of their high personality profile correlations with WC. Hence, the personality profile correlation of the anthropometric indicators advocates that BMI and WHR are not best to use in correlation with personality due to their weak correlation whereas WC, RFM and WHtR are better considering their comparatively high associations.

Taken all analyses together, there is a tendency that WC and WHtR show the strongest associations with personality traits. In the correlations with individual domains and items they show very similar results. Further in the indicators' personality profiles the correlation of WC and WHtR were relatively high as well. This was confirmed by the variance explained again. Although research suggests that WHtR corrects WC according to the individual's height which is seen as a big advantage of WHtR (Browning et al., 2010), in the association with personality it seems to make no significant difference. Since the relationships between WC and WHtR with personality are just as strong, studies can continue using the simpler indicator WC. In all analysis is a common inference that WHR is not a good indicator to use in association with personality traits and body weight: the current evidence suggests that it does not relate to personality traits as strongly as the other indicators do.

This study has several strengths. Roughly similar results were found in the correlations with individual domains and items as in previous studies. Probably the biggest limitation of the study is that the participants' age was very high and geographically they were in the same area. Thus, the sample is not representative of all ages and cultures, and findings may not be generalizable. Moreover, the questionnaire for the personality assessment is likely to cover only a limited set of personality traits. Not only is the number of items small but these items also tend to overlap in their content, for example, 'To what extent do you agree that you see yourself as someone who tends to be quiet?' and 'To what extent do you agree that you see yourself as someone who is talkative?' or 'To what extent do you agree that you see yourself as someone who is emotionally stable and not easily upset?' and 'To what extent do you agree that you see yourself as someone who worries a lot?'. Therefore, approximately the same attributes have been measured while the domain itself is broader and it does not give as much as information as it could. Moreover, the indicator which relates strongest with personality traits might not be the most accurate, since the goal is not to find out which indicator relates most but which indicator can tell most about the actual body weight and personality associations. The strongest relation might not be the most accurate.

The results suggest that previous studies using BMI alone have underestimated the relation between personality and body weight. This research suggests using WC as an indicator for body weight in relation with personality in future research. Since WC assesses visceral fat (Lemieux et al., 1996) we can assume that visceral fat plays an important role in personality. Although we found an answer to the research question, there needs to be done more research on different anthropometric indicators since based on one study we cannot decide conclusively which indicator is the most accurate in association with body weight and personality. Further, future research should use a wider range of the population as participants and a more comprehensive questionnaire. We do believe that despite the limitations this research contributes to the research on body weight and personality and encourages researchers to consider using different anthropometric indicators in addition to BMI.

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