


Body Mass is Linked With a Broad Range of Personality Nuances, but Especially Those With Behavioral Content: A Multi-Sample Exploration

Kadri Arumäe¹ , Uku Vainik^{1,2} , René Mõttus^{1,3} 

[1] *Institute of Psychology, University of Tartu, Tartu, Estonia.* [2] *Montreal Neurological Institute, McGill University, Montreal, Canada.* [3] *Department of Psychology, University of Edinburgh, Edinburgh, United Kingdom.*

Personality Science, 2022, Vol. 3, Article e7583, <https://doi.org/10.5964/ps.7583>

Received: 2021-10-04 • **Accepted:** 2022-03-08 • **Published (VoR):** 2022-10-26

Handling Editor: Markus Jokela, University of Helsinki, Helsinki, Finland

Reviewing: Round 1 - Anonymous #1. Open reviews are available. [see [Index of Supplementary Materials](#)]

Corresponding Author: Kadri Arumäe, Näituse 2, 50409, Tartu, Estonia. E-mail: kadri.arumae@ut.ee

Supplementary Materials: Data, Materials [see [Index of Supplementary Materials](#)]



Abstract

Various personality domains and facets correlate with body mass index (BMI), but recent studies suggest that using narrower personality traits—nuances—could contribute to a more detailed understanding of personality–body weight associations. We used three large datasets with different inventories to describe nuances’ correlations with BMI and explore whether BMI predominantly correlated with affective, behavioral, cognitive, or motivational item content. BMI correlated with many nuances, most prominently those reflecting immoderation, lack of orderliness, talkativeness, leadership tendencies, anger, traditionalism, and preference for routine. The highest nuance-level correlation was .21, compared to .11 for the Five-Factor Model domains. BMI correlated most strongly with nuances predominantly reflecting behaviors. Nuance-based approaches can thus reveal the strength, multitude, and content-nature of personality–outcome correlations that can potentially remain hidden in broader traits. If personality traits become relevant in the prevention or treatment of obesity, a focus on narrow behavioral traits may be especially warranted.

Keywords

personality nuances, items, item content, persome, inventories, obesity, overweight, BMI



This is an open access article distributed under the terms of the [Creative Commons Attribution 4.0 International License, CC BY 4.0](#), which permits unrestricted use, distribution, and reproduction, provided the original work is properly cited.

Relevance Statement

Exploring personality nuances' associations with BMI in three large datasets, we found that BMI has stronger and more numerous correlations with personality traits than studies have shown. Personality may be more relevant in obesity than thought.

Key Insights

- BMI correlated with many nuances across the personality space.
- Nuance-level correlations tended to be stronger than domain-level correlations.
- Analyses with domains cannot adequately represent trait–BMI associations.
- Some variability in correlations was observed across inventories.
- BMI was most strongly related to behavioral item content.

Personality traits are known to correlate with a variety of life outcomes. Among these are various health outcomes such as excess adiposity, a major risk factor for conditions like type 2 diabetes (Bjerregaard et al., 2018), cardiovascular disease (Van Gaal et al., 2006), and mortality (Lewis et al., 2009). If these correlations reflect causal influences between personality traits and overweight as is sometimes assumed (Kim, 2016; Sutin & Terracciano, 2017) and as some empirical findings also suggest (Arumäe et al., 2021), studying them could pave the way to an improved understanding of the development of overweight and obesity on the one hand and their contributors to personality differences on the other. Among other things, understanding these associations could inform us about whether and how weight-management interventions could benefit from the consideration of personality traits or, perhaps, influence them.

So far, it has been shown that broad personality trait domains like conscientiousness, as well as numerous narrower facets of these domains, correlate consistently with body mass index (BMI), the most commonly used proxy for adiposity (Jokela et al., 2013; Sutin et al., 2018; Vainik et al., 2019). Specifically, as facet-level analyses have repeatedly shown, relying on domains that aggregate various facets can mask the correlations of narrower traits with BMI, whereas facets can give a clearer picture of these associations (Sutin et al., 2018; Terracciano et al., 2009; Vainik et al., 2019). It therefore seems essential to use such narrower facets to describe personality traits' correlations with BMI. Although the idea that narrower traits provide incremental prediction of important outcomes over domains is not new (Dudley et al., 2006), only in recent years have researchers started to focus on even narrower traits than facets: nuances (McCrae, 2015; Möttus et al., 2017; Revelle et al., 2021). Here, we aimed to provide a detailed picture of how personality traits intersect with body weight by using these nuances.

Using Narrow Traits to Describe Associations With BMI

It is well-established that BMI associates with various broad and narrower personality traits (Jokela et al., 2013; Vainik et al., 2019). Facets are more numerous and more specific than the broader personality domains which they comprise and may therefore provide more precise information on which kinds of behaviors, thoughts, feelings, and motivations BMI correlates with. Incorporating facets in analyses has revealed that they tend to correlate with BMI independently of the broader domains they constitute. For instance, the extraversion domain itself does not reliably correlate with BMI, but some of its facets do (Sutin et al., 2011; Vainik et al., 2019). In fact, facets within the same domain may relate to BMI even in opposite directions: of the facets of extraversion, BMI correlates negatively with activity, but positively with warmth, assertiveness, and positive emotions (Vainik et al., 2019). These results confirm what logic suggests: broad traits alone cannot provide a detailed description of BMI–personality trait associations.

However, as useful as facets have been, they themselves are made up of even narrower nuances that could be used to provide an even more thorough description of BMI's correlations with personality traits. Like broader traits, nuances are partly stable and heritable and have appropriate levels of cross-method agreement (Mõttus et al., 2019)—that is, they appear to have the same properties that broader traits do, but summarize individual differences in more specific thoughts, emotions, motivations, and behaviors. Although a comprehensive list of personality nuances does not (yet) exist, the individual items in already existing personality inventories can be used to represent such nuances (Condon et al., 2020; Seeboth & Mõttus, 2018). While the unique variance of single items has sometimes been thought of simply as measurement error, these items' trait-like properties suggest that they are suited for use in the same ways as broader traits—to describe, predict, and guide potential explanations for the associations of interest (Mõttus et al., 2019).

So far, nuances have been shown to provide incremental prediction of BMI over broader traits (Adan et al., 2019; Elleman et al., 2020; Mõttus et al., 2019; Seeboth & Mõttus, 2018), and hence they have been used to construct aggregate bespoke personality scores to explore the direction of causal influences between personality traits and BMI (Arumäe et al., 2021). No studies have, however, focused on *describing* nuances' associations with BMI. Still, it has been noted that BMI is more consistently related to personality scales that tap into the impulsivity and anger aspects of neuroticism rather than emotional vulnerability (Sutin & Terracciano, 2017). Yet more specifically, the impulsiveness–BMI association has been found to be driven by the two items within the impulsiveness facet of the NEO–PI–R/3 questionnaire that directly relate to eating behavior (Terracciano et al., 2009; Vainik et al., 2015). These findings demonstrate that broader traits can obfuscate associations and attest to the utility of sub-facet traits, nuances, in understanding personality traits' associations with criteria like BMI.

BMI and Personality Item Content: Affect, Cognition, Motivation, and Behavior

When the associations between personality traits and BMI have been described on an appropriately narrow level, a next step is to clarify which types of processes give rise to these associations. For instance, it is believed that the relations between traits and outcomes of interest are mediated by the thoughts, feelings, and behaviors that the traits are associated with (Roberts & Yoon, 2022). If there is a way to isolate these personality trait-related manifestations, it will be possible to test which, if any, of these expressions of personality traits is primarily associated with BMI. And this is indeed possible: although personality inventories do not explicitly differentiate such components of traits, it is possible to distinguish the so-called ABCD components of personality traits—*affect* (A), *behavior* (B), *cognition* (C), and *motivation* (or *desire*, D)—in personality inventories by having knowledgeable raters assess to what extents items contain these components (Pytlik Zillig et al., 2002; Wilt & Revelle, 2015).

Nuances and the domains they make up differ in their ABCD content. The items included in the extraversion and conscientiousness domains are, on average, somewhat more behavioral, items of neuroticism are more affective, those entailed in openness tend to reflect cognition, and items in the agreeableness domain have the most balanced ABCD content (Pytlik Zillig et al., 2002; Wilt & Revelle, 2015); however, there remains a substantial variability within the domains in their items' ABCD content. Distinguishing the content of items and domains makes it possible to test whether items that correlate highly with BMI also have higher-than-average levels of affective, behavioral, cognitive, or motivational content—in other words, whether any of those components primarily account for the correlations BMI has with personality traits. This could potentially suggest how, or through which pathways, personality traits may relate to body weight.

