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1 How the Unhealthy = Tasty Belief is Associated with BMI through Reduced Consumption of
2 Vegetables: A Cross-National and Mediation Analysis

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1 How the Unhealthy = Tasty Belief is Associated with BMI through Reduced Consumption of
2 Vegetables: A Cross-National and Mediational Analysis

3
4 Obesity is one of the greatest public health challenges of modern times and its
5 prevalence is increasing worldwide. With food so abundant in developed countries, many
6 people face a conflict between desires for short-term taste and the goal of long-term health,
7 multiple times a day. Recent research suggests that consumers often resolve these conflicts
8 based on their lay beliefs about the healthiness and tastiness of food. Consequently, such lay
9 beliefs can play critical roles not just in food choice but also weight gain. In this research, we
10 show, across six countries and through mediation analysis, that adults who believe that tasty
11 food is unhealthy (the Unhealthy = Tasty Intuition, or “UTI”; Raghunathan, Naylor, & Hoyer
12 2006) are less likely to consume healthy food, and thereby have a higher body mass index
13 (BMI). In Study 1, we conducted a cross-sectional survey in five countries (Australia,
14 Germany, Hong Kong, India, and the UK), and found that greater strength of belief in UTI
15 was associated with higher BMI, and this relationship was mediated by lower consumption of
16 fruits and vegetables. The observed patterns largely converged across the sampled Western
17 and Asian-Pacific countries. In Study 2, we teased apart the mediating role of vegetable
18 versus fruit consumption and also addressed the issue of reversed causality by predicting
19 BMI with a measure of UTI belief taken 30 months previously. We found that vegetable
20 consumption, but not fruit consumption, mediated the association between UTI belief and
21 BMI. Our findings contribute to the literature by showing how lay beliefs about food can
22 have pervasive and long-lasting effects on dietary practices and health worldwide.
23 Implications for public policy and health practitioners are discussed.

24

25 Keywords: lay beliefs, food psychology, unhealthy = tasty intuition, healthy food, BMI.

26

1 1. Introduction

2

3 Obesity is one of the most serious public health challenges of the 21st century (WHO
4 2018). Since 1975, its prevalence has nearly tripled. In 2016, more than 1.9 billion adults
5 were overweight, of whom over 650 million were obese. Multidisciplinary academic research
6 identifying modifiable risks, protective factors and potential intervention opportunities is
7 necessary to address this important public health issue (Nader et al., 2012).

8 Recently, lay beliefs have attracted scholarly attention because of their direct and
9 substantial effect on obesity (Mukhopadhyay, 2011; Raghunathan et al., 2006). McFerran &
10 Mukhopadhyay (2013) showed that lay people mostly either believe that obesity is caused by
11 a lack of exercise or by a poor diet, and that those who indict a lack of exercise are more
12 likely to be overweight because they tend to consume greater quantities of food. These results
13 suggest that consumers' lay beliefs are an important yet largely overlooked risk factor for
14 obesity. Given the importance of diet over exercise in causing obesity (Livingston & Zylke,
15 2012), other research has investigated the role of lay beliefs about food. Germane to the
16 present research, Raghunathan and colleagues (2006) found that people who generally
17 believe that there is a trade-off between the healthiness and tastiness of food (the Unhealthy =
18 Tasty Intuition, or "UTI") tend to under-consume food portrayed as healthy because they
19 expect that such food does not taste good. As a result, research has shown a positive
20 association between the UTI belief and body mass index ("BMI"; Mai & Hoffmann, 2015;
21 Cooremans, Geuens, & Pandelaere, 2017). While these findings are intriguing, several
22 unanswered questions remain. For instance, UTI and food choices have been found to be
23 culturally determined (Werle, Trendel, & Ardito, 2013; Januszewska, Pieniak, & Verbeke,
24 2011), and hence it is unclear whether the association between UTI belief and BMI, mediated
25 through decreased consumption of healthy foods, holds across countries. Also, while Mai and

1 Hoffmann (2015) found that a stronger belief in UTI led to an increase in BMI due to
2 decreased consumption of healthy foods, it is not clear yet what aspect of healthy food
3 consumption, fruit versus vegetables, is more important in this relationship. Hence, in this
4 research, we contribute by demonstrating the association between UTI belief and BMI across
5 several different countries, and by isolating the mediating role of vegetable (from fruit)
6 consumption. We find that the relationship between UTI belief and BMI is driven by
7 vegetable consumption rather than fruit consumption. Collectively, the present research
8 makes an important theoretical contribution to our understanding of lay beliefs and food
9 perceptions and provides useful insights for a broad audience that is interested in tackling the
10 obesity issue.

