Association of eating motives with anthropometry, body composition, and dietary intake in healthy German adults

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A R T I C L E I N F O

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A B S T R A C T

Effective policies to address poor food choices and dietary patterns need to consider the complex set of motives affecting eating behavior. This study examined how different eating motives are associated with anthropometry, body composition, and dietary intake. Our analysis is based on a cross-sectional sample with 429 healthy adults in three different age groups collected in Germany from 2016 to 2018. Dietary intake, Body Mass Index (BMI), waist circumference (WC), and fat-free mass (FFM) were measured by standardized methods. Eating motives were measured using The Eating Motivation Scale (TEMS). Regressing dietary intakes and anthropometric indicators on TEMS motives, we identify the main sources of variation in diet and nutritional status separately for men and women. Results indicated the *Health* motive to be positively associated with FFM ($B \pm SE = 1.72 \pm 0.44$) and negatively with WC ($B \pm SE = -3.23 \pm 0.81$) for men. For women, the *Need & Hunger* motive was positively associated with FFM ($B \pm SE = 1.63 \pm 0.44$) and negatively with WC ($B \pm SE = -2.46 \pm 0.81$). While *Liking* and *Habits* were the most frequently stated eating motives, we did not find them to be significantly related to the nutritional status. Other motives were associated with dietary intake but not anthropometry or body composition. The *Price* motive was positively and the *Convenience* motive was negatively associated with energy ($B \pm SE = 63.77 \pm 19.98$; $B \pm SE = -46.96 \pm 17.12$) and carbohydrate intake ($B \pm SE = 7.15 \pm 2.65$; $B \pm SE = -5.98 \pm 2.27$) for men. The results highlight the need for more differentiated analyses of eating motives, beyond comparing the relative importance of motives based on mean values, towards the association of motives with dietary intake and nutritional status.

1. Introduction

Unhealthy diets and poor nutrition are among the top risk factors worldwide for obesity, cardiovascular diseases, and diabetes. The World Health Organization (WHO) estimates that more than 1.9 billion adults were overweight and 650 million of these were obese in 2016 (World Health Organization, 2020a) and that the prevalence of diabetes among adults increased from 4.7% in 1980 to 8.5% in 2014 (World Health Organization, 2020b). The scientific and public debate about appropriate and effective policies to counter these developments increasingly acknowledges that poor food choices and dietary patterns are the results of multiple motives and determinants (Naughton et al., 2015; Pollard et al., 1998, 2002; Sproesser, Moraes, et al., 2019; Steptoe et al., 1995). Hence, there is no 'one-size-fits-all' solution (Hawkes et al., 2015; Just & Gabrielyan, 2016; Lusk, 2017) as the factors affecting food choice and eating behavior are complex (Köster, 2009).

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Literature has discussed a wide range of different motives that affect food choice (Renner et al., 2012). Compiling, extending, and consolidating the empirical evidence on motives for eating behavior since Steptoe et al.'s (1995) seminal study, Renner et al. (2012) developed The Eating Motivation Scale (TEMS). Their measure includes 15 factors, which are *Liking, Habits, Need & Hunger, Health, Convenience, Pleasure, Traditional Eating, Natural Concerns, Sociability, Price, Visual Appeal, Weight Control, Affect Regulation, Social Norms*, and *Social Image* (Renner et al., 2012).

A growing number of studies has investigated the relative importance of food choice motives in general, across socio-demographics, by body weight, and across different countries and cultures. *Liking* or *Sensory Appeal, Habits, Need & Hunger, Health, Convenience* and *Price* are consistently reported as the most prominent drivers of food choice (Chambers et al., 2016; Phan & Chambers, 2016a; Renner et al., 2012; Sproesser, Moraes, et al., 2019; Sproesser, Ruby, et al., 2018; Steptoe et al., 1995). Results for different age groups suggest that factors driving younger consumers' eating behavior are more "short-term oriented" (Renner et al., 2012) including *Liking, Need & Hunger, Pleasure, Convenience, and Visual Appeal*. For older people, in contrast, long-term motives such as *Health* and *Natural Concerns* have been found to be more relevant based on TEMS (Renner et al., 2012). Another recurring finding is that women rated most motives significantly higher on average than men (Renner et al., 2012; Steptoe et al., 1995).

Food choice motives have also been shown to vary with nutritional status indicated mainly by the Body Mass Index (BMI). Renner et al. (2012) found that participants in the normal-weight range reported their eating behavior to be driven more frequently by *Liking*, *Health*, and *Need & Hunger*. The motives *Weight Control*, *Affect Regulation*, and *Social Norms* were more prevalent among participants who had overweight or obesity. Similar findings are reported by Sproesser, Moraes, et al. (2019) and Rempe et al. (2019).

While it is important to quantify the self-reported motives in their own right, targeted public policy measures need information on how these different motives drive actual eating behavior, and intake of critical nutrients, as well as how they affect both the nutrition and health status. Studies have shown that motives are associated with choice and consumption of individual food groups (Hebden et al., 2015; Phan & Chambers, 2016b; Souza et al., 2020) and vary over eating occasions (Chambers et al., 2016; Phan & Chambers, 2016a, 2018). Motives have further been shown to be associated with preferences for specific food product attributes such as 'organic' or 'local' (Hasselbach & Roosen, 2015; Honkanen et al., 2006) or functional properties in food products (Ares & Gámbaro, 2007).

However, empirical evidence on how motives drive nutritional and health outcomes such as dietary intakes and indicators of nutritional status other than BMI is scarce. The present study contributes to the literature by providing empirical evidence on how different eating motives are associated with variation in anthropometric parameters, body composition, and dietary intake. Collecting evidence on the relative importance of motives and their association with consumption of specific food groups, diets, or meal occasions, is important for understanding drivers of food choice. At the same time, investigating which motives drive health- and nutrition-relevant behavior and outcomes, may yield specific insights on the levers that health and nutrition policies should be addressing.

Our analysis is based on a unique dataset from a study with 429 healthy adults at three defined age groups conducted in Germany from 2016 to 2018 (Brandl et al., 2020). The collected data include information on usual dietary intake (Mitry et al., 2019) for a wide range of energy and macronutrients, anthropometric measures (BMI and waist circumference), and body composition. Additionally, participants reported socio-demographic variables and their eating motivations by completing The Eating Motivation Scale (TEMS) (Renner et al., 2012). We regressed anthropometric indicators, body composition, and energy and nutrient intakes on motives from TEMS controlling for socio-demographic characteristics to identify associations that are responsible for variation in dietary intake and nutritional status separately for men and women. This approach goes one step further than existing literature, which has mostly analyzed relationships of motives with nutritional status or dietary intakes based on simple correlations or for specific subsets of motives. Since motives have been found to be correlated among each other as well as with socio-demographic characteristics, parameters of such analyses are likely to be biased when confounders are not accounted for.

2. Methods

2.1. Study design and participants

Data for this study come from the phenotyping program of the *enable* cluster of nutrition research performed between February 2016 and February 2018. The cluster's major objective was to identify determinants of a healthy nutrition and lifestyle for defined stages of life (Brandl et al., 2020). For this cross-sectional study, healthy volunteers were recruited from three different age groups, each of which is characterized by specific nutritional requirements and transitions in dietary habits and food selection: young adults aged 18–25 years (n = 94), adults aged 40–65 years ("middle agers", n = 205), and older adults aged 75–85 years (n = 160). While young adults and middle agers were recruited at one study site (Freising), participants in the older adults group came from two sites (Freising and Nuremberg, two cities in Bavaria, Germany). Participants were recruited by advertising in kindergarten, newspapers, senior homes, and other media in the region of Freising and Nuremberg, Germany. In total 459 healthy subjects were comprehensively phenotyped. Apart from anthropometry and body composition analysis, participants completed standardized questionnaires regarding their dietary intake and eating motives. The study was approved by the ethics committee of the Faculty of Medicine of Technical University of Munich (#492/17S) and by the ethics committee of Friedrich-Alexander-Universität Erlangen-Nürnberg (#291_15 B). It was registered on German Clinical Trial register (DRKS-ID: DRKS00009797). Written informed consent was obtained from all participants prior to the assessments. For detailed information on selection and eligibility criteria and study procedure see Brandl et al. (2020).

2.2. Dietary intake, anthropometry, and body composition

In the different age groups dietary habits were recorded by using a food frequency questionnaire (FFQ2) referring to a twelve-months period (Nöthlings et al., 2007) and two 24h-food lists (Freese et al., 2014). Based on these questionnaires, the "usual intake" of energy, carbohydrates, fat, protein, fiber, and alcohol for every participant was estimated by a multi-step procedure. First, the probability of consuming a certain food item was estimated using logistic regression models on the repeated 24h-food-list data, controlling for age, sex, BMI, smoking, physical activity level, education level, and the consumption frequency for each food item derived from the FFQ. Second, the consumption amount for each food item on a consumption day was estimated on the basis of the Second Bavarian Food Consumption Survey (BVS II) (Himmerich et al., 2003). The usual food intake was then derived by multiplying consumption probability and quantity of each food item. All usual food intakes were then linked to the "Bundeslebensmittelschlüssel" (BLS, German Nutrient Data Base) to derive the usual intake of energy and nutrients. Details on the procedure are described in detail in Mitry et al. (2019).

All anthropometric parameters (body height, body weight, waist and hip circumference) were measured in the morning following an overnight fast using established standard operation procedure (SOP). Body composition including fat free mass (FFM) and fat mass (FM) was measured by bioelectrical impedance using the Seca mBCA 515 device (Seca GmbH & Co KG, Hamburg, Germany).

2.3. Eating motives

All participants completed the German short version of the eating motivation survey (TEMS) consisting of 15 motivational factors, each measured by three items (Renner et al., 2012). For example, the items for the factor *Affect Regulation* started with "I eat what I eat, …" followed by 1) "… because I am sad", 2) "… because I am frustrated", and 3) "… because I feel lonely". Each item was measured on a 7-point Likert scale whose extremes were labeled as 1 "never" to 7 "always".

In order to compare the quality of our TEMS data with those of previous studies (Rempe et al., 2019; Renner et al., 2012; Sproesser, Ruby, et al., 2018), we tested the original model with a confirmatory factor analysis (CFA) allowing for correlated factors ('sem' and 'alpha' commands in Stata 14). Results of the CFA showed a very good fit as indicated by a comparative fit index (CFI) of 0.94, a root-mean-square error of approximation (RMSEA) of 0.043, a standardized root mean square residual (SRMR) of 0.045 and a χ^2/df-value of 1.8 (Kline, 2011). These values compare very well to or even exceed previous assessments of TEMS (Rempe et al., 2019; Renner et al., 2012; Sproesser, Ruby, et al., 2018). The factor loadings were significant ($p < .001$), with values larger than 0.4. Factor correlations ranged from −0.18 (*Price* and *Sociability*) to 0.53 (*Need & Hunger* and *Habits*). The Cronbach's Alpha values for the 15 factors indicated very good reliabilities, with the lowest value being 0.62 for *Need & Hunger*. For more details, see Table A1 in the appendix.

2.4. Data analysis

We analyzed the relation between eating motives and anthropometry, body composition, and dietary intake, respectively, via multiple regression models based on eq. (1):

$$Y_i = \left(\alpha + \sum_{j=1}^{15} \beta_j \cdot Motive_{ji} + \sum_{k=2}^{4} \delta_k \cdot Age\ Group_{ki} + \delta_5 \cdot Middle\ Income_i + \delta_6 \cdot High\ Income_i + \sum_{l=2}^{6} \eta_l \cdot Education_{li}\right) \cdot \left(D_{Male,\ i} + D_{Female,i}\right) + \varepsilon_i \quad (1)$$

Dependent variables Y_i were either anthropometric measures (BMI and waist circumference), body composition (FFM), or energy and nutrient intakes (energy, protein, carbohydrates, fat, fiber, alcohol) of participant *i*. The key explanatory variables were the 15 motivation factors ($Motive_{ji}$). We controlled for the effects of age groups, income, and education level, as these affect most of the dependent variables and have been shown to also correlate with the eating motives in previous studies (Renner et al., 2012). For these sets of categorical variables, *Age Group*$_1$, *Low Income*, and *Education*$_1$ were omitted as reference categories to avoid singularity. All independent variables including the constant were multiplied by the term $(D_{Male,\ i} + D_{Female,i})$, where D_{Male} and D_{Female} are binary indicators for male and female participants, respectively. This way we obtain a full set of motive parameters separately for men and women, which has two advantages. First, we have a larger sample size yielding more precise coefficient estimates. Second, we can immediately test for equality of male and female coefficients for each motive.

The set of equations for all dependent variables was estimated via seemingly unrelated regression (SUR) (Zellner, 1962), to account for correlated error terms within individuals across equations. For each equation, we test for equality of each parameter of all 30 motive-sex combinations with zero based on the standard errors and corresponding p-values provided by the regression. We consider multiplicity by controlling for the false discovery rate (FDR) using Benjamini and Hochberg's (1995) procedure. The p-values we report in the text represent adjusted p-values, i.e. so-called "q-values" derived by Stata's *qqvalue* command. We test for equality of male and female parameters for each motive using simple Wald tests after the regression (using Stata's *test* command).

3. Results

3.1. Sample characteristics

From the original sample, 29 observations were dropped because of incomplete dietary data and one person was dropped due to a missing BMI value, yielding a final sample of 429 participants. Table 1 shows definitions and summary statistics for the sociodemographic variables as well as national statistics for Germany for comparison. Men and women had equal shares in the sample, which is representative for sex/gender. 22% of respondents belong to the young adults' group, 47% to the middle-age group, and 31% were older adults. Given this study's focus on specific phases of life, all age groups included had a higher share than in the national statistics. The three binary variables for income represent lower, middle, and upper tertiles of the income distribution in our data. The proportion of participants with a monthly household income <2000 € was comparable to official statistics, while the group with monthly incomes between 2000 € and 3000 € had a higher and the group with monthly incomes above 3,000 € had a lower share. The average education level was high, with 54% of participants graduating from schools that qualify for university admission compared to 32.5% in the German population.

Table 1
Summary statistics for sociodemographic variables for the total sample (n = 429).

Variable	Definition	Mean (± SD)/Percentage	Germany
Male	= 1, if respondent is male	49.2%	49.3%
Age	Respondent's age in years	53.8 (± 20.7)	
Age Cohort 1 (young adults)	= 1 if Age is 18–25 years	21.7%	8.8%
Age Cohort 2 (middle agers)	= 1 if Age is 40–65 years	47.3%	36.8%
Age Cohort 3 (older adults, FS)	= 1 if Age is 75–85 years (Freising sample)	8.4%	9.5%
Age Cohort 4 (older adults, N)	= 1 if Age is 75–85 years (Nuremberg sample)	22.6%	
Low Income	= 1, if monthly household income <2000 €	39.9%	36.6%
Middle Income	= 1, if monthly household income ≥2000 € and <3000 €	28.9%	21.9%
High Income	= 1, if monthly household income ≥3000 €	31.2%	41.4%
General secondary	= 1, if highest education is "General secondary school (Hauptschule)"	16.8%	29.6%
Intermediate secondary	= 1, if highest ed. is "Intermediate secondary school (Mittlere Reife)"	24.7%	23.3%
Polytechnical secondary	= 1, if highest ed. is "Polytechnical secondary school (Polytechnische Oberschule)"	1.9%	6.6%
Technical college qualification	= 1, if highest ed. is "Advanced technical college entrance qualification (Fachhochschulreife)"	10.5%	32.5%
International baccalaureate	= 1, if highest ed. is "International baccalaureate (Abitur)"	44.1%	
Other	= 1, if degree from abroad or other degree	2.1%	0.2%

Note: Official statistics for *Male* and *Education Groups* from the German Statistical Yearbook (Destatis, 2019), for *Age Cohorts* from Destatis (2021), *Income tertiles* from Destatis (2018).

Table 2 shows summary statistics for anthropometric indicators, body composition, and usual dietary intakes for the overall sample as well as for the male and female subsamples.

Table 3 presents the mean values of the 15 motivation factors for the overall sample, as well as for the male and female subsamples. Additionally, we included the values reported by Renner et al. (2012) for comparison purposes. Top-rated factors of eating motivation overall were *Liking* with a mean score of 5.6, *Health* (4.7), *Need & Hunger* (4.5), *Natural Concerns* (4.5), and *Habits* (4.2). Factors with the lowest average scores were *Price* (3.3), *Social Norms* (2.7), *Visual Appeal* (2.6), *Affect Regulation* (2.0), and *Social Image* (1.5).

Compared to Renner et al. (2012), the present sample had lower values for most motivation factors, especially for *Habits*, *Visual Appearance*, *Traditional Eating,* and *Affect Regulation*. Exceptions with higher values in the present sample were *Natural Concerns*, *Weight Control*, and *Social Norms*.

We found significantly lower factor values for men compared to women for 11 out of 15 motives. The male and female subgroups differed most prominently for *Natural Concerns*, *Traditional Eating*, *Affect Regulation, Health, Sociability, and Social Norms*. No differences occurred for *Price, Liking, Habits*, and *Visual Appeal*.

3.2. Regressions for anthropometric indicators

Table 4 presents the results of multiple regression models for anthropomety and body composition separate for men and women based on eq. (1). Results without differentiating coefficients by sex are depicted Table A2 in the appendix. Regarding goodness of fit, R^2-values range from 34% for BMI to 69% for FFM. These values are relatively high for models explaining the variation in anthropometric measures influenced by a complex set of biological, personal, social, or environmental factors (Chou et al., 2004; Schmeiser, 2009; Schroeter & Lusk, 2008). Estimated coefficients show similar effects for men and women for some eating motives, but pronounced differences for others as indicated by magnitude, sign, and/or tests for equality (significance levels from these tests are depicted in the Δ-column). We report corrected p-values (i.e., "q-values") based on Benjamini and Hochberg (1995) in the following.

For males, the *Health* motive showed particularly pronounced effects. The estimated parameters suggest that a 1-point increase in the valuation of the health motive (on a scale from 1 to 7) was associated with a decrease of 1.72%-points increase in FFM ($p < .001$), and a decrease of 3.23 cm in waist circumference ($p < .001$). The *Health* coefficient in the BMI model showed a considerable magnitude (−0.74), but the estimate was less precise and not significantly different from zero. Higher scores for *Affect Regulation* as an eating motive was linked to a lower share of FFM (−1.26; p = .068) and a higher waist circumference (2.38; p = .070). Also here, the coefficient for BMI was substantial in size but not significant. We were unable to reject hypotheses of equality between the parameters for these variables between women and men, except for the case of Affect Regulation and waist circumference.

Results for the female sample indicate that a strong *Need & Hunger* motive was negatively associated with waist circumference (−2.46; p = .030) and positively with FFM (1.63; $p < .001$). These coefficients were also statistically different from those estimated for men. High values in the *Traditional Eating* motive were associated with higher BMI (0.77; p = .060) and lower FFM (−1.04; p = .060). These coefficients were not different from those obtained for men.

While the estimated parameters for *Weight Control* and *Sociability* were not significantly different from zero, the tests for equality between men and women indicate differences for FFM (in the case of *Weight Control*) and waist circumference. While *Weight Control* seems to be negatively associated with FFM and positively with waist circumference for men, the opposite seems to hold for women.

3.3. Regressions for energy and macronutrient intake

Tables 5a and 5b shows the results of regression models for energy and nutrient intake. Results without differentiating coefficients by sex are depicted Table A3 in the appendix. The values of R^2 range from 0.30 to 0.46 and indicate a reasonable share of explained variation in dependent variables. Results suggest that the motives playing a relevant role for intakes differ to a certain degree from those relevant for anthropometry and body composition.

Among men, the *Health* motive is linked to intakes of those nutrients that can be clearly identified as "healthy" or "unhealthy". Specifically, the *Health* motive is positively associated with fiber intake (1.58; $p < .001$) and negatively associated with alcohol intake (−1.67; p = .030). The *Price* motive is significantly and positively associated with intakes of energy (63.77; p = .030), carbohydrates (7.15; p = .090), and alcohol (1.23; p = .050). Additionally, high scores on the *Habit* motive are positively related to higher intakes of carbohydrates (7.75; p = .090) and high scores on the *Convenience* motive are linked to lower intake of energy (−46.96; p = .090) and carbohydrates (−5.98; p = .090). A final noteworthy result is the significant negative relation of *Social Norm* with alcohol intakes (−1.33; p = .050).

For women, a positive association of the *Health* motive was only found for fibre intake (1.41; p = .015). We were not able to reject further null hypotheses of coefficients being significantly different from zero for women. Often, the estimates point to the same direction for men and a look at the relative size of the coefficients, e.g., for *Visual Appeal*, *Health*, and *Need & Hunger* suggests non-negligible effects. However, from a statistical perspective, these estimated parameters show too large standard errors for rejecting the null hypothesis.

We find significantly higher coefficients for men compared to women for the motives *Habits* (energy, carbohydrates, fat, and fibre), *Need & Hunger* (fibre), and *Price* (energy, protein), and higher coefficients for

Table 2
Summary statistics for anthropometric indicators and usual daily nutrient intakes for the total sample and for male and female subsamples.

Variable name [unit]		Overall (n = 429)		Male (n = 211)		Female (n = 218)		*t*		Effect size (Cohen's d) [a)]
		M	SD	M	SD	M	SD			
Anthropometric measures and body composition										
BMI	SECA Body Mass Index [kg/m^2]	26.0	4.5	26.7	4.2	25.3	4.7	3.28	***	0.32
FFM	SECA Fat free mass [%]	68.7	10.0	73.8	8.2	63.7	9.1	12.06	***	1.16
Waist	Waist circumference [cm]	91.3	14.9	97.3	13.9	85.5	13.5	8.98	***	0.87
Energy and nutrient intake										
Energy	Energy [kcal/d]	1936	388	2168	357	1711	264	15.01	***	1.46
Protein	Protein [g/d]	75	16	84	14	67	12	10.45	***	1.01
Carbs	Carbohydrates, absorbable [g/d]	204	47	225	47	183	36	13.02	***	1.26
Fat	Fat [g/d]	83	17	93	16	75	13	12.84	***	1.24
Fibre	Fibre [g/d]	21	6	21	7	20	6	1.62		0.16
Alcohol	Alcohol (Ethanol) [g/d]	8	8	12	10	3	2	12.48	***	1.22

Note: M Mean, SD Standard deviation. ****p* < .01, ***p* < .05, **p* < .1, based on t-tests. [a)] Effect size for differences in variables between sexes.

Table 3
Mean (M) and standard deviation (SD) of the motivation factors from this study (total sample, male and female subsamples) and by the study of Renner et al. (2012).

	Overall		Male		Female		*t*		Effect size (Cohen's d)[a)]	Renner et al. (2012)	
	(n = 429)		(n = 211)		(n = 218)					(n = 1040)	
	M	SD	M	SD	M	SD				M	SD
Liking	5.6	1.1	5.6	1.0	5.7	1.1	1.49		0.14	5.9	0.7
Health	4.7	1.2	4.4	1.3	4.9	1.1	4.13	***	0.40	4.7	1.0
Need & Hunger	4.5	1.2	4.4	1.2	4.6	1.1	2.06	**	0.20	4.8	0.8
Natural Concerns	4.5	1.5	4.1	1.6	4.9	1.4	5.56	***	0.54	4.0	1.4
Habits	4.2	1.3	4.1	1.3	4.2	1.4	1.05		0.10	4.8	0.9
Convenience	4.1	1.4	4	1.5	4.3	1.4	2.31	**	0.22	4.5	1.0
Pleasure	4.1	1.3	3.9	1.3	4.3	1.3	3.12	***	0.30	4.3	0.9
Sociability	3.9	1.5	3.6	1.4	4.2	1.5	3.94	***	0.38	3.7	1.1
Weight Control	3.7	1.5	3.6	1.6	3.9	1.5	1.92	*	0.19	3.3	1.3
Traditional Eating	3.6	1.4	3.3	1.3	3.9	1.4	4.41	***	0.43	4.1	0.9
Price	3.3	1.4	3.3	1.4	3.2	1.4	−0.04		0.00	3.7	1.0
Social Norms	2.7	1.5	2.5	1.4	3	1.5	3.70	***	0.36	2.4	0.7
Visual Appeal	2.6	1.1	2.5	1.1	2.6	1.2	1.27		0.12	3.5	0.9
Affect Regulation	2.0	1.2	1.7	1.0	2.3	1.4	5.26	***	0.50	2.7	1.2
Social Image	1.5	0.7	1.4	0.6	1.6	0.8	2.36	**	0.23	2.0	0.7

Note: M Mean, SD Standard deviation. ****p* < .01, ***p* < .05, **p* < .1, based on t-tests. [a)] Effect size for differences in motive scores between sexes.

women for *Pleasure* (protein), *Social Norms* (alcohol), and *Health* (alcohol).

4. Discussion

The present study aimed to investigate associations of eating motives with anthropometric parameters, body composition, and dietary intake. The analysis was based on comprehensive data from the *enable* study (Brandl et al., 2020) and used the 15 TEMS factors (Renner et al., 2012) to measure eating motivation.

4.1. Motives and their association with nutritional status and dietary intake

A major result of this study was that there was a difference between whether a motive is ranked highly on average and whether that motive is associated with variation in anthropometric parameters. Only two out of the top five motives (*Health*, *Need & Hunger*) showed significant associations with anthropometric parameters, while effects for *Liking* and *Habits,* in particular, were absent. *Liking* appears to be the most frequent eating motive throughout for people with healthy and unhealthy diets and has low discriminatory power (Glanz et al., 1998; Pollard et al., 1998). Likewise, *Habits* as a major determinant of eating behavior (Köster, 2009; Pollard et al., 2002) can be "good" or "bad" and may thus lead to more or less desirable nutritional outcomes.

Health emerged as a central motive with strong positive effects on desirable values of both anthropometric parameters and nutrient intakes. While we find significant associations for men only, most estimated parameters for women show the same direction and substantial magnitudes compared to coefficients of other motives. We were not able to reject hypotheses of equal parameters for the *Health* motive for men and women. Hence, we cannot interpret our findings in the sense that women's anthropometry or dietary intakes are not affected by *Health* or that the effects differ from those for men. The restricted sample size as well as the high scores of the *Health* motive paired with a low variability in women (Mean = 4.9; SD = 1.1, Table 3) apparently impede a more precise parameter estimation.

Our findings are in line with previous studies that showed a positive association of stronger health attitude or motivation to eat healthily with various desirable eating behaviors (Eertmans et al., 2005; Hearty et al., 2007; Naughton et al., 2015; Pollard et al., 1998; Rempe et al., 2020). At the same time, this result underlines that individual health motivation matters. While an obesogenic environment has been increasingly blamed as the main source of increasing waistlines (Swinburn & Egger, 2002), our results suggest that personal motivation to eat healthily still needs to be considered as an important driver of health outcomes and a relevant factor in policy design. The results on energy nutrient intakes suggest that the *Health* motive is especially relevant for unambiguously healthy or unhealthy nutrients. It is positively associated with fiber intake and negatively associated with alcohol intake. The positive but insignificant coefficients for energy, carbohydrates, protein, and fat suggest that the *Health* motive is only weakly related to specific dietary intakes.

The association of *Need & Hunger* with anthropometric parameters confirms previous studies on intuitive eating (Tylka, 2006). We found a strongly positive association of this factor with FFM and a strongly negative one with waist circumference for women. Characterized as "eating based on perceived internal states", intuitive or adaptive eating has been found to be negatively related to BMI, supportive of weight maintenance, and positively associated with physical health indicators, dietary intake and behavior and psychological well-being (Augustus-Horvath & Tylka, 2011; Tylka, 2006; van Dyke & Drinkwater, 2014). The pronounced differences between men and women may be related to "pressure for thinness" and "internalization of a thin ideals" (Tylka, 2006) imposed by media and society, with potentially adverse effects as women then respond more to external cues. Hence, this factor may have more discriminatory power for women. While increased pressure can also be exerted on men regarding muscle mass and strength, most studies were so far conducted in female samples (van Dyke & Drinkwater, 2014).

Results suggest that *Traditional Eating* may be an unfavorable factor for anthropometric parameters in women. Literature has only recently begun to address the question of what constitutes traditional eating and food products (Sproesser, Imada et al., 2018; Sproesser, Ruby et al., 2019), emphasizes that it depends on the context, but also suggests that traditional is more related to unprocessed, natural, and healthier food. The single items in the TEMS factor ("… because it belongs to certain situations"; "… out of traditions (e.g. family traditions, special occasions)"; "… because I grew up with it"), however, suggest that traditional food in our study sample may refer to old-fashioned Bavarian-style foods, recipes, and cooking practices heavy in meat and fat, as well as large portion sizes and rigid meal times. In this particular case, high scores on *Traditional Eating* may be inappropriate for modern, more sedentary lifestyles.

Our results indicate that higher scores of *Affect Regulation*, i.e., eating in response to sadness, frustration, and loneliness as measured by TEMS, are associated with lower FFM and higher Waist Circumference. This finding is in line with literature on eating as a strategy for regulating

Table 4
Regression results for anthropometric measures and body composition.

	BMI (kg/m^2)					FFM (%)					Waist (cm)				
	Male		Female		Δ	Male		Female		Δ	Male		Female		Δ
	B	SE	B	SE		B	SE	B	SE		B	SE	B	SE	
Liking	0.05	0.28	0.05	0.27		0.06	0.43	0.31	0.42		0.20	0.78	0.43	0.77	
Habits	−0.31	0.25	0.24	0.22	†	0.08	0.39	−0.61	0.34		−0.39	0.72	−0.36	0.63	
Need & Hunger	0.18	0.27	−0.69	0.28	††	0.05	0.42	**1.63**	0.44 ***	†††	0.56	0.77	**−2.46**	0.81 **	†††
Health	−0.74	0.28	−0.27	0.30		**1.72**	0.44 ***	0.78	0.46		**−3.23**	0.81 ***	−1.48	0.84	
Convenience	0.39	0.22	0.08	0.20		0.01	0.33	−0.29	0.31		0.59	0.62	0.46	0.58	
Pleasure	−0.04	0.27	−0.20	0.25		−0.28	0.41	−0.18	0.39		0.01	0.76	0.32	0.72	
Traditional Eating	0.35	0.29	**0.77**	0.25 *		−0.26	0.44	**−1.04**	0.38 *		1.52	0.82	1.36	0.70	
Natural Concerns	0.24	0.21	0.21	0.25		−0.53	0.33	−0.41	0.38		1.02	0.61	−0.45	0.71	
Sociability	−0.43	0.24	−0.03	0.20		0.33	0.37	0.52	0.31		−1.66	0.69	0.37	0.57	††
Price	−0.04	0.25	−0.06	0.22		−0.22	0.39	0.34	0.34		0.26	0.72	0.65	0.63	
Visual Appeal	0.27	0.32	0.07	0.27		−0.57	0.49	−0.27	0.41		−0.01	0.90	1.32	0.76	
Weight Control	0.31	0.20	−0.04	0.18		−0.60	0.31	0.17	0.28	†	1.00	0.56	−0.47	0.52	†
Affect Regulation	0.36	0.31	0.18	0.24		**−1.26**	0.48 *	−0.44	0.37		**2.38**	0.89 *	0.52	0.68	†
Social Norms	0.04	0.26	−0.03	0.21		0.06	0.40	0.08	0.33		−0.31	0.74	0.00	0.60	
Social Image	−0.01	0.54	−0.68	0.38		1.56	0.83	0.71	0.58		0.15	1.53	−2.08	1.07	
Age group 2 (middle agers)[a]	5.04	0.87	5.24	0.92		−10.55	1.44	−10.24	1.54		17.69	2.38	14.20	2.57	
Age group 3 (older adults, FS) [a]	4.61	1.20	3.62	1.16		−12.44	2.05	−12.99	1.92		20.20	3.59	15.98	3.03	
Age group 4 (older adults, N) [a]	4.46	1.00	4.99	0.94		−15.46	1.49	−16.91	1.44		23.13	2.67	16.75	2.89	
Constant	21.78	2.10	21.11	2.50		81.38	3.42	68.12	3.84		83.18	6.47	80.22	6.68	
R^2	0.34					0.69					0.52				
N	429					429					429				

Note: ***, **, and * indicate significance at the 0.01-, 0.05-, and 0.1-level of regression coefficients based on adjusted p-values (Benjamini & Hochberg, 1995); Δ-column: $^{†††}p < 0.01$, $^{††}p < 0.05$, and $^{†}p < 0.1$, based on post-regression Wald tests of equality between coefficients for males and females. Standard errors in parentheses. BMI, Body Mass Index; FFM, fat free mass; [a]Reference: *Young adults*.

Table 5a
Regression results for energy, carbohydrate and fat intake.

	Energy (kcal/day)						Carbohydrates (g/day)						Fat (g/day)				
	Male			Female		Δ	Male			Female		Δ	Male		Female		Δ
	B	SE		B	SE		B	SE		B	SE		B	SE	B	SE	
Liking	18.80	21.78		−28.70	21.47		1.89	2.89		−4.06	2.85		0.19	1.00	−1.35	0.99	
Habits	41.52	19.88		−24.53	17.36	††	**7.75**	2.64	*	−2.77	2.30	†††	1.22	0.91	−1.04	0.80	†
Need & Hunger	16.84	21.51		27.00	22.37		−0.23	2.85		5.04	2.97		1.15	0.99	1.08	1.03	
Health	25.45	22.44		22.86	23.46		5.99	2.98		2.07	3.11		0.77	1.03	0.87	1.08	
Convenience	**−46.96**	17.12	*	−17.52	16.09		**−5.98**	2.27	*	−2.25	2.14		−1.50	0.79	−0.41	0.74	
Pleasure	−31.97	21.04		14.92	20.01		−4.10	2.79		0.60	2.66		−1.38	0.97	0.78	0.92	
Traditional Eating	9.45	22.64		1.21	19.31		−2.29	3.00		1.87	2.56		1.09	1.04	−0.35	0.89	
Natural Concerns	13.00	16.85		17.04	19.62		0.43	2.24		3.87	2.60		0.88	0.77	0.13	0.90	
Sociability	3.61	19.11		−13.74	15.72		0.93	2.54		−4.33	2.09		−0.50	0.88	0.41	0.72	
Price	**63.77**	19.98	**	5.59	17.53	††	**7.15**	2.65	*	0.69	2.33	†	2.29	0.92	0.40	0.81	
Visual Appeal	−1.05	24.92		45.34	21.15		−1.46	3.31		5.65	2.81		0.05	1.15	1.72	0.97	
Weight Control	−23.08	15.68		−13.40	14.51		−2.67	2.08		−2.44	1.93		−1.45	0.72	−1.05	0.67	
Affect Regulation	−19.01	24.75		−25.16	18.84		−1.78	3.28		−2.12	2.50		−0.81	1.14	−1.19	0.87	
Social Norms	−28.47	20.56		10.83	16.74		−1.82	2.73		0.68	2.22		−0.78	0.95	0.61	0.77	
Social Image	67.00	42.51		7.51	29.77		7.64	5.64		1.01	3.95		2.37	1.95	0.16	1.37	
Age group 2 (middle agers)[a]	15.48	83.27		14.70	58.88		−11.89	11.15		−7.10	7.44		5.02	3.97	4.53	3.10	
Age group 3 (older adults, FS) [a]	154.91	121.93		162.07	83.48		0.79	16.80		18.05	10.32		12.66	5.71	8.54	4.68	
Age group 4 (older adults, N) [a]	56.86	95.34		114.02	67.39		−1.05	12.50		14.36	8.84		5.67	4.21	6.29	3.37	
Constant	1552.88	211.66		1493.37	173.35		167.35	28.62		164.82	23.15		67.47	9.42	63.94	7.99	
R^2	0.46						0.35						0.39				
N	429						429						429				

Note: ***, **, and * indicate significance at the 0.01-, 0.05-, and 0.1-level of regression coefficients based on adjusted p-values (Benjamini & Hochberg, 1995); Δ-column: $^{†††}p < 0.01$, $^{††}p < 0.05$, and $^{†}p < 0.1$, based on post-regression Wald tests of equality between coefficients for males and females. Standard errors in parentheses. BMI, Body Mass Index; FFM, fat free mass; [a]Reference: *Young adults*.

Table 5b
Regression results for protein, fibre, and alcohol intakes.

	Protein (g/day)					Fibre (g/day)					Alcohol (g/day)				
	Male		Female		Δ	Male		Female		Δ	Male		Female		Δ
	B	SE	B	SE		B	SE	B	SE		B	SE	B	SE	
Liking	0.82	0.93	−0.20	0.91		−0.14	0.40	−0.41	0.39		0.86	0.48	0.07	0.48	
Habits	0.82	0.85	−0.95	0.74		0.86	0.36	−0.49	0.32	†††	−0.61	0.44	0.03	0.38	
Need & Hunger	1.23	0.91	0.22	0.95		−0.26	0.39	0.98	0.41	††	0.38	0.48	−0.59	0.50	
Health	1.34	0.95	1.38	1.00		**1.58**	0.41***	**1.41**	0.43**		**−1.67**	0.50**	0.12	0.52	††
Convenience	−1.13	0.73	−0.89	0.68		−0.68	0.31	−0.21	0.29		−0.70	0.38	−0.15	0.36	
Pleasure	−1.95	0.89	1.17	0.85	††	−0.43	0.39	−0.22	0.37		0.71	0.47	0.10	0.44	
Traditional Eating	0.77	0.96	−0.80	0.82		−0.57	0.41	−0.51	0.35		0.87	0.50	0.05	0.43	
Natural Concerns	0.56	0.72	−0.45	0.83		0.58	0.31	0.40	0.36		0.22	0.37	0.26	0.43	
Sociability	−0.38	0.81	−0.01	0.67		0.20	0.35	−0.20	0.29		0.82	0.42	0.06	0.35	
Price	1.57	0.85	−0.59	0.75	†	0.10	0.37	−0.39	0.32		**1.23**	0.44**	0.26	0.39	
Visual Appeal	−0.10	1.06	2.18	0.90		−0.30	0.46	0.63	0.39		0.66	0.55	−0.27	0.47	
Weight Control	0.16	0.67	1.03	0.62		−0.21	0.29	−0.21	0.27		−0.06	0.35	0.19	0.32	
Affect Regulation	−0.18	1.05	−1.14	0.80		−0.34	0.45	−0.16	0.34		−0.54	0.55	−0.20	0.42	
Social Norms	−1.15	0.87	0.57	0.71		−0.24	0.38	−0.10	0.31		**−1.33**	0.46**	0.06	0.37	††
Social Image	3.44	1.81	−0.02	1.27		1.35	0.78	0.60	0.54		0.09	0.94	0.26	0.66	
Age group 2 (middle agers)[a]	0.42	3.46	0.32	2.94		−2.95	1.51	−2.05	1.25		2.69	2.28	0.51	0.47	
Age group 3 (older adults, FS)[a]	1.95	5.02	2.17	4.13		0.58	2.35	2.13	1.82		4.47	3.28	0.47	0.76	
Age group 4 (older adults, N)[a]	−2.31	3.99	−0.55	3.25		0.02	1.59	0.37	1.43		3.05	2.38	0.37	0.61	
Constant	56.31	7.98	57.29	7.65		14.76	3.52	14.94	3.52		5.67	6.31	2.12	1.36	
R^2	0.39					0.30					0.39				
N	429					429					429				

Note: ***, **, and * indicate significance at the 0.01-, 0.05-, and 0.1-level of regression coefficients based on adjusted p-values (Benjamini & Hochberg, 1995); Δ-column: $^{\dagger\dagger\dagger}p < 0.01$, $^{\dagger\dagger}p < 0.05$, and $^{\dagger}p < 0.1$, based on post-regression Wald tests of equality between coefficients for males and females. Standard errors in parentheses. BMI, Body Mass Index; FFM, fat free mass; [a]Reference: *Young adults*.

negative affective states (Canetti et al., 2002; Macht, 2008; Macht & Simons, 2011). The strong coefficients for FFM and Waist circumference and the observation that the results hold for the male sample only suggest that emotional eating is particularly related to increased fat accumulation in the abdominal region. In contrast, *Affect Regulation* did not show any association with nutrient intakes. One potential reason could be inflated self-reports on the TEMS items as persons with overweight or obesity may be sensitized for the drivers of their eating behavior (Macht & Simons, 2011). A second explanation may be underreporting of hedonic or guilt-related food intake during phases of negative affective states (Haftenberger et al., 2010).

Convenience, the motivation to choose food because it is most convenient, quick, and easy to prepare, is consistently negatively associated with intakes of most nutrients. However, this finding was more pronounced among men and significant for energy and carbohydrate intake. Previous literature has pointed to the emergence and easy accessibility of "convenience" foods (such as fast food, take-away, snacks, frozen meals, etc.) as a potentially important driver of soaring obesity rates (Dixon et al., 2006). Our results suggest that people with a high *Convenience* motive may have a rather low preoccupation with food and the aim to keep food preparation simple leads to lower overall intake. Hence, it may not be the convenience part in "convenience" foods that is detrimental to nutritional status, but rather other characteristics such as being high-fat, high-energy foods.

The positive association of the *Price* motive with the intake of energy, carbohydrates, and alcohol – in particular among men – is in line with literature that connects energy density and energy costs with obesity. In this framework poorer households are assumed to economize on energy costs leading to higher intakes of palatable, energy-dense foods (Drewnowski & Specter, 2004). While our results support these arguments, the *Price* motives was unrelated to anthropometric parameters, hence higher intakes do not seem to translate into increased body mass or body fat in the long term. A potential explanation could be that higher physical activity at work or during leisure may compensate for higher intakes.

A final motivational factor with interesting results regarding dietary intake parameters is *Social Norms*, where higher values are related to lower alcohol intake for men. Social norms have been identified as one of the best predictors of alcohol consumption (Neighbors et al., 2007). The literature distinguishes descriptive norms (i.e., the perceived prevalence of drinking by a typical member of the peer group) and injunctive norms (i.e., the perception of how much others such as friends or parents approve of someone's drinking behavior) (Neighbors et al., 2007). Both a higher perception of the usual alcohol quantity consumed and higher perceived approval of drinking predict higher quantities consumed. Against this background, our result is surprising at first sight given the formulation of this factor's items ('…because it would be impolite not to eat it'; ' … to avoid disappointing someone who is trying to make me happy'; … because I am supposed to eat it'). We would expect someone scoring higher on these to be more susceptible to invitations of others to have a drink. However, the negative correlation we find suggests that this motive rather measures a general tendency to adhere to what others or society deem appropriate. Apparently, people who pay attention to the judgement of others (report to) drink less.

4.2. Relation between TEMS and other approaches to identify motives

The aim of this study was to investigate the association of a comprehensive set of eating motives with nutritional status and dietary intake. We used the TEMS as a "concise questionnaire that allows for a comprehensive, systematic, and psychometric sound measurement and investigation of motives for normal eating behavior" (Renner et al., 2012). As each TEMS factor is based on just three items, a discussion is in order whether the motives participants endorse on this concise and simple instrument and their relationships to anthropomorphic data align well with those found for more specialized, extensive instruments such as the Three-factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985), the Dutch Eating Behavior Questionnaire (DEBQ) (van Strien, Frijters, Bergers, & Defares, 1986), and others. We would briefly like to highlight how "core, higher order motives of food choice" (Renner et al., 2012) such as health, body weight control, affect regulation, or hunger relate to anthropometry when measured by TEMS versus measured by other instruments.

Our result of a higher *Health* motive being related to healthier anthropometry and body composition (for males) aligns well with findings from studies using different instruments to measure eating for health reasons. These include the FCQ (Eertmans et al., 2005; Pollard et al., 1998), self-administered questionnaires (Hearty et al., 2007), a Healthy Eating Motivation Score based on the FCQ and the Health and Taste Attitude Scale (HTAS) (Naughton et al., 2015), as well as TEMS itself (Rempe et al., 2020). Likewise, the finding that higher *Health* values are positively correlated with healthier intake patterns for specific nutrients (higher fiber, lower alcohol) is in line with studies using the Health and Taste Attitude Scale (Roininen et al., 1999) to study preference for reformulated or functional food products.

The same holds for the *Need & Hunger* motive, where we find a negative association with fat-free mass and a positive one with waist circumference (for females). This is coherent with research reporting high scores on different versions of the Intuitive Eating Scale (Tylka, 2006) to be associated with lower BMI (Augustus-Horvath & Tylka, 2011; Tylka, 2006; van Dyke & Drinkwater, 2014). The result of a higher score for *Affect Regulation* being negatively related to a healthy nutritional status is in line with studies that measure emotional eating using the "Ways of Coping Checklist" (Laitinen et al., 2002), the TFEQ (Konttinen, Männistö, et al., 2010; Konttinen, Silventoinen, et al., 2010; Péneau et al., 2013) as well as the DEBQ (Pothos et al., 2009; Sung et al., 2009; van Strien et al., 2009).

Finally, *Weight Control* is a major TEMS factor that relates to measures of cognitive restraint (TFEQ) or dietary restraint (DEBQ). Our results for this motive were rather inconclusive and insignificant. Coefficients indicate that higher values of *Weight Control* for men relate positively to BMI and WC, and negatively to FFM. Coefficients for women significantly differed from these and pointed to opposite directions. Results suggest that higher scores on this factor were associated with lower intakes of energy, carbohydrates, and fat. Literature provides a mixed picture as well. Many studies find positive correlations with BMI or overweight based on the TFEQ (Anglé et al., 2009; Cappelleri et al., 2009; Lauzon-Guillain et al., 2006) and the DEBQ (Lluch, Herbeth, Méjean, & Siest, 2000; Olea López & Johnson, 2016; Snoek, van Strien, Janssens, & Engels, 2007). However, Johnson et al. (2012) report that these are mostly seen in normal-weight samples, while for samples of persons with overweight or obesity, the relation is often negative. The authors interpret positive restraint-BMI associations such that restraint may be "acting as a marker for overeating tendencies". Price et al. (2015) show that restraint measures from different instruments (TFEQ, DEBQ) load on the same factor, which is positively associated with BMI. The authors interpret this relation to reflect "unsuccessful attempts at dietary control".

In summary, these examples suggest that the relations of TEMS motives with anthropometry are congruent to findings for other measures from more specialized and extensive instruments. TEMS motives seem able to capture relevant constructs accurately and to provide a large set of potential predictors of anthropometric measures and their confounders at the same time. The simple comparison of different instruments and their relations to anthropometry over distinct samples and studies as done here needs to be confirmed by either comparing relations for different measures based on the same sample or more systematic meta-analyses.

A related question concerns the comparability of TEMS motives and behavioral measures of related constructs such as the "eating in the absence of hunger" test and their relation to anthropomorphic data. While such tests have been mostly used in research on children (French et al., 2012; Goldschmidt et al., 2017), Carnell and Wardle (2007) compared parental reports on the Child Eating Behaviour Questionnaire (CEBQ) to results from several behavioral tests. They found that higher values for the subscale "satiety responsiveness" were associated with lower intakes in the "eating in the absence of hunger" test and higher values in the "enjoyment of food" subscale with higher intakes in the test. They concluded that "the CEBQ is capable of capturing important facets of children's eating behavior that have previously been assessed only with behavioral tests". These findings should inspire future research comparing behavioral and self-reported measures for adults as well.

Another example is the social facilitation of eating where a recent review and meta-analysis (Ruddock et al., 2019) has shown that significant effort is required to obtain empirical evidence by experiments and naturalistic observations. While the evidence strongly suggests that eating with friends and family increases food and energy intake, there is no evidence yet, whether the phenomenon of social facilitation of eating affects the long-term energy balance positively (Ruddock et al., 2021). Accordingly, there are no insights on the relation to anthropometric measures. Our findings indicate higher *Sociability* to be related to lower BMI, higher FFM, and inconclusive evidence on waistlines (lower for men, higher for females). Future research is needed on how self-reported measures compare to high-effort behavioral tests and procedures.

4.3. Implications for public health interventions

The results of the present study suggest a series of implications for design and strategic levers of public health measures. The identification of the *Health* motive as a major factor in relation to anthropometric parameters may be used in two ways. The nearest thought is attempting to increase those persons' *Health* motivation, where it is low. However, changing the underlying attitudes, values, and social norms may be complex and difficult, promising only little success. Alternatively, one could approach the group with low health motivation through factors on which they have a higher score. Motives for which this study found a low or negative correlation with the health motive are *Price*, *Visual Appeal*, *Affect Regulation*, *Social Norms*, and *Social Image*. A more promising strategy could be to make healthy foods more appealing regarding these factors, in particular those that are significantly related to the nutritojnal status. This could be done, for example, through social marketing campaigns, but certainly also through product development, innovation, and marketing strategies in the food industry, the food service sector, and retailing.

A similar case could be made for *Traditional Eating*, where eating is guided by specific meals, meal occasions, or sensory components. A lever would be to create opportunities for new experiences, opening up alternatives to rigid structures and standard dishes. Such a strategy might be particularly fruitful, if people were provided with healthier alternatives that match their taste, needs, and routines. For *Affect Regulation*, with its prominent role in the male sample, a strategy would be to provide men with alternative means to cope with their emotions other than eating and drinking. From a broader perspective it would also be a societal and institutional challenge to reduce potential stressors and sources for negative emotions at work and in private lifes in the first place. Results for *Need & Hunger* as a beneficial factor for nutritional status suggest increasing awareness on feelings of hunger and satiety as well as equipping people with techniques and methods to listen more carefully to internal cues.

4.4. Strengths, limitations and avenues for future research

The major strength of the study is that it was based on comprehensive data for eating motivations, nutrient intakes, and anthropometric parameters from a large sample covering different age groups. The results highlight that it is important to investigate the associations of motives with eating behavior to derive meaningful and promising strategies for public health measures. The results also suggest that it is important to look to look separately at nutrition behavior, i.e. the observed dietary intake, and nutritional status, i.e. anthropometry and body composition. While some motives are consistently related to both stages, some are exclusively related to nutritional status and others exclusively with dietary intake. This has a major effect on the implications that follow from the study of motives. If we were to measure only the effect of price motivation on dietary intake and not on nutritional status, we would agree with previous literature that price-sensitive consumers would consume more energy and have a higher chance of developing obesity. However, as we have additional data that indicate no direct relation to nutritional status, we are reluctant to draw such a conclusion.

Of course, this raises questions about the reasons for the discrepancy between dietary intake and nutritional status. One missing piece in the equation is the level of physical activity that may be higher in people with a high score on the price motive. However, additional checks with several indicators for physical activity did not confirm this hypothesis. Another limitation is that the cross sectional nature of our data set only allows us to study correlations but not direct causation. This could affect especially coefficients for *Weight Control* motive, where persons with overweight or obesity may report a higher motivation to control their weight leading to reverse causation. Also, as Macht and Simons (2011) have argued, persons with overweight or obesity may be more sensitized regarding the underlying reasons of their eating behavior so that their self-reports on *Affect Regulation* may be more accurate than for participants with normal weight.

A last point touches issues of intra- and inter-individual variability in dietary intake or motives. The implications of day-to-day variability on measurements of usual food and nutrient intakes have been already discussed by literature (Palaniappan et al., 2003). We are confident that we safeguarded our measures of dietary intake from high variability in 24 h-recalls by the careful procedure we apply to obtain usual dietary intake as described above. What may be more relevant is that both motives and intakes present in the short- and medium-term period surrounding data collection may be different from those that are responsible for observed anthropometry and body composition in the long-term. Wahl et al. (2020) recently showed that motives from TEMS measured in single-time-point questionnaires, interpreted as "situation-stable dispositions (traits)" correlated well with "in-the-moment (state) assessments", i.e. experienced eating motives in the moment of consumption. However, trait motives had higher average values than state motives and intraindividual motive profiles differed substantially between participants. The authors argue that representativeness heuristics or response biases may have contributed to these observations. While we exclusively measure trait motives, we cannot rule out that these, too, vary over time. Hence, it could be that some motives are rather stable over time and correlate to long-term nutritional status, while other motives may be more medium to short term (or more salient during the study period) and correlate more closely with the nutrition behavior observed during the study. To resolve these questions, it would be helpful to have longitudinal data with repeated measurement of motives to assess whether they are stable as traits or whether some of them vary in a more pronounced way than others.

5. Conclusion

This study identified specific eating motives based on TEMS as potential drivers of energy and macronutrient intake and nutritional status. Controlling for sex, age, income, and education, we found motives related to *Health*, *Need & Hunger*, *Traditional Eating*, and *Affect Regulation* to be strongly associated with BMI, FFM, and waist circumference. While motives related to *Liking* and *Habits* were stated as most frequent drivers of eating behavior, we did not find a significant relation to nutritional status. Other motives such as *Price* and *Convenience* were associated with intake, but not anthropometric measures. The results highlight the need for more differentiated analyses regarding eating motives, beyond simple comparisons of relative importance, towards the association of motives to consumption patterns, dietary intake, and nutritional status. Such analyses would yield even more specific and targeted implications for nutrition interventions and counselling. Future research should seek to collect more longitudinal data to trace changes in motives and nutrition in the long term and control for unobservable third-factor effects.

Author contributions

Data base establishment: J.R. sociodemographics and TEMS; B.B., T. S., D.V., E.K., H.S., H.H. dietary intakes, anthropometric parameters, and body composition. J.L. and N.W. computation of usual intakes of participants. M.S. and B.B. conceived and designed the structure of the statistical analysis, M.S. analyzed and interpreted results, M.S. and B.B. conceptualized the manuscript and wrote the paper. M.S., B.B., E.K., J. R., H.S., T.S., D.V., J.L., N.W., H.H. revised it critically. All authors have read and approved the final version of the article.

Data availability

The data used for this study are part of *Project Z* within the *enable* cluster of nutrition research. Researchers who are interested in working with these data can request access at the study center (please contact Dr. Beate Brandl, beate.brand@tum.de). Applicants will have to sign a data use agreement including a confirmation that they will comply with the General Data Protection Regulation (GDPR).

Ethical statement

The study was approved by the ethics committee of the Faculty of Medicine of Technical University of Munich (#492/17S), by the ethics committee of Friedrich-Alexander-Universität Erlangen-Nürnberg (#291_15 B) and was registered on German Clinical Trial register (DRKS-ID: DRKS00009797). Written informed consent was obtained from all participants prior to the assessments.

Declaration of competing interest

The authors declare no conflict of interest. The funding sponsor (BMBF) had no role in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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Appendix

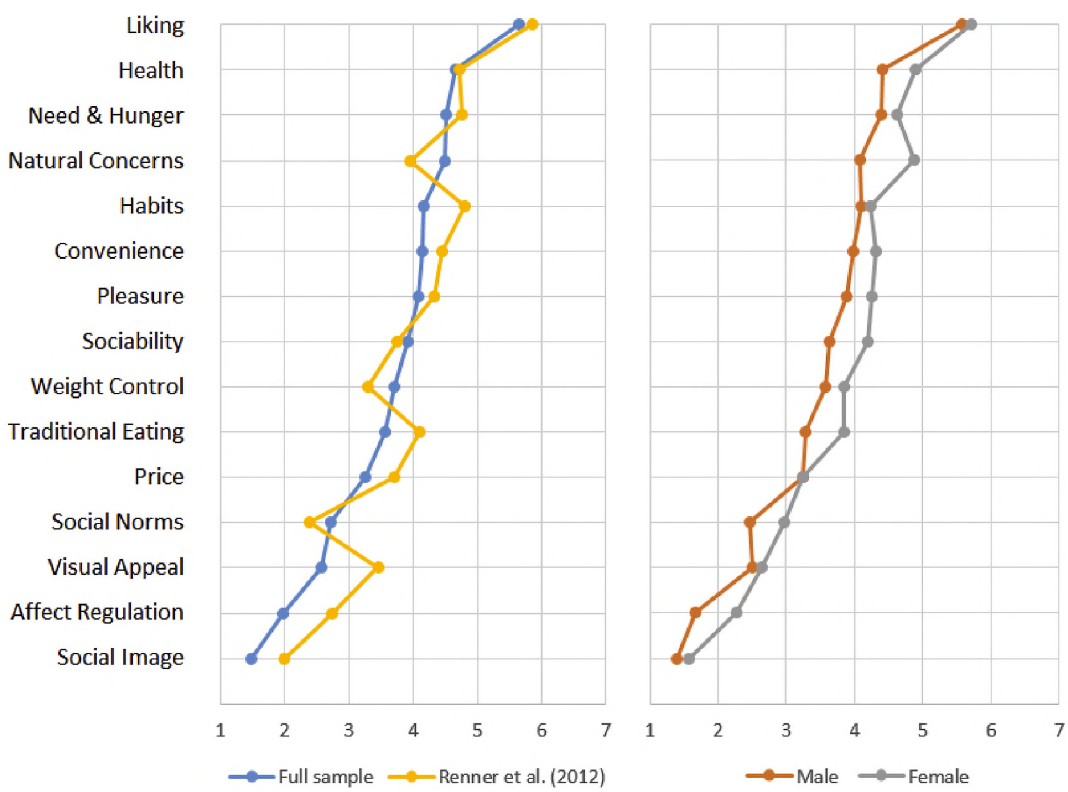

Fig. A1. Mean values of the motivation factors for the full sample (n = 429; blue) versus the study by Renner et al. (2012; n = 1,040; blue) and for male (n = 211; orange) and female (n = 218; grey) subsamples..

Table A1
Correlations and internal consistencies of 15 TEMS factors (n = 429).

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	*Liking*															
2	*Habits*	.19 *														
3	*Need & Hunger*	.29 *	.59 *													
4	*Health*	.30 *	.30 *	.56 *												
5	*Convenience*	.12	.31 *	.36 *	.23 *											
6	*Pleasure*	.27 *	.33 *	.45 *	.40 *	.28 *										
7	*Traditional Eating*	.06	.42 *	.46 *	.33 *	.25 *	.59 *									
8	*Natural Concerns*	.15 *	.06	.24 *	.58 *	.02	.32 *	.28 *								
9	*Sociability*	.16 *	.13	.25 *	.29 *	.20 *	.48 *	.58 *	.33 *							
10	*Price*	.04	.36 *	.30 *	.08	.33 *	.27 *	.35 *	-.18 *	.21 *						
11	*Visual Appeal*	.05	.25 *	.21 *	-.01	.19 *	.39 *	.53 *	.01	.39 *	.40 *					
12	*Weight Control*	.04	.16 *	.14	.31 *	.25 *	.21 *	.22 *	.20 *	.20 *	.22 *	.22 *				
13	*Affect Regulation*	-.10	.12	.02	-.08	.15 *	.30 *	.35 *	.04	.17 *	.21 *	.45 *	.20 *			
14	*Social Norms*	.06	.27 *	.24 *	.10	.21 *	.35 *	.56 *	.13	.41 *	.27 *	.51 *	.26 *	.40 *		
15	*Social Image*	-.07	.19 *	.12	.03	.18 *	.25 *	.39 *	.09	.23 *	.28 *	.43 *	.15 *	.55 *	.54 *	
	Crohnbach's Alpha	**.87**	**.84**	**.62**	**.86**	**.92**	**.77**	**.78**	**.87**	**.89**	**.84**	**.74**	**.84**	**.91**	**.89**	**.83**

Note: *$p < .01$.

Table A2
Regression results for anthropometric measures – no separation of coefficients by sex

	BMI (kg/m^2)			FFM (%)			Waist (cm)		
	B	SE		B	SE		B	SE	
Liking	0.04	0.19		0.25	0.30		0.47	0.56	
Habits	−0.04	0.16		−0.19	0.25		−0.60	0.48	
Need & Hunger	−0.22	0.20		**0.73**	0.30	*	−1.12	0.57	
Health	**−0.51**	0.20	*	**1.30**	0.32	***	**−2.26**	0.59	***
Convenience	0.25	0.14		−0.28	0.22		0.63	0.41	
Pleasure	−0.12	0.18		−0.26	0.29		0.13	0.54	
Traditional Eating	**0.53**	0.19	*	−0.62	0.29		1.24	0.54	
Natural Concerns	0.21	0.16		−0.47	0.25		0.27	0.46	
Sociability	−0.17	0.15		0.39	0.24		−0.42	0.44	
Price	−0.02	0.17		0.06	0.26		0.48	0.48	
Visual Appeal	0.13	0.20		−0.30	0.31		0.75	0.59	
Weight Control	0.14	0.13		−0.14	0.21		0.40	0.38	
Affect Regulation	0.25	0.19		**−0.74**	0.29	*	1.32	0.55	
Social Norms	−0.06	0.16		0.20	0.25		−0.46	0.47	
Social Image	−0.39	0.31		0.86	0.48		−1.10	0.90	
Male	1.53	0.41		10.13	0.63		11.81	1.18	
Age group 2 (middle agers)[a]	5.01	0.62		−10.33	0.96		15.24	1.80	
Age group 3 (older adults, FS) [a]	3.71	0.85		−12.75	1.32		17.39	2.48	
Age group 4 (older adults, N) [a]	4.56	0.68		−15.89	1.05		18.89	1.97	
Constant	20.98	1.60		69.03	2.48		77.14	4.65	
R^2	0.31			0.67			0.48		
N	429			429			429		

Note: ***, **, and * indicate significance at the 0.01-, 0.05-, and 0.1-level based on adjusted p-values (Benjamini & Hochberg, 1995); Standard errors in parentheses. BMI, Body Mass Index; FFM, fat free mass; [a]Reference: *Young adults*.

Table A3
Regression results for energy and nutrient intakes – no separation of coefficients by sex

	Energy (kcal/day)		Carbohydrates (g/day)		Fat (g/day)		Protein (g/day)		Fibre (g/day)			Alcohol (g/day)	
	B	SE	B	SE	B	SE	B	SE	B	SE		B	SE
Liking	−7.63	15.37	−1.45	2.05	−0.66	0.70	0.12	0.66	−0.27	0.28		0.51	0.34
Habits	5.32	12.96	1.92	1.73	0.00	0.59	−0.18	0.55	0.11	0.24		−0.24	0.29
Need & Hunger	22.40	15.52	2.47	2.07	0.95	0.71	0.64	0.66	0.28	0.28		0.18	0.35
Health	24.86	16.22	4.41	2.16	0.83	0.74	1.39	0.69	1.63	0.29	***	−0.92	0.36
Convenience	−22.41	11.22	−2.72	1.50	−0.68	0.51	−0.54	0.48	−0.29	0.20		−0.45	0.25
Pleasure	−9.75	14.63	−2.06	1.95	−0.35	0.67	−0.42	0.62	−0.41	0.27		0.50	0.33
Traditional Eating	6.71	14.69	0.35	1.96	0.36	0.67	−0.13	0.63	−0.47	0.27		0.41	0.33
Natural Concerns	13.28	12.58	1.50	1.68	0.57	0.57	0.15	0.54	0.46	0.23		0.23	0.28
Sociability	−5.14	12.01	−1.98	1.60	0.10	0.55	−0.19	0.51	−0.07	0.22		0.40	0.27
Price	31.82	13.16	3.28	1.76	1.31	0.60	0.53	0.56	−0.23	0.24		0.72	0.29
Visual Appeal	25.29	16.08	2.46	2.15	0.99	0.73	1.25	0.69	0.26	0.29		0.18	0.36
Weight Control	−22.37	10.48	−3.17	1.40	−1.28	0.48	0.47	0.45	−0.24	0.19		−0.05	0.23
Affect Regulation	−18.67	15.03	−1.36	2.01	−0.89	0.69	−0.65	0.64	−0.16	0.27		−0.36	0.34
Social Norms	−6.40	12.91	−0.12	1.72	−0.10	0.59	−0.27	0.55	−0.11	0.23		−0.55	0.29

(*continued on next page*)

Table A3 (*continued*)

	Energy (kcal/day)		Carbohydrates (g/day)		Fat (g/day)		Protein (g/day)		Fibre (g/day)		Alcohol (g/day)	
	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Social Image	22.86	24.51	2.33	3.27	0.84	1.12	1.07	1.05	0.77	0.45	0.20	0.55
Male	441.02	32.26	40.62	4.30	17.37	1.47	16.05	1.38	1.47	0.59	8.37	0.72
Age group 2 (middle agers)[a]	14.85	48.96	−8.35	6.53	4.38	2.24	−0.29	2.09	−2.61	0.89	1.75	1.09
Age group 3 (older adults, FS) [a]	186.12	67.60	15.80	9.02	10.66	3.09	1.60	2.88	1.73	1.23	2.83	1.51
Age group 4 (older adults, N) [a]	84.40	53.83	8.69	7.18	5.43	2.46	−2.09	2.30	0.10	0.98	1.42	1.20
Constant	1340.92	126.74	151.92	16.91	58.16	5.79	50.14	5.41	14.42	2.30	−0.63	2.83
R^2	0.42		0.30		0.36		0.35		0.26		0.34	
N	429		429		429		429		429		429	

Note: ***, **, and * indicate significance at the 0.01-, 0.05-, and 0.1-level based on adjusted p-values (Benjamini & Hochberg, 1995); Standard errors in parentheses. BMI, Body Mass Index; FFM, fat free mass; [a]Reference: *Young adults*.

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