It may be the dominant opinion among researchers that personality traits are related to BMI through behaviors, including those related to health: for instance, conscientiousness may go with higher frequency of health-protective behaviors and lower frequency of health-damaging or risky behaviors, therefore resulting in healthier body weight as well as other health outcomes (Keller & Siegrist, 2015; Lunn et al., 2014). However, BMI may also relate to the affective content of personality traits as both positive and negative emotions have been found to be related to increased food intake (Canetti et al., 2002; Evers et al., 2018; Sultson et al., 2017). If BMI is found to correlate with higher proportions of behavioral content, for instance, this would be consistent with personality traits relating to BMI mainly through (health-relevant) behaviors; if it correlates most strongly with affective, cognitive, or desire content, this would instead suggest that processes related to emotions, thoughts, or motivations, respectively, are driving personality trait–BMI correlations. Therefore, the degrees to which items with high proportions of certain types of content correlate with BMI may shed light on the types of processes that link personality traits to body weight.

The Present Study

The current study aimed to provide a detailed description of BMI's cross-sectional associations with personality traits. First, we correlated over 700 personality items of three different inventories with BMI to clarify which of them associate with BMI most strongly. Second, we assessed the correlations between BMI and ABCD content to see whether body weight tends to relate to any certain type of personality item content. Most studies on BMI–personality trait associations have focused on one sample and one inventory (most commonly a version of the NEO Personality Inventory, i.e., NEO–PI–R or NEO–PI–3; McCrae et al., 2005). Here, we include three independent datasets, each of which includes personality traits measured using a different inventory: either NEO–PI–3, IPIP-NEO (Goldberg, 1999), or a recently developed item pool intended to measure a broad range of nuances (which we call here „A Hundred Nuances of Personality“; 100NP). Because a broad representation of personality nuances is necessary for the identification of the most relevant ones for an outcome, we focused on datasets where personality had been measured with a large number of items; the sample sizes were also sufficiently large to allow detecting non-trivial personality trait–BMI correlations while controlling for multiple testing. Including different inventories allowed us to investigate a broader set of personality nuances than any individual inventory would have, and therefore increase the possibility of finding the nuances most strongly related to BMI, as well as assess whether ABCD content calculated based on different sets of items relate to BMI similarly. Because the magnitude of correlations between BMI and nuances can best be interpreted in comparison to broader traits, we also report the correlations between BMI and the domains of the Five-Factor Model in the three inventories.

Method

Materials

Datasets

NEO–PI–3 Data — The NEO–PI–3 is a 240-item inventory that measures the five domains of the Five-Factor Model, as well as 30 facets, six of which belong within each domain. Answers to personality items in this inventory are provided on a 5-point Likert scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*). We used NEO–PI–3 personality data of a subsample of the Estonian Biobank of the Estonian Genome Center, University of Tartu (Leitsalu et al., 2015). This sample represents a cohort of Estonian adults from whom DNA samples as well as various other medical data have been collected, including height and weight based on which BMI could be calculated. BMI was calculated as weight in kilograms divided by height in meters squared. Within the sample, 3,562 individuals (2,147 female) had the necessary data available to calculate the BMI–personality item correlations while accounting for the covariates used throughout

this study (age, age², and sex). Mean age of these individuals was 48.80 years ($SD = 17.00$, range 18–91); mean BMI was 25.98 kg/m² ($SD = 4.87$). Descriptive statistics and Cronbach's alphas for the personality domains of all samples are provided in Table 1 and Table S1, respectively.

Table 1

Means and Standard Deviations of Personality Domains in the Three Inventories

Domain	NEO-PI-3 ^a		IPIP-NEO		100NP	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Agreeableness	2.48 (4.10)	0.38 (0.48)	4.14	0.65	4.26	0.66
Conscientiousness	2.52 (4.15)	0.45 (0.56)	4.15	0.69	4.08	0.71
Extraversion	2.12 (3.65)	0.54 (0.68)	3.64	0.74	4.13	0.70
Neuroticism	1.79 (3.23)	0.51 (0.64)	3.46	0.90	3.60	0.82
Openness	2.19 (3.74)	0.46 (0.57)	4.46	0.56	4.40	0.61

Note. For IPIP-NEO, descriptive statistics were found in subsamples of individuals who had responded to a minimum of 20 items within the domain (N s ranged from 2,209 to 2,480 individuals).

^aIn NEO-PI-3, answers are given on a scale from 0 to 4; in IPIP-NEO and 100NP, they are given on a scale from 1 to 6. For the sake of comparability between the inventories, NEO-PI-3 descriptives are provided not only as measured on its original scale, but also after converting the scores to a scale of 1 to 6 (in parentheses) with the formula $(\text{raw score} / 4) \times 5 + 1$.

IPIP-NEO Data — The IPIP-NEO is a 300-item inventory that assesses the same five domains as well as 30 facets conceptually similar to those of the NEO-PI-3. Ten items represent each facet; answers are given on a scale from 1 (*very inaccurate*) to 6 (*very accurate*). We used a publicly available dataset (Condon et al., 2019) where subsets of 696 personality questions of the International Personality Item Pool had been randomly administered to over 48,000 people online. From this data pool, we selected the 300 items included in the IPIP-NEO for which the ABCD ratings were available. After excluding respondents with missing data on BMI, age, sex, or country, a total of 37,971 participants from 191 countries remained (23,940 female) with a mean age of 26.34 years ($SD = 11.41$, range 14–89) and a mean BMI of 24.88 kg/m² ($SD = 5.91$). Because of the diversity of the respondents' geographic locations, we additionally accounted for the continent of the participants' countries in the IPIP-NEO data. Specifically, the countries were recoded as continents as follows: North America ($n = 27,767$), Europe ($n = 5,286$), Asia ($n = 3,081$), Oceania ($n = 979$), Africa ($n = 438$), and South America ($n = 429$). Due to the use of the Synthetic Aperture Personality Assessment (SAPA) method, the IPIP-NEO data had high (~ 90%) missingness; specifically, the participants had responded to 35.06 items on average ($SD = 27.97$, range 1–158 items) and each item had responses from an average of 4,437 participants for whom BMI was also available ($SD = 1,081.97$, range 3,787–9,751).

100NP Data — 100NP is a 257-item item pool developed to measure a broad range of personality nuances. The items were largely drawn from the publicly available International Personality Item Pool (Goldberg, 1999) and Synthetic Aperture Personality Assessment item pool (Condon, 2018). The items were responded to using a scale from 1 (*very inaccurate*) to 6 (*very accurate*); detailed information on the item pool is available at <https://osf.io/tcfgz/>. The 100NP differs from classical personality inventories in that it was not designed with the purpose of assessing any broad-level traits, but many of its items can nevertheless be mapped to the domains of the Five-Factor Model. For the purposes of the current study, the items were aggregated into these five domains using principal component analysis: items with loadings of .40 or greater on one component were assigned to the domain that the component represented. Thirty-two items represented agreeableness, 25 conscientiousness, 33 extraversion, 40 neuroticism, and 17 openness, with the remaining 110 items falling outside of these domains. Participants for the 100NP dataset were recruited from Prolific Academic. After removing participants with missing data on BMI, age, sex, or country, the sample consisted of 1,101 persons (595 female) from 37 countries with a mean age of 27.83 years ($SD = 10.88$, range 12–77) and a mean BMI of 24.20 kg/m² ($SD = 5.09$). Because a majority of participants were from the United Kingdom, geographic location was coded as United Kingdom ($n = 748$) or other ($n = 353$) and used as a covariate in statistical analyses.

Item Content Ratings

Item content ratings for the three inventories were obtained from various sources, but the procedure was similar in all cases. Specifically, for each item of each inventory, the raters were instructed to assess to what extent, in their opinion, each item contained affective, behavioral, cognitive, and motivational content. These four ratings had to add up to 100%. A detailed description of the procedure is provided by Wilt & Revelle (2015).

Ratings for NEO-PI-3 Items — ABCD ratings for NEO-PI-3 items were collected from eight respondents: six female, two male; all respondents had university degrees, six of them in psychology. Ratings were collected for all items included in the NEO-PI-R and NEO-PI-3 (i.e., a total of 277 items), but only ratings for the latter inventory were used in the current study. The ratings are publicly available and can be accessed via the [Supplementary Materials](#). Average-rater intraclass correlations (ICCs; interpretable similarly to Cronbach's alphas) for the ABCD components of NEO-PI-3 items were .90, .87, .83, and .67, respectively.

Ratings for IPIP-NEO Items — Ratings for the IPIP-NEO items were obtained from two sources. Namely, six respondents' ratings were collected by Wilt & Revelle (2015); ratings from three additional persons were collected separately in the process of another ongoing study. Of the nine raters, six were female and three were male; most had

university degrees and a background in psychology. The aggregated ICCs of the ABCD components across the nine raters were .88, .83, .88, and .78, respectively.

Ratings for 100NP Items – Ratings for the 100NP items were collected from ten persons using a similar procedure for the ongoing study mentioned above. All raters had a university degree and a background in psychology; the ABCD components' ICCs were .87, .88, .87, and .80, respectively.

Statistical Analyses

The 20 items most strongly correlated with BMI in each inventory were found by calculating Spearman's ρ between BMI and personality items after residualizing BMI and every personality item for age, age², and sex, as well as geographic region in IPIP-NEO data and 100NP data. Geographic location was included as a covariate as a proxy for environmental or cultural differences which can moderate personality–BMI associations (Sutin & Terracciano, 2017). Geographic location was not corrected for in the NEO–PI–3 data because all respondents were Estonian residents. Because we were interested in the strongest correlated items, not necessarily the directions of the associations (which depend on the precise wording of the item), the 20 items most strongly correlated with BMI were chosen based on the absolute value of the correlation coefficient; correlations are reported in the direction implied by item content (i.e., they have not been reversed to match any broader traits). Analyses were repeated after additionally residualizing BMI and personality items for level of education. The covariates were included as potential influences on both personality traits and BMI which could inflate estimates of BMI–personality trait correlations; however, should personality traits also (or instead) influence level of education, controlling for education would result in statistical overcontrol and underestimation of effects (Kim, 2016). Because the influences between BMI, personality traits, and the covariates are insufficiently understood, we report results of analyses with education as an additional covariate in a supplementary document.

To facilitate comparison of the three datasets as well as the strength of BMI's associations with domains and nuances, we also report correlations between BMI and the five domains of personality in each inventory. These correlations were calculated the same way as BMI–item correlations, but after aggregating the items into domains. Two items related to eating were excluded from the neuroticism domain in the NEO–PI–3 and IPIP-NEO datasets prior to calculating the domain's correlation with BMI to avoid inflation of the correlations.

Because the IPIP-NEO and 100NP items were both drawn from a common set of items (IPIP), the two questionnaires have 69 items in common. This overlap allowed us to additionally assess the similarity of the shared items' correlations with BMI in the two datasets, to test the replicability of the associations. To this end, the item–BMI correlations in the IPIP-NEO dataset were correlated with the item–BMI correlations

in the 100NP dataset. Considering the overlapping items, our analyses included a total sample of 728 items.

To test whether BMI tended to correlate with any certain type of item content, we first correlated BMI with each item, adjusting for covariates as described above. We then correlated the absolute values of these correlations to the items' proportions of ABCD content. Absolute values were used to test whether the items' content was related to the strength of their correlations with BMI as the direction each specific item is phrased is arbitrary in this analysis. For each inventory, the sample size in these analyses was the number of items included in that inventory (i.e., 240–300); a fixed-effects meta-analysis where effect sizes were weighted by the inverse of standard errors was additionally conducted for increased statistical power and to summarize which of the ABCD components associated with BMI across the three samples.

All analyses were run using R 3.6.1 using RStudio. All p -values were adjusted for false discovery rate with the number of comparisons being the number of associations tested in each inventory (i.e., five in case of domains and the number of items in the inventory in case of items).

Transparency, Openness, and Reproducibility

Analyses reported in the current study were not preregistered. The supplementary document where analyses with education as an additional covariate are reported can be found in the [Supplementary Materials](#).

Results

[Table 2](#) shows the correlations between BMI and the five domains of personality in the three samples (correlations when additionally accounting for education can be found in [Table S2](#)). Each sample showed a significant negative correlation between BMI and conscientiousness. In some cases, however, correlations differed considerably between the three inventories, especially for neuroticism and openness, with estimates ranging from .02 to .11 for the former and from -.09 to .01 for the latter, suggesting that different samples and/or different inventories can lead to considerably different estimates of correlations.

Correlations between BMI and the individual items by domain are shown in [Figure 1](#). This figure illustrates the distribution of BMI's correlations, showing that the correlations of BMI with items within each domain varied considerably in size and differed in direction.

Table 2

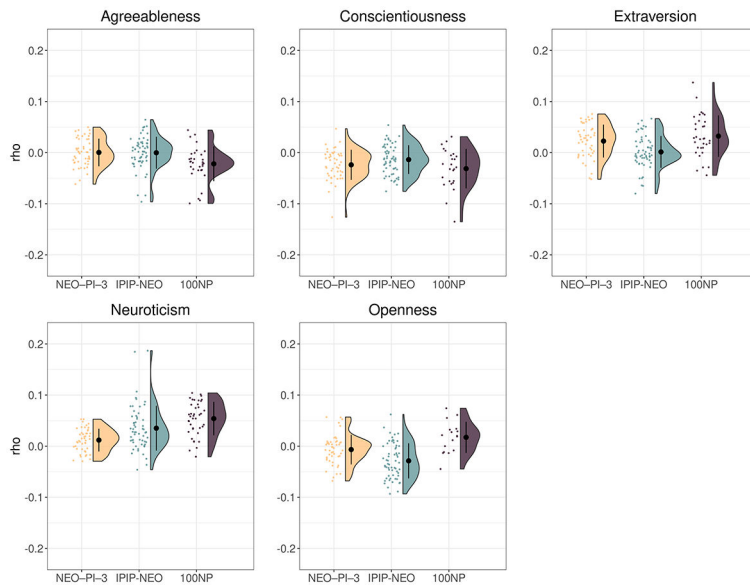
Correlations Between BMI and the Five Personality Domains

Domain	NEO-PI-3		IPIP-NEO		100NP	
	r_s [95% CI]	p	r_s [95% CI]	p	r_s [95% CI]	p
A	-.01 [-.04, .03]	.638	-.01 [-.05, .03]	.531	-.04 [-.10, .02]	.294
C	-.06 [-.09, -.03]	.002	-.07 [-.11, -.03]	< .001	-.07 [-.13, -.01]	.043
E	.04 [.01, .07]	.037	-.03 [-.07, .01]	.136	.03 [-.03, .09]	.454
N	.02 [-.02, .05]	.352	.11 [.06, .15]	< .001	.08 [.02, .13]	.043
O	-.02 [-.05, .02]	.352	-.09 [-.13, -.05]	< .001	.01 [-.05, .07]	.632

Note. Two eating-related items were removed from the NEO-PI-3 and IPIP-NEO before calculating the correlations to avoid inflation of the estimates. For IPIP-NEO, the domains' correlations were found in subsamples of individuals who had responded to a minimum of 20 items within the domain (N s ranged from 2,209 to 2,480 individuals). The domain-level correlations with NEO-PI-3 domains in overlapping samples have also been reported by Vainik et al. (2015) and Arumäe et al. (2022), and included in a meta-analysis by Vainik et al., 2019; as a difference, the correlation with neuroticism in the current study is calculated after excluding the two eating-related items from the scale. All p -values are adjusted for false discovery rate.

Figure 1

Individual Items' Correlations With BMI, by Domain



Note. Each colored dot represents an item within the specified domain. The items with reverse phrasing have been coded to match their broader domains. The eating-related items included in the NEO-PI-3 and IPIP-NEO are not shown. Dots with error bars reflect BMI's average correlations with the domain's items. Error bars denote standard deviations.

Items With the Strongest Correlations

Tables 3–5 show the items that most strongly correlated with BMI in NEO–PI–3, IPIP–NEO, and 100NP. Correlations after additionally adjusting for level of education are shown in Tables S3–S5.

Table 3

Twenty Items of the NEO–PI–3 Most Strongly Correlated With BMI

Position	Item meaning ^a	r_s [95% CI]	p	Domain
#1	Eats excessively	.26 [.23, .29]	< .001	N
#2	Overeats favorite foods	.22 [.19, .25]	< .001	N
#3	Gives up on self-improvements	.13 [.09, .16]	< .001	C
#4	Keeps possessions tidy	-.08 [-.11, -.04]	< .001	C
#5	Is easy to make laugh	.08 [.04, .11]	< .001	E
#6	Emerges as leader	.07 [.04, .10]	.001	E
#7	Vacations in different places	-.07 [-.10, -.04]	.001	O
#8	Is the most talkative person in conversations	.07 [.04, .10]	.001	E
#9	Is sometimes overwhelmed by joy	.07 [.03, .10]	.002	E
#10	Is meticulous	-.07 [-.10, -.03]	.002	C
#11	Likes roller coasters	.06 [.03, .10]	.002	E
#12	Is commanding	.06 [.03, .10]	.003	E
#13	Doesn't worry that kinds acts have ulterior meanings	-.06 [-.09, -.03]	.004	A
#14	Values sticking with principles rather than being flexible-minded	-.06 [-.09, -.03]	.004	O
#15	Is full of energy	.06 [.03, .09]	.005	E
#16	Sees the bright side	.06 [.03, .09]	.005	E
#17	Is very disciplined	.06 [-.09, -.03]	.005	C
#18	Enjoys gabbing	.06 [.03, .09]	.006	E
#19	Acts strenuously	.06 [.03, .09]	.006	E
#20	Enjoys letting fantasies develop	.06 [.02, .09]	.008	O

Note. BMI and personality items were residualized for age, age², and sex. All p s are corrected for false discovery rate.

^aBecause NEO–PI–3 is proprietary, we present the meaning of the items, but not the items themselves as they appear in the inventory, throughout the manuscript.

Table 4

Twenty Items of the IPIP-NEO Most Strongly Correlated With BMI

Position	Item	r_s [95% CI]	p	Domain
#1	Often eat too much.	.42 [.39, .44]	< .001	N
#2	Rarely overindulge.	-.19 [-.22, -.16]	< .001	N
#3	Am able to control my cravings.	-.18 [-.21, -.15]	< .001	N
#4	Love to eat.	.14 [.11, .17]	< .001	N
#5	Go on binges.	.11 [.08, .14]	< .001	N
#6	Yell at people.	.10 [.07, .13]	< .001	A
#7	Easily resist temptations.	-.09 [-.13, -.06]	< .001	N
#8	Prefer to stick with things that I know.	.09 [.06, .12]	< .001	O
#9	Never spend more than I can afford.	-.09 [-.12, -.06]	< .001	N
#10	Like to stand during the national anthem.	.09 [.06, .12]	< .001	O
#11	Seldom get mad.	-.09 [-.12, -.06]	< .001	N
#12	Believe in an eye for an eye.	.08 [.05, .11]	< .001	A
#13	Hold a grudge.	.08 [.05, .11]	< .001	A
#14	Never splurge.	-.08 [-.11, -.05]	< .001	N
#15	Believe that we coddle criminals too much.	.08 [.05, .11]	< .001	O
#16	Like to take it easy.	.08 [.05, .11]	< .001	E
#17	Dislike myself.	.08 [.05, .11]	< .001	N
#18	Feel comfortable with myself.	-.08 [-.11, -.05]	< .001	N
#19	Lose my temper.	.08 [.05, .11]	< .001	N
#20	Leave a mess in my room.	.08 [.05, .11]	< .001	C

Note. BMI and personality items were residualized for age, age², sex, and geographic location. All ps are corrected for false discovery rate.

Table 5

Twenty Items of the 100NP Most Strongly Correlated With BMI

Position	Item	r_s [95% CI]	p	Domain
#1	Am able to control my cravings.	-.21 [-.26, -.15]	< .001	Others
#2	Consider myself healthy for my age.	-.20 [-.27, -.14]	< .001	Others
#3	Spend more money than I should.	.20 [.13, .25]	< .001	Others
#4	Do things that men traditionally do.	.17 [.11, .23]	< .001	Others
#5	Talk a lot.	.14 [.08, .20]	< .001	E
#6	Leave a mess in my room.	.14 [.07, .20]	< .001	C
#7	Easily resist temptations.	-.13 [-.19, -.07]	< .001	Others
#8	Often forget things.	.13 [.07, .19]	< .001	Others
#9	Am good at saving money.	-.13 [-.19, -.07]	.001	Others
#10	Act as a leader.	.12 [.06, .18]	.003	Others
#11	Buy only the things I need.	-.12 [-.18, -.06]	.004	Others

Position	Item	r_s [95% CI]	p	Domain
#12	Consider myself good looking.	-.11 [-.18, -.05]	.007	Others
#13	Know how to comfort others.	.11 [.05, .17]	.007	E
#14	Wear stylish clothing.	-.11 [-.17, -.05]	.012	Others
#15	Often feel that others laugh or talk about me.	.10 [.04, .17]	.016	N
#16	Have a low opinion of myself.	.10 [.04, .16]	.013	N
#17	Make enemies.	.10 [.04, .16]	.021	A
#18	Act without thinking.	.10 [.04, .16]	.016	C
#19	Often do things that I later regret.	.10 [.04, .16]	.016	N
#20	Am often bored.	.09 [.03, .16]	.027	N

Note. BMI and personality items were residualized for age, age², sex, and geographic location. For 100NP, items that do not belong to any of the five domains are labeled “others.” All p s are corrected for false discovery rate.

The two eating-related items in NEO-PI-3 predictably occupied the first two positions in Table 3, but no other neuroticism items were found on the list, consistent with the absence of a significant domain-level association when excluding those two items. Although all domains were represented, it stands out that 10 of the 20 items belonged to the extraversion domain—items reflecting positive emotions (#5, #9, #16), talkativeness (#8, #18), assertiveness (#6, #12), activity (#15, #19), and excitement-seeking (#11), all related to BMI positively. These associations suggest that BMI is related to many aspects of extraversion as measured by the NEO-PI-3, but because the associations with other items vary in direction, the association tends to be „washed out“ in typical domain-level analyses. The four conscientiousness items included in the list reflected orderliness (#4, #10, #17) and achievement striving (#3). The openness items reflecting a preference for variety related to BMI negatively (#7, #14) and the item regarding fantasy, positively (#20). Finally, an item related to trust (#13) correlated with BMI negatively. A breakdown of the number of represented items by domain and inventory is shown in Table 6 (see Table S6 for the breakdown after additionally adjusting for education).

Table 6

Breakdown of the Number of Items Among the 20 Most Strongly Correlated with BMI, by Domain

Inventory	A	C	E	N	O
NEO-PI-3	1	4	10	2	3
IPIP-NEO	3	1	1	12	3
100NP ^a	1	2	2	4	0

^aStrongest correlated items of 100NP also included 11 items that did not belong to any of the four domains.

In IPIP-NEO, items of neuroticism were well-represented among the items most strongly correlated with BMI (12 items). Given the substantial correlation between BMI and the

neuroticism domain in this inventory, this is not surprising, although it contrasts with the results found in NEO-PI-3 where impulsivity items other than eating-related did not appear among the items most highly correlated with BMI. Eight of the twelve items reflected immoderation in relation to food (#1, #4), money (#9, #14), and a general tendency to overindulge or an inability to resist temptations (#2, #3, #5, #7). A theme of self-consciousness also emerged (#17, #18). Items related to holding grudges or getting mad belonging to the agreeableness (#6, #12, #13) and neuroticism domains (#11, #19) also stood out. The openness items reflected conservative beliefs or values (#10, #15), including a lower preference for variety (#8) which was also seen in NEO-PI-3 data. Although BMI was also correlated to conscientiousness, only one item of this domain was represented, reflecting orderliness (#20). Finally and unlike in the NEO-PI-3 data, only one extraversion item was included which reflected a preference for a leisurely level of activity (#16) and, also in contrast to NEO-PI-3 data, correlated with BMI positively.

In the list for 100NP, as in that of IPIP-NEO, items related to immoderation or impulsivity were again present: inability to resist temptations (#1, #7), carelessness with money (#3, #9, #11), and impulsive behavior (#18, #19). Also similar to the results found with the IPIP-NEO data was the presence of items relating to self-consciousness (#15, #16), orderliness (#6), and making enemies (#17). Similarly with NEO-PI-3, on the other hand, items related to talkativeness (#5) and assertiveness (#10) were included. Items related to self-perceptions of appearance (#12, #14) and health (#2) also stood out, as well as following traditional masculine gender roles (#17), being forgetful (#8), knowing how to comfort others (#13), and a tendency for boredom (#20).

When additionally accounting for education, the items most strongly related to BMI largely remained the same as those reported in Tables 3–5. In NEO-PI-3 data, 18 of the 20 items overlapped regardless of whether education was accounted for. In IPIP-NEO data and 100NP data, 19 items overlapped. While there were slight changes in the magnitude of correlations and the order of the items, additionally controlling for education did not therefore make a major difference to the overall results.

Of the 69 items shared by IPIP-NEO and 100NP, three were present in both top lists (“Am able to control my cravings,” “Easily resist temptations,” and “Leave a mess in my room”). Two of the shared items were found in the list of 100NP (“Have a low opinion of myself,” “Act without thinking”) and one was in the list of IPIP-NEO (“Yell at people”). Sixty-three were present in neither. To get a sense of the extent to which an item’s correlations with BMI differ between the two samples, we estimated the correlation of the 69 overlapping items’ associations with BMI in each sample. The vectors of the 69 items’ correlations with BMI in the samples correlated at $r = .66$ ($p < .001$), suggesting that the correlations in different samples overlapped substantially.

Finally and as expected, in each inventory, various items correlated with BMI more strongly than domains did. In the NEO-PI-3 sample, the strongest domain-level correlation was $-.06$; in IPIP-NEO, $.11$, and in the 100NP dataset, this was $-.10$. For single items,

however, correlations were in many cases stronger (up to .13, -.19, and -.21, respectively, excluding eating-related items), suggesting that these narrow personality traits may be particularly relevant in body weight.

ABCD Components

First, we determined whether the proportions of ABCD content of the five domains were similar in the three inventories. We found that to be largely the case, although a few differences could be seen. For instance, among the NEO-PI-3 items, agreeableness had a higher proportion of cognitive content, whereas in the other inventories the domain was more balanced in its content; extraversion in the NEO-PI-3 was highest in affective content but behavioral in the other inventories. Across all items, the NEO-PI-3 had a somewhat higher cognitive content and slightly lower behavioral content when compared to the other inventories. However, the item content of the three inventories largely resembled the proportions reported elsewhere (Pytlik Zillig et al., 2002; Wilt & Revelle, 2015). Importantly for the current results, the overall similarity of the item content across inventories suggests that the three inventories were comparable in terms of ABCD content. Item content of the three inventories is illustrated in Figure S1. Although some items were relatively more „pure“ in their content, not a single item was rated as reflecting just one component. Instead, items tended to be mixtures of all four components. The distribution of individual items' content by domain can be seen in Figure S2.

Table 7 shows the correlations between each inventory's items' proportions of ABCD content and their correlations with BMI; analyses additionally accounting for education are reported in Table S7. The meta-analytic estimates showed that BMI was associated with items high in behavioral content regardless of accounting for education, and was additionally related to the proportions of cognitive and motivational content when accounting for education. Personality traits' correlations with BMI may therefore mainly be mediated by the behaviors relevant to the traits, although cognitions and motivations may additionally be relevant in these associations.

Table 7*Correlations Between Personality Items' ABCD Content and Their Correlations With BMI*

Component	NEO-PI-3	IPIP-NEO	100NP	Meta-analysis		
				B [95% CI]	Z	p
Affective	-.06 [-.18, .06]	-.03 [-.15, .09]	-.02 [-.14, .10]	-.04 [-.10, .02]	-1.06	.290
Behavioral	.26 [.14, .38]	.10 [-.02, .22]	.14 [.02, .26]	.17 [.11, .23]	4.81	< .001
Cognitive	-.18 [-.30, -.06]	-.02 [-.14, .10]	-.04 [-.16, .08]	-.08 [-.14, -.02]	-2.01	.063
Desire	-.02 [-.14, .10]	-.07 [-.19, .05]	-.15 [-.27, -.03]	-.08 [-.14, -.02]	-2.31	.063

Note. Coefficients for the three inventories are Spearman's ρ with 95% confidence intervals. Two eating-related items have been removed from both NEO-PI-3 and IPIP-NEO to avoid inflation of the estimates. Correlations between BMI and personality items were adjusted for age, age², sex, and, for IPIP-NEO and 100NP, geographic location. Meta-analytic p -values are adjusted for false discovery rate.

Discussion

This exploration of BMI's cross-sectional associations with personality nuances and their content adds to previous domain- and facet-level analyses in various ways. BMI correlated with many nuances across the personality space rather than being associated with only few narrow traits, and these nuance-level correlations were often stronger than domain-level correlations. Moreover, the correlations between BMI and the items in each domain varied considerably in their size and direction, suggesting that the domain level is often not optimal for describing personality traits' associations with BMI, at least when simplicity is not paramount such as in case of public engagement. It therefore seems that there is a lot in personality that is linked with BMI, but analyses with broader traits do not (and cannot) adequately represent the multitude and strength of nuance-level associations. BMI-personality trait associations appeared to be driven by behavioral item content, suggesting that traits may largely relate to adiposity through behaviors related to the traits.

BMI and Nuances of Personality

Facet-level analyses have previously shown that narrower traits correlate with outcomes like BMI irrespective of the broader traits that subsume them (Vainik et al., 2019). As we expected, the same held for nuances. Indeed, BMI had substantial correlations with items included in each Five-Factor Model domain, although it did not correlate with all domains. Nuance-level analyses identified that, in all three datasets, the items most strongly related to BMI included items related to orderliness or discipline (conscientiousness), immoderation and impulsivity (neuroticism/conscientiousness), getting angry and holding grudges (agreeableness/neuroticism), traditionalism and conservative beliefs (openness), self-consciousness (neuroticism), as well as leadership tendencies and

talkativeness (extraversion). These items may or may not be included in the domains of particular inventories: if they are, the domains are more likely to be correlated with BMI as well.

Some of the item-level correlations are well in line with previous domain- and facet-level findings. For instance, the positive correlations with items reflecting leadership tendencies (“Act as a leader”, “Emerges as a leader”) and talkativeness (“Is the most talkative person in conversations”, “Talk a lot”) mirror the association between BMI and assertiveness (Sutin et al., 2011; Terracciano et al., 2009). The negative correlations between BMI and items like “Is meticulous” and “Leave a mess in my room” similarly resemble the repeatedly reported correlation with orderliness (Sawhney et al., 2020; Sutin et al., 2018). Further, items related to anger (“Seldom get mad”, “Yell at people”) and making enemies (“Hold a grudge”, “Make enemies”) seem to conceptually align with the positive association between BMI and hostility (Gerlach et al., 2015). Therefore, nuance-level analyses often capture similar associations as have been found in analyses with broader traits. This makes sense: after all, if a facet or domain is associated with an outcome (BMI), then this association must be driven by the items that make up these broader traits.

In some cases, however, the domain- and nuance-level correlations were less aligned with each other, as has been previously observed with some domain- and facet-level correlations (Vainik et al., 2019). For instance, despite the significant negative correlation between BMI and conscientiousness in the IPIP-NEO dataset, the 20 items with the strongest correlations only included a single item from this domain. This suggests that even if BMI most consistently associates with the domain conscientiousness, it has stronger correlations with items of other domains. As another example, despite there being no domain-level correlation with openness in the NEO-PI-3 dataset, items within this domain (“Vacations in different places”, “Values sticking with principles rather than being flexible-minded”, “Enjoys letting fantasies develop”) did associate with BMI. In some cases, therefore, domains seem to be too broadly defined to detect associations, even if nuances entailed in them have substantial correlations with BMI. This supports the premise of the current study: in order to get a thorough understanding of what exactly in personality relates to BMI, narrow traits need to be considered.

Further, the results of the three inventories differed considerably in some cases. For instance, some domains were represented in very different numbers among the 20 strongest-correlated items between the inventories. Most notably, extraversion was represented with ten items in the case of the NEO-PI-3 dataset and with only one in the case of the IPIP-NEO dataset. Although differences like this may be due to sample characteristics or the particular items in the inventories, it may also suggest that different trait configurations may correspond to similar levels of BMI—or, as has been stated previously: there is no single personality profile associated with obesity (Generali & De Panfilis, 2018). In the NEO-PI-3 dataset, higher BMI was associated with lower orderliness or

discipline combined with higher scores on talkativeness, leadership tendencies, positive emotions, and traditionalism. In the IPIP-NEO dataset, in contrast, higher BMI appeared to associate with high immoderation combined with higher conservatism/traditionalism and a tendency towards feeling anger. The items most strongly related to BMI in the 100NP dataset varied the most in content, but this may not be surprising given that the inventory was designed to measure a broad range of nuances rather than a smaller number of internally consistent domains or facets. To conclude, however, it appears that people with high BMI are not alike: rather, overweight (as well as normal weight and underweight) are associated with different configurations of traits.

BMI and Personality Item Content

The meta-analytic results suggested that items most strongly related to BMI had, on average, higher behavioral content. This is consistent with personality influencing BMI through health-relevant behavior, a prominent hypothesis to explain their associations (Keller & Siegrist, 2015; Lunn et al., 2014). For instance, some traits have behavioral expressions that clearly relate to intake or expenditure of calories: traits related to activity levels entail keeping busy and moving vigorously (Costa & McCrae, 1992) which require energy; traits related to getting angry can lead to impulsive eating behavior (Canetti et al., 2002), increasing energy intake. If personality traits represent the frequency of trait-relevant expressions (Fleeson & Jayawickreme, 2015) such as certain kinds of behaviors, the current results are consistent with the view that personality traits can increase body weight through, for instance, altering the frequency of behaviors that increase or decrease intake or expenditure of calories.

While the finding that BMI is related to behavioral personality-related processes is consistent with previous literature, it is more surprising that no consistent association appeared between BMI and, for instance, affective item content. After all, studies have shown that positive and negative emotions alike can increase calorie intake (Canetti et al., 2002; Evers et al., 2018; Sultson et al., 2017). Because affective items represent all kinds of emotions regardless of valence, it seems likely that a propensity for affective experiences would lead to increases in weight. Of course, the current results do not rule out the influence of affective item content on BMI. Similarly, rather than suggesting that certain cognitions and motivations cannot be reliably linked to BMI, these results indicate that BMI does not seem to have any systemic associations with the strength, variety, or frequency of different cognitions or motivations. Indeed, the items reflecting cognition are very diverse in content, reflecting a variety of beliefs, opinions, cognitive abilities, and other peculiarities in information processing (see Wilt & Revelle, 2015, for an overview of items with high cognitive content). Therefore, many types of affective, cognitive, and motivational processes may still associate with BMI. Perhaps BMI relates to only specific types of affective, cognitive, and motivational processes while being

unrelated to most, which is why we did not find such a consistent correlation as we did with behavior.

Still, when additionally accounting for education, cognitive and motivational content was also significantly related to BMI in addition to behavioral content. As a potential explanation, the variability of cognitions and motivations associated with different levels of education may suppress the association between BMI and personality item content, but certain types of thoughts and motivations may mediate the association between BMI and personality traits within groups of people with similar levels of education. However, because BMI's association with these types of item content was not consistent across analyses, these effects should be interpreted with caution.

It should be noted that we may have been limited in our ability to detect BMI's associations with item content due to the nature of the variables analyzed. Because the proportions of ABCD content in each item had to add up to 100%, a higher weight for one component meant lower weights for others and the proportion of ABCD content in each item indicated the *relative* importance of the components in regard to BMI. As also pointed out by [Wilt & Revelle \(2015\)](#), relying on percentage data can artificially introduce negative correlations between the ABCD domains. This dependency can ultimately manifest in the ABCD components' correlations with BMI: for instance, if the component that correlates with BMI most strongly has a positive association with it, then BMI's correlations with other components may turn out negative. Therefore, the correlations should be interpreted as the contribution of a component to a trait's correlation with BMI in relation to the other components.

Implications

As discussed above (and as expected), BMI correlated with a broad range of narrow traits independently of and often more strongly than with their domains. Indeed, it also correlated with items in the 100NP dataset that did not belong in any domains. Thus, there seems to be a lot in personality that relates to BMI: results suggest that body weight correlates with items within each domain as well as items not covered by those domains, and its associations with various nuances appear stronger than its correlations with broader traits. Knowing which narrow traits are most strongly related to BMI can ultimately help pinpoint which specific trait-related expressions (e.g., behaviors) primarily account for their links with body weight. Indeed, it has been argued that all aspects of a broad trait are unlikely to be equally relevant in health outcomes, and when it comes to personality-focused health interventions, certain specific aspects of the traits may be the appropriate targets ([Chapman, 2013](#); [Murray & Booth, 2015](#)). Our results are consistent with this view and suggest that if personality traits are ever to be considered in weight-management interventions, narrow traits and their behavioral manifestations may be the most appropriate targets. Nuance-level analyses may help pinpoint what have been called the “active ingredients” of personality traits ([Chapman, 2013](#)) that may

most likely lead to improvements in health outcomes if the traits can be successfully altered.

But which items represent meaningfully unique nuances to qualify as the “active ingredients” of personality in relation to BMI? Neither the cross-sectional associations nor our intuition is the best guide in saying which items are meaningful or intervenable influences on BMI. This question can be addressed with data that allows for stronger causal inferences such as longitudinal or genetically informative data: nuances that appear to be causally linked with BMI are more likely to be the active ingredients whereas those that appear to simply (e.g., spuriously) correlate with or be influenced by BMI (Arumäe et al., 2021) are less likely to be the active ingredients.

However, the current results do suggest that the item-level associations should probably not be generalized to domains. If a domain correlates with an outcome, then all of its components (e.g., facets and nuances) should also correlate with the outcome for it to make sense that the outcome associates with the domain as a whole (Vainik et al., 2015). If, on the other hand, the components of a domain correlate with the outcome differently, then this would indicate that the components’ correlations should not be generalized to the domain. In the case of BMI, it was fairly clear that the items in any of the five domains did not correlate with BMI uniformly regardless of the inventory, and therefore the associations seem to pertain to traits narrower than domains.

But beyond clarifying BMI’s associations with personality traits, the results also suggest that different inventories and different samples can lead to different results. Although the strongest nuance-level associations highlighted certain narrow traits that appeared to correlate with BMI consistently, some associations appeared more dependent on the particular dataset. One noteworthy difference between the inventories is the absence of strong correlations with impulsivity-related traits in the NEO-PI-3 data (aside from the ones with the two eating-related items). Similar results have been observed before and it has been concluded that the association between BMI and the trait impulsiveness is mostly driven by these eating-related items (Terracciano et al., 2009). In contrast, items related to impulsivity and immoderation were among the highest correlated with BMI in both IPIP-NEO and 100NP datasets, suggesting that people with high BMI are also impulsive in other ways beyond tending to overeat. Why exactly most of the items in the impulsiveness facet of NEO-PI-3 do not associate with BMI is unclear, but nevertheless, these results illustrate the importance of using different instruments, even to measure the ostensibly same constructs, to fully understand traits’ associations with BMI and other outcomes.

Differences between inventories and samples were also evident in domain-level correlations. Even though all three inventories measure the same domains, these domains’ correlations with BMI were, at times, substantially different, ranging from .02 to .11 for neuroticism and from -.09 to .01 for openness. Whether these differences are due to the different items included in each inventory or due to sample characteristics, the correla-

tions suggest that relying on broader traits and a single inventory is likely insufficient to understand what in personality relates to BMI. If the differences in the domain-level correlations are due to the way different inventories measure the traits, it would be hard to say which of the estimates is the most “correct”. However, in this situation, nuance-level analyses can bring some clarity. To conclude, these results illustrate the necessity of using inventories that cover a broad set of (narrow) personality traits.

Limitations

While using different samples and different inventories is a strength of this study, it is nevertheless hard to tell where domain- and nuance-level correlations differed between datasets due to the way particular inventories conceptualize or measure these traits and where they differed due to sample characteristics. Although the samples included people of diverse backgrounds, people of western countries were altogether overrepresented in the current study. The IPIP-NEO and 100NP samples were likely affected by self-selection bias; for instance, both samples had higher average levels of openness than the Estonian Biobank sample. Sample characteristics should therefore be considered when interpreting and comparing the results of the different datasets.

Further, it should also be considered that all items in each personality inventory may not be equally good representations of actual personality nuances. That is, items differ in the extent to which they capture unique variance in personality, with nuances that have higher cross-rater agreement also having, on average, higher rank-order stability and heritability (Mõttus et al., 2019). Even though the current study considered a larger number of personality traits than previous studies have, this is by no means a comprehensive set of personality items, and other nuances not included here may also have meaningful correlations with BMI.

Finally, although cross-sectional correlations can generate hypotheses, they are uninformative on the existence of causal relations: longitudinal or causal associations may not even match cross-sectional ones. Studies aiming to test if the nuance–BMI links are consistent with causal influences of nuances on BMI (or *vice versa*) could compare mediation models to test possible causal pathways and to rule out possible confounders (Deary et al., 2010), as well as make use of longitudinal and genetically informative designs. Although these possibilities are limited by the availability of nuanced personality data (e.g., large studies tend to use brief personality inventories), these kinds of data are more likely to be collected once the relevance of narrow personality traits in important life outcomes becomes more widely acknowledged.

Conclusions

To summarize, we found that BMI correlated with many narrow traits across the personality space and that these correlations were often stronger than correlations with broad

traits. Analyses with item content indicated that BMI may primarily relate to behavioral content of personality traits. Beyond describing how people with overweight differ from others, these results may have implications for weight-management interventions: if personality traits can be considered in these interventions, narrow traits and their behavioral manifestations may ultimately be the optimal level of personality-related phenomena to target. Finally, the results indicate that the clearest understanding of the personality profile(s) that accompany high BMI can be best understood by using inventories that cover a large number of traits.

Funding: Uku Vainik has been funded by Estonian Research Council's personal research funding start-up grants PSG656 and PSG759. The funder had no role in the study's design, execution, analysis, interpretation, or reporting.

Acknowledgments: We are grateful to Joshua Wilt and William Revelle for sharing the item content ratings for IPIP-NEO items, as well as to Dmitri Rozgonjuk for sharing the ratings from the additional three individuals. We also thank Shivani Khanna and Raffaele Gidoro for their contribution to collecting the item content ratings for 100NP items, and Sam Henry for help with collecting the 100NP self-report data.

Competing Interests: The authors have declared that no competing interests exist.

Author Contributions: *Kadri Arumäe*—Idea, conceptualization | Design planning | Research implementation (software, hardware, etc.) | Data collection | Visualization (data presentation, figures, etc.) | Data analysis | Writing | Feedback, revisions | Project coordination, administration. *Uku Vainik*—Resource provision (materials, participants, etc.) | Data collection | Feedback, revisions | Supervision, mentoring | Funding to conduct the work. *René Mõttus*—Idea, conceptualization | Design planning | Resource provision (materials, participants, etc.) | Data collection | Feedback, revisions | Supervision, mentoring.

Data Availability: For this article, data is freely available ([Arumäe et al., 2022a](#)).

Supplementary Materials

For this article, the following Supplementary Materials are available (for access see [Index of Supplementary Materials](#) below):

- Item content ratings for NEO-PI-R and NEO-PI-3
- Analysis code
- Supplementary tables and figures
- Domains assigned to the items of 100NP using PCA
- Open peer-review

Index of Supplementary Materials

- Arumäe, K., Vainik, U., & Möttus, R. (2022a). *Supplementary materials to "Body mass is linked with a broad range of personality nuances, but especially those with behavioral content: A multi-sample exploration"* [Data]. PsychOpen GOLD. <https://doi.org/10.23668/psycharchives.8264>
- Arumäe, K., Vainik, U., & Möttus, R. (2022b). *Supplementary materials to "Body mass is linked with a broad range of personality nuances, but especially those with behavioral content: A multi-sample exploration"* [Code]. PsychOpen GOLD. <https://doi.org/10.23668/psycharchives.8263>
- Arumäe, K., Vainik, U., & Möttus, R. (2022c). *Supplementary materials to "Body mass is linked with a broad range of personality nuances, but especially those with behavioral content: A multi-sample exploration"* [Additional Materials]. PsychOpen GOLD. <https://doi.org/10.23668/psycharchives.8262>
- Personality Science. (Ed.). (2022). *Supplementary materials to "Body mass is linked with a broad range of personality nuances, but especially those with behavioral content: A multi-sample exploration"* [Open peer-review]. PsychOpen GOLD. <https://doi.org/10.23668/psycharchives.8265>

References

- Adan, R. A. H., van der Beek, E. M., Buitelaar, J. K., Cryan, J. F., Hebebrand, J., Higgs, S., Schellekens, H., & Dickson, S. L. (2019). Nutritional psychiatry: Towards improving mental health by what you eat. *European Neuropsychopharmacology*, *29*(12), 1321–1332. <https://doi.org/10.1016/j.euroneuro.2019.10.011>
- Arumäe, K., Briley, D., Colodro-Conde, L., Mortensen, E. L., Jang, K., Ando, J., Kandler, C., Sørensen, T. I. A., Dagher, A., Möttus, R., & Vainik, U. (2021). Two genetic analyses to elucidate causality between body mass index and personality. *International Journal of Obesity*, *45*, 2244–2251. <https://doi.org/10.1038/s41366-021-00885-4>
- Arumäe, K., Möttus, R., & Vainik, U. (2022). Beyond BMI: Personality traits' associations with adiposity and metabolic rate. *Physiology & Behavior*, *246*, Article 113703. <https://doi.org/10.1016/j.physbeh.2022.113703>
- Bjerregaard, L. G., Jensen, B. W., Ångquist, L., Osler, M., Sørensen, T. I. A., & Baker, J. L. (2018). Change in overweight from childhood to early adulthood and risk of type 2 diabetes. *The New England Journal of Medicine*, *378*(14), 1302–1312. <https://doi.org/10.1056/NEJMoa1713231>
- Canetti, L., Bachar, E., & Berry, E. M. (2002). Food and emotion. *Behavioural Processes*, *60*(2), 157–164. [https://doi.org/10.1016/S0376-6357\(02\)00082-7](https://doi.org/10.1016/S0376-6357(02)00082-7)
- Chapman, B. P. (2013). Invited commentary: Personality phenotype and mortality—New avenues in genetic, social, and clinical epidemiology. *American Journal of Epidemiology*, *178*(5), 676–678. <https://doi.org/10.1093/aje/kwt169>
- Condon, D. (2018). *The SAPA Personality Inventory: An empirically-derived, hierarchically-organized self-report personality assessment model* [Preprint]. PsyArXiv. <https://doi.org/10.31234/osf.io/sc4p9>

- Condon, D., Roney, E., & Revelle, W. (2019). Selected personality data from the SAPA-Project: 22Dec2015 to 07Feb2017. *Harvard Dataverse*. <https://doi.org/10.7910/DVN/TZJGAT>
- Condon, D. M., Wood, D., Möttus, R., Booth, T., Costantini, G., Greiff, S., Johnson, W., Lukaszewski, A., Murray, A., Revelle, W., Wright, A. G. C., Ziegler, M., & Zimmermann, J. (2020). Bottom up construction of a personality taxonomy. *European Journal of Psychological Assessment*, 6, 923–934. <https://doi.org/10.1027/1015-5759/a000626>
- Costa, P. T., & McCrae, R. R. (1992). *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional manual*. Psychological Assessment Resources.
- Deary, I. J., Weiss, A., & Batty, G. D. (2010). Intelligence and personality as predictors of illness and death: How researchers in differential psychology and chronic disease epidemiology are collaborating to understand and address health inequalities. *Psychological Science in the Public Interest*, 11(2), 53–79. <https://doi.org/10.1177/1529100610387081>
- Dudley, N. M., Orvis, K. A., Lebiecki, J. E., & Cortina, J. M. (2006). A meta-analytic investigation of conscientiousness in the prediction of job performance: Examining the intercorrelations and the incremental validity of narrow traits. *The Journal of Applied Psychology*, 91(1), 40–57. <https://doi.org/10.1037/0021-9010.91.1.40>
- Elleman, L. G., McDougald, S. K., Condon, D. M., & Revelle, W. (2020). That takes the BISCUIT: Predictive accuracy and parsimony of four statistical learning techniques in personality data, with data missingness conditions. *European Journal of Psychological Assessment*, 36(6), 948–958. <https://doi.org/10.1027/1015-5759/a000590>
- Evers, C., Dingemans, A., Junghans, A. F., & Boevé, A. (2018). Feeling bad or feeling good, does emotion affect your consumption of food? A meta-analysis of the experimental evidence. *Neuroscience and Biobehavioral Reviews*, 92, 195–208. <https://doi.org/10.1016/j.neubiorev.2018.05.028>
- Fleeson, W., & Jayawickreme, E. (2015). Whole trait theory. *Journal of Research in Personality*, 56, 82–92. <https://doi.org/10.1016/j.jrp.2014.10.009>
- Generali, I., & De Panfilis, C. (2018). Personality traits and weight loss surgery outcome. *Current Obesity Reports*, 7(3), 227–234. <https://doi.org/10.1007/s13679-018-0315-x>
- Gerlach, G., Herpertz, S., & Loeber, S. (2015). Personality traits and obesity: A systematic review. *Obesity Reviews*, 16(1), 32–63. <https://doi.org/10.1111/obr.12235>
- Goldberg, L. R. (1999). A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. J. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe* (Vol. 7, pp. 7–28). Tilburg University Press.
- Jokela, M., Hintsanen, M., Hakulinen, C., Batty, G. D., Nabi, H., Singh-Manoux, A., & Kivimäki, M. (2013). Association of personality with the development and persistence of obesity: A meta-analysis based on individual-participant data. *Obesity Reviews*, 14(4), 315–323. <https://doi.org/10.1111/obr.12007>
- Keller, C., & Siegrist, M. (2015). Does personality influence eating styles and food choices? Direct and indirect effects. *Appetite*, 84, 128–138. <https://doi.org/10.1016/j.appet.2014.10.003>

- Kim, J. (2016). Personality traits and body weight: Evidence using sibling comparisons. *Social Science & Medicine*, *163*, 54–62. <https://doi.org/10.1016/j.socscimed.2016.06.054>
- Leitsalu, L., Haller, T., Esko, T., Tammesoo, M.-L., Alavere, H., Snieder, H., Perola, M., Ng, P. C., Mägi, R., Milani, L., Fischer, K., & Metspalu, A. (2015). Cohort profile: Estonian Biobank of the Estonian Genome Center, University of Tartu. *International Journal of Epidemiology*, *44*(4), 1137–1147. <https://doi.org/10.1093/ije/dyt268>
- Lewis, C. E., McTigue, K. M., Burke, L. E., Poirier, P., Eckel, R. H., Howard, B. V., Allison, D. B., Kumanyika, S., & Pi-Sunyer, F. X. (2009). Mortality, health outcomes, and body mass index in the overweight range. *Circulation*, *119*(25), 3263–3271. <https://doi.org/10.1161/CIRCULATIONAHA.109.192574>
- Lunn, T. E., Nowson, C. A., Worsley, A., & Torres, S. J. (2014). Does personality affect dietary intake? *Nutrition*, *30*(4), 403–409. <https://doi.org/10.1016/j.nut.2013.08.012>
- McCrae, R. R. (2015). A more nuanced view of reliability: Specificity in the trait hierarchy. *Personality and Social Psychology Review*, *19*(2), 97–112. <https://doi.org/10.1177/1088868314541857>
- McCrae, R. R., Costa, P. T., Jr., & Martin, T. A. (2005). The NEO-PI-3: A more readable revised NEO Personality Inventory. *Journal of Personality Assessment*, *84*(3), 261–270. https://doi.org/10.1207/s15327752jpa8403_05
- Möttus, R., Kandler, C., Bleidorn, W., Riemann, R., & McCrae, R. R. (2017). Personality traits below facets: The consensual validity, longitudinal stability, heritability, and utility of personality nuances. *Journal of Personality and Social Psychology*, *112*(3), 474–490. <https://doi.org/10.1037/pspp0000100>
- Möttus, R., Sinick, J., Terracciano, A., Hřebíčková, M., Kandler, C., Ando, J., Mortensen, E. L., Colodro-Conde, L., & Jang, K. L. (2019). Personality characteristics below facets: A replication and meta-analysis of cross-rater agreement, rank-order stability, heritability, and utility of personality nuances. *Journal of Personality and Social Psychology*, *117*(4), e35–e50. <https://doi.org/10.1037/pspp0000202>
- Murray, A. L., & Booth, T. (2015). Personality and physical health. *Current Opinion in Psychology*, *5*, 50–55. <https://doi.org/10.1016/j.copsyc.2015.03.011>
- Pytlik Zillig, L. M., Hemenover, S. H., & Dienstbier, R. A. (2002). What do we assess when we assess a Big 5 trait? A content analysis of the affective, behavioral, and cognitive processes represented in Big 5 personality inventories. *Personality and Social Psychology Bulletin*, *28*(6), 847–858. <https://doi.org/10.1177/0146167202289013>
- Revelle, W., Dworak, E. M., & Condon, D. M. (2021). Exploring the persome: The power of the item in understanding personality structure. *Personality and Individual Differences*, *169*, Article 109905. <https://doi.org/10.1016/j.paid.2020.109905>
- Roberts, B. W., & Yoon, H. J. (2022). Personality psychology. *Annual Review of Psychology*, *73*(1), 489–516. <https://doi.org/10.1146/annurev-psych-020821-114927>
- Sawhney, M., Hawkins, M. A. W., Stout, M. E., Keirns, N. G., Mullins-Sweatt, S. N., & Finn, J. A. (2020). The facets of conscientiousness and body mass index: Potential mediation by eating

- factors. *Personality and Individual Differences*, 166, Article 110157.
<https://doi.org/10.1016/j.paid.2020.110157>
- Seeboth, A., & Möttus, R. (2018). Successful explanations start with accurate descriptions: Questionnaire items as personality markers for more accurate predictions. *European Journal of Personality*, 32(3), 186–201. <https://doi.org/10.1002/per.2147>
- Sultson, H., Kukk, K., & Akkermann, K. (2017). Positive and negative emotional eating have different associations with overeating and binge eating: Construction and validation of the Positive-Negative Emotional Eating Scale. *Appetite*, 116, 423–430.
<https://doi.org/10.1016/j.appet.2017.05.035>
- Sutin, A. R., Ferrucci, L., Zonderman, A. B., & Terracciano, A. (2011). Personality and obesity across the adult life span. *Journal of Personality and Social Psychology*, 101(3), 579–592.
<https://doi.org/10.1037/a0024286>
- Sutin, A. R., Stephan, Y., & Terracciano, A. (2018). Facets of conscientiousness and objective markers of health status. *Psychology & Health*, 33(9), 1100–1115.
<https://doi.org/10.1080/08870446.2018.1464165>
- Sutin, A. R., & Terracciano, A. (2017). Personality and body weight: Mechanisms, longitudinal associations and context. *The Japanese Journal of Personality*, 26(1), 1–11.
<https://doi.org/10.2132/personality.26.1.1>
- Terracciano, A., Sutin, A. R., McCrae, R. R., Deiana, B., Ferrucci, L., Schlessinger, D., Uda, M., & Costa, P. T. (2009). Facets of personality linked to underweight and overweight. *Psychosomatic Medicine*, 71(6), 682–689. <https://doi.org/10.1097/PSY.0b013e3181a2925b>
- Vainik, U., Dagher, A., Realo, A., Colodro-Conde, L., Mortensen, E. L., Jang, K., Juko, A., Kandler, C., Sørensen, T. I. A., & Möttus, R. (2019). Personality-obesity associations are driven by narrow traits: A meta-analysis. *Obesity Reviews*, 20(8), 1121–1131. <https://doi.org/10.1111/obr.12856>
- Vainik, U., Möttus, R., Allik, J., Esko, T., & Realo, A. (2015). Are trait-outcome associations caused by scales or particular items? Example analysis of personality facets and BMI. *European Journal of Personality*, 29(6), 622–634. <https://doi.org/10.1002/per.2009>
- Van Gaal, L. F., Mertens, I. L., & De Block, C. E. (2006). Mechanisms linking obesity with cardiovascular disease. *Nature*, 444, 875–880. <https://doi.org/10.1038/nature05487>
- Wilt, J., & Revelle, W. (2015). Affect, behaviour, cognition and desire in the big five: An analysis of item content and structure. *European Journal of Personality*, 29(4), 478–497.
<https://doi.org/10.1002/per.2002>

The logo for the European Association of Personality Psychology (EAPP), consisting of the lowercase letters 'eapp' in white on a dark green rectangular background.

Personality Science (PS) is an official journal of the European Association of Personality Psychology (EAPP).



leibniz-psychology.org

PsychOpen GOLD is a publishing service by Leibniz Institute for Psychology (ZPID), Germany.