11

12 2. Conceptual Development

13

14 The current concern for a healthier diet notwithstanding, taste is a primary
15 determinant in the selection of food (Tepper & Trail, 1998; Mai & Hoffmann, 2015). Glanz
16 et al. (1998) report that taste is the most important attribute in food choice, and Sullivan et al.
17 (2015) showed that during a food-choice task, the tastiness of food, as a more concrete
18 attribute, is processed faster than the more abstract healthiness of food, rendering tastiness a
19 more reliable predictor of food choices than healthiness. This preference for taste is innate: it
20 is adaptive for new-borns to recognize high-calorie foods as tasty to ensure their survival.
21 Humans have therefore evolved to favor the taste of energy-dense foods. However, now that
22 food is abundant and readily available in much of the developed world, this innate desire to
23 consume tasty but high-calorie foods may be one of the underlying causes of the obesity
24 epidemic (Pinsel, Assanand, & Lehman, 2000).

25 Ideally, in modern societies, people should thus focus more on the healthiness of food

1 rather than its taste, but the natural appeal of highly palatable foods makes this challenging.
2 Moreover, and in line with this evolutionary link between palatability and calorie density,
3 many people have come to believe that taste and healthiness are negatively correlated—in
4 other words, they assume that unhealthy foods are tasty (the UTI, Raghunathan et al., 2006).
5 Further, this belief in the association between unhealthiness and tastiness can be held either
6 explicitly, or implicitly, or both. While people can form an explicit belief in UTI, they can
7 also simultaneously hold an implicit intuition associating unhealthiness and tastiness
8 (Raghunathan et al., 2006; Werle et al. 2013). In accordance with this distinction between
9 implicit intuition and explicit belief in UTI, some research has mainly measured UTI at the
10 implicit level (e.g., Implicit Association Test; Mai et al., 2015; Raghunathan et al., 2006;
11 Werle et al., 2013), while more recent papers have measured UTI as a belief at the explicit
12 level (e.g., a scale-based measure; Cooremans et al., 2017; Hassova & Florack, 2019). Our
13 research adds to the latter stream by measuring the explicit trade-off belief between health
14 and taste in food through self-reports. Hence, in line with this stream of research (Cooremans
15 et al., 2017; Hassova & Florack, 2019), we refer to this explicit belief in the negative
16 correlation between healthiness and tastiness of food as “UTI belief”, rather refer more
17 generally to “UTI” as that term without the specification may connote an implicit intuition.
18 We elaborate further on this distinction and its implications in the General Discussion.

19 Holding the UTI belief makes it difficult to adopt a healthy diet because unhealthy
20 food is inferred to be tasty and enjoyable, while adopting a healthy diet is assumed to require
21 sacrificing the enjoyment of taste—which is a key if not primary determinant in food choice.
22 This suggests that people with a strong UTI belief are often confronted with the dilemma
23 between the short-term desire for the experience of tastiness and their long-term health goals
24 (Metcalf & Mischel, 1999). As the desire for tastiness often prevails in such dilemmas,
25 people with a strong UTI belief are less likely to consume healthy food, thereby increasing

1 the possibility of weight gain. In support, Cooremans and colleagues (2017) showed in a
2 cross-national investigation of determining factors of obesity that explicit UTI belief
3 increased the likelihood of being obese. While Cooremans et al. (2017) looked at the
4 relationship between UTI belief and BMI, Mai and Hoffmann (2015) delved further into the
5 matter and found that the relationship between UTI and BMI was explained by decreased
6 consumption of healthy food items. Specifically, in their first study, Mai and Hoffmann
7 (2015) showed that consumers who strongly held an explicit UTI belief evinced less interest
8 in healthy food items and more in unhealthy items, although only the consumption of healthy
9 food items significantly influenced BMI. Collectively, these studies suggest that, although
10 people in general wish to be healthy, their explicit belief that healthy foods are relatively
11 unpalatable might lead them to consume fewer healthy food, thereby increasing their risk of
12 being overweight.

13 In the present research, first, we aim to extend the aforementioned research in a cross-
14 cultural investigation. Countries with different cultures often have different food attitudes and
15 choices (Rozin et al., 1999). Moreover, Raghunathan et al. (2006) established the prevalence
16 of the UTI in American samples, but Werle and colleagues (2013) did not find evidence of
17 the UTI being prevalent in France. In contrast to these results, recent research has suggested
18 that due to rapid globalization and urbanization, food beliefs may be converging across many
19 different cultures (Cooremans et al., 2017; Pearcey & Zhan, 2018). For instance, Cooremans
20 et al. (2017) found that French participants hold a similar degree of UTI as participants in the
21 US, UK, and Belgium. Hence, it remains unclear whether the prevalence of the UTI is
22 generally similar across countries, especially outside Western Europe and North America.
23 Furthermore, even if the prevalence of the UTI does not vary significantly across countries,
24 the downstream effects of the UTI on healthy food consumption and BMI may be culturally
25 influenced. While Mai and Hoffmann (2015) demonstrated that UTI is associated with BMI,

1 mediated by healthy food consumption, their sample only consisted of German consumers.
2 However, Europeans tend to be more pleasure-oriented in food choice (Rozin et al., 1999),
3 and hence it is unclear whether the association between UTI, healthy food consumption, and
4 BMI is similarly prevalent in non-European and non-Western countries. Overall, the existing
5 research on the UTI has focused on Western countries, and it is thus both interesting and
6 important to broaden the empirical investigation and examine the UTI among Asian
7 consumers. European consumers may be more driven by sensory appeal and taste in their
8 food choices, whereas Asian consumers may be more driven by health and symbolic value
9 (Januszewska, Pieniak, & Verbeke, 2011; Prescott et al., 2002). These cultural differences
10 could in turn have an influence on Asian consumers' adoption of the UTI as well as their
11 decision making process regarding the consumption of healthy food.

12 Because of these open questions regarding cultural differences, our first goal is
13 therefore to explore the association between the UTI belief and BMI through healthy food
14 consumption across a broader sample of countries, including Asian countries. In so doing, we
15 also assess the cross-cultural validity of the scale-based measure of UTI by comparing it with
16 an indirect measure of this trade-off belief. Specifically, we will assess individuals' health-
17 taste correlations of twenty food options varying widely on healthiness and tastiness. Since a
18 scale-based measure of UTI is often used in research on the UTI (e.g., Werle et al., 2013; Mai
19 & Hoffmann, 2015; Cooremans et al., 2017) it is important to test its validity and examine
20 how closely it is related to individuals' ratings of healthiness and tastiness of actual food
21 options (see also Hassova & Florack, 2019).

22 Our second objective in this research is to determine more precisely what aspect of
23 healthy food consumption drives the association between the UTI belief and BMI.
24 Specifically, we first explore whether the UTI belief differentially influences vegetable
25 versus fruit consumption, and second, we test how vegetable versus fruit consumption

1 differentially influences BMI. Concerning the first step, namely the relation between the UTI
2 belief and eating fruits versus vegetables, the predictions could go both ways. On the one
3 hand, as both vegetables and fruits are considered healthy foods (Woodside, Young, &
4 McKinley, 2013) and dietary guidelines typically recommend eating a variety of fruits and
5 vegetables to reduce the risk of chronic diseases¹, the UTI belief may lead to similar
6 reductions in both fruit and vegetable consumption. On the other hand, there are also
7 important differences between fruit and vegetables that would predict a stronger effect for
8 UTI belief on vegetable consumption than fruit consumption. While fruit is generally sweet
9 and can be consumed as a snack, drink or dessert, vegetables taste less sweet and are
10 sometimes even bitter, are usually harder in texture, and are typically consumed as part of a
11 meal as opposed to alone (Alinia, Hels, & Tetens, 2009). Hence, if fruit consumption is
12 perceived as both a tasty and healthy experience, it may be less relevant to the UTI belief
13 than vegetable consumption. Concerning the second step, namely the relation between fruit
14 and vegetable consumption and BMI, previous literature does not suggest a straightforward
15 prediction. Though the literature suggests that both fruit and vegetable consumption generally
16 serve to lower BMI (Bertoia et al., 2015), the relation between fruit consumption and BMI is
17 more complex. Fruit consumption can increase body weight if fruit juice is included in the
18 category, because fruit juice consists of fruit without dietary fibers, and often contains added
19 sugar (Tetens & Alinia, 2009; Libuda et al., 2008). This is particularly problematic because,
20 for many children and adults, fruit juice is the main source of fruit consumption (Lorson,
21 Melgar-Quinonez, & Taylor, 2009). Thus, vegetable and fruit consumption may play
22 different roles in the association between the UTI belief and BMI. Since no previous research
23 has separated these two possible mediation pathways, we retain it as an empirical question

¹ Dietary Guidelines for Americans, 2015-2020, <https://health.gov/dietaryguidelines/2015/>

1 whether the overall effect of the UTI belief on BMI is differentially determined by vegetable
2 versus fruit consumption.

3 To better understand the positioning and contribution of the present paper, Table 1
4 gives an overview of past UTI research: the authors, year and country of investigation,
5 measurements of UTI (implicit, explicit direct, & explicit indirect), samples, positive versus
6 negative UTI, and the relevant findings and relationships to BMI.

7

8 **TABLE 1: OVERVIEW OF EXTANT RESEARCH ON UTI**

9

Source	Year	Country	Measurement	Sample size	UTI belief	Relevant findings
Raghunathan, Naylor and Hoyer	2006	USA	Explicit and implicit measures (IAT)	Study 1: N = 138; Study 2: N = 110; Study 3: N = 40; Study 4: N = 293	Implicit measure: Positive UTI *	<ul style="list-style-type: none"> • Unhealthy food is perceived to be tastier, more enjoyable and chosen more often when hedonic goal is salient. • The UTI belief exists at both implicit and explicit levels
Werle, Trendel and Ardito	2013	France	Explicit and Implicit measures (IAT)	Study 1: N = 94	Explicit measure: Negative UTI Implicit measure: Negative UTI	<ul style="list-style-type: none"> • Negative UTI belief (i.e., healthy food is linked to tastiness) prevails in France • The negative UTI belief exists at both implicit and explicit levels, and they are highly correlated.
Mai and Hoffmann	2015	Austria and Germany	Explicit and Implicit measures (IAT)	Study 1: N = 560; Study 2: N = 203	Explicit measure: Negative UTI^ Implicit measure: Positive UTI	<ul style="list-style-type: none"> • Explicit UTI increases BMI through a decrease in healthy food consumption • The relation between UTI and BMI operates at both implicit and explicit levels.
Mai, Hoffmann, Hoppert, Schwarz, Rohm	2015	Germany	Implicit measure (IAT)	Main study: N = 91	Implicit measure: Positive UTI	<ul style="list-style-type: none"> • For those who have strong (vs. weak) implicit belief in UTI, their intention

Cooremans, Geuens and Pandelaere	2017	Belgium, France, UK, USA	Explicit measure	Main study: N = 2167	Explicit measure: Positive but weak UTI	<p>of adopting a healthy diet is lowered when they have low nutrition self-efficacy</p> <ul style="list-style-type: none"> • Explicit UTI increases the chance of being obese by 1.18 times • There is no significant between-country difference in explicit UTI belief
Hassova and Florack	2019	Austria and Germany	Explicit and indirect measures (correlation between healthiness and tastiness for 40 food items)	Study 1: N = 547; Study 2: N = 283	<p>Explicit measure: Negative UTI</p> <p>Indirect measure: Negative UTI</p>	<ul style="list-style-type: none"> • Negative UTI belief prevails in both explicit and indirect measures. • There is no significant between-country difference in the UTI belief
The current research	2020	Australia, Germany, Hong Kong, India, The Netherlands, UK	Explicit and indirect measures (correlation between healthiness and tastiness for 20 food items)	Study 1: N = 3,064; Study 2: N = 1002	<p>Explicit measure: varies across countries</p> <p>Positive UTI: Hong Kong and India; Negative UTI: UK, Germany and Australia</p> <p>Indirect measure: Negative UTI (except Hong Kong)</p>	<ul style="list-style-type: none"> • The UTI belief is generally more positive in non-Western countries than in Western countries. • Despite the between-country differences in UTI, it is generally associated with an increase in BMI through a decrease in consumption of fruit and vegetables • The association between UTI and BMI is mediated by vegetable but not fruit consumption.

1 *The degree of UTI belief at the explicit level was not reported in the paper.

2 ^The explicit measure of UTI belief had a mean of 2.6 (SD = 1.0) out of 5 in study 1, and a
3 mean of 3.35 out of 7 in study 2. Both were significantly below the midpoint of the scale,
4 implying that participants did not agree with the belief that unhealthy food is tasty.

6 3. Studies

8 3.1 Study 1: Cross-National Study

1 Study 1 was set up to serve two purposes. First, we tested whether the relationship
2 between the UTI belief and BMI through healthy food consumption would hold across
3 different countries. Second, we tested the construct validity of the scale-based measure of the
4 UTI belief across five countries by testing whether it captures individual-level perceptions of
5 a tradeoff between the tastiness and healthiness of twenty unique food items.

6 7 3.1.1 Method

8
9 Prior to the data collection, this study obtained ethics approval from the Institutional
10 Review Board of Nanyang Technological University of Singapore (Titled: “Effect of Lay
11 Belief on Health and Healthy Behavior”; IRB-2017-03-019). All participants gave informed
12 consent before taking part in the study.

13 3,064 respondents (51.8% female; $M_{\text{age}} = 44.31$ years, $SD = 16.56$) participated from
14 five countries: Australia, Germany, Hong Kong, India, and the UK ($N_{\text{Australia}} = 712$, $N_{\text{Germany}} =$
15 730 , $N_{\text{Hong Kong}} = 218$, $N_{\text{India}} = 703$, $N_{\text{UK}} = 701$). These countries were selected for their
16 diversity with respect to the geographic locations (i.e., countries located in
17 Asia/Europe/Australia) in collaboration with Qualtrics. The study was conducted online using
18 Qualtrics Panels, as part of a larger cross-national investigation of food consumption
19 behaviors. Our initial plan was to recruit 600 participants from each country. However, due to
20 difficulties in recruiting participants from Hong Kong (owing to the relatively small target
21 population of English-speakers available to the service provider), we decided to terminate
22 data collection there and reallocate resources to the remaining four countries. The survey was
23 conducted in English for all countries except Germany, where it was conducted in German.

24 In the survey, participants rated tastiness and healthiness of twenty different food
25 items (i.e., apple, banana, raisins, orange, tomato, cucumber, carrot, broccoli, McDonald’s

1 burger, McDonald's French fries, KFC fried chicken, Pringle's potato chips, milk chocolate,
2 vanilla ice cream, chocolate chip cookies, brownie, Coca-Cola, orange juice, Kellogg's corn
3 flakes, and ketchup). These items were chosen as being commonly consumed foods in the
4 selected countries, which serve as exemplars of broad food categories including fruit,
5 vegetables, fast-food items, sweet foods, and ultra-processed snacks. For each item,
6 participants indicated how tasty and how healthy they thought it is, on separate seven-point
7 scales (1 = "not tasty at all" to 7 = "very tasty", and 1 = "not healthy at all" to 7 = "very
8 healthy," respectively). Similar measures of people's subjective judgments of the healthiness
9 and tastiness of food have been used in previous research (e.g., Haasova & Florack, 2019).

10 After indicating the tastiness and healthiness of each food item, participants
11 responded to Raghunathan et al.'s (2006) three items assessing the strength of the UTI belief:
12 "There is no way to make food healthier without sacrificing taste," "Things that are good for
13 me rarely taste good," and "There is usually a trade-off between healthiness and tastiness of
14 food," (1 = "Strongly disagree" to 5 = "Strongly agree"). Participants then reported how
15 many servings of fruits and vegetables they eat on average per day (0 = "0" to 5 = "5 or
16 more"). Finally, they provided their demographic information, including their height and
17 weight, which we used to calculate their BMI (kg/m^2).

18 *Statistical Approach.* This study was set up to test the association between the UTI
19 belief and BMI through healthy consumption across different countries, and the construct
20 validity of the scale-based measure of the UTI belief. Hence, all the hypotheses were
21 specified before the data collection. To test these hypotheses, we analysed the data following
22 the procedure of Mai and Hoffmann (2015). The pre-specified analytical plan was to conduct
23 a linear regression to test the association between UTI belief and BMI, and a mediation
24 analysis (PROCESS Model 4, Hayes 2017) to test the potential mediating role of healthy
25 consumption. Similar analyses were performed on each of the different countries to test the

1 cross-country associations with both the scale-based and indirect measure of the UTI belief.

2

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TABLE 2: WITHIN-COUNTRY DESCRIPTIVE STATISTICS (STUDY 1)

	Australia	Germany	Hong Kong	India	UK
N	711	730	218	698	701
Age					
mean	53.95	44.42	35.49	32.26	49.29
SD	15.94	15.61	10.28	10.87	15.72
Gender					
male	42.1%	44.4%	40.8%	63.8%	45.2%
female	57.9%	55.6%	59.2%	36.2%	54.8%
UTI belief: scale-based					
Mean	2.50	2.30	3.28	3.37	2.70
SD	1.04	1.02	.90	.99	1.07
UTI belief: indirect measure					
mean	-.15	-.28	.11	-.12	-.09
SD	.44	.38	.42	.40	.44
Daily servings of fruit/vegetables					
mean	3.12	1.98	2.23	2.39	3.19
SD	1.36	1.09	1.08	1.08	1.40
Correlation between scale-based and indirect measure of UTI beliefs					
Pearson's r	.40	.37	.31	.08	.45
p-value	< .001	< .001	<.001	.037	<.001
BMI					
mean	27.16	25.82	22.09	23.02	26.43
SD	6.16	5.46	4.85	4.47	6.27
95% CI	[26.7, 27.6]	[25.4, 26.2]	[21.4, 22.7]	[22.8, 23.4]	[26.0, 26.9]
WHO National Average BMIs (for 2016)*					
mean	27.4	27.4	24.0	21.8	27.5
95% CI	[26.9, 27.9]	[26.7, 28.1]	[23.6, 24.4]	[21.4, 22.2]	[27.2, 27.8]

4

* World Health Organization (2017) Mean body mass index trends among adults, crude (kg/m²) estimates by country, Global health observatory data repository.
<http://apps.who.int/gho/data/view.main.BMIMEANADULTCv?lang=en>

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3.1.2 Results and Discussion

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Six participants (0.2%) indicated unrealistic heights (e.g., 585cm) and thus were not included in the analyses. Analysing the data without excluding any participants yields similar patterns of results.

Validation of scale-based UTI belief. The strength of the UTI belief was computed as the average of the three items on the health-taste trade-off scale (Raghunathan et al., 2006; $\alpha = .85$). Because the scale-based measure of the UTI belief may possibly elicit a social desirability bias or demand characteristics (King & Bruner, 2000), we examined whether the UTI belief captures the perceived trade-off between tastiness and healthiness of 20 food items (i.e., indirect UTI) in different countries. We first computed the correlation between each participant's rating of healthiness and tastiness for the 20 food items, and multiplied it by -1 so that higher scores represent stronger perceptions of trade-off between healthiness and tastiness of food. More formally, given paired data of tastiness and healthiness of 20 food items $\{(t_1, h_1), \dots, (t_{20}, h_{20})\}$, the indirect measure of UTI belief was computed as $-r_{th}$ where t_i is the tastiness score and h_i is the healthiness score for food item i . We then correlated the scale-based measure of the UTI belief with this indirect measure of UTI and found a significant correlation in all countries (Pearson's r ranged from .31 to .45, all p 's $< .001$, except in India, Pearson's $r_{India} = .08$, $p = .037$), thereby validating the scale-based measure of the UTI belief across multiple countries in the East and West.

Belief in UTI across countries. A one-way ANOVA was conducted to examine whether there are between-country differences in the scale-based UTI belief. The result revealed significant between-country differences ($F(4, 3053) = 129.58$, $p < .001$). Respondents in India and Hong Kong showed the strongest UTI belief ($M_{India} = 3.37$, $SD = 0.99$ vs. $M_{HK} = 3.28$, $SD = 0.90$, Bonferroni pairwise comparison test $p > .99$), followed by respondents in the UK ($M_{UK} = 2.70$, $SD = 1.07$), Germany ($M_{Germany} = 2.30$, $SD = 1.02$), and

1 Australia ($M_{\text{Australia}} = 2.50$, $SD = 1.04$; all Bonferroni tests p 's $< .01$). Although significant,
 2 the mean UTI belief in all countries was not very far from the midpoint of the scale (i.e., 3).
 3 The UTI belief scores were above the midpoint in India and Hong Kong (India, $t(697) = 9.76$,
 4 $p < .001$; Hong Kong, $t(217) = 4.51$, $p < .001$), whereas the UTI scores in the UK, Australia,
 5 and Germany were below the midpoint (the UK, $t(700) = -7.54$, $p < .001$; Australia, $t(710) =$
 6 -12.87 , $p < .001$; Germany, $t(729) = -18.45$, $p < .001$).

7 *Association between the UTI belief and BMI.* To test the relationship between the UTI
 8 belief and BMI, we conducted a linear regression in which BMI was regressed on scale-based
 9 UTI belief with age and gender (coded as male = 0, female = 1) as control variables. The
 10 regression model ($F(3, 3052) = 99.52$, $p < .001$, $R^2 = .089$) yielded a significant main effect
 11 of UTI belief, such that the more strongly participants believed in a trade-off between
 12 healthiness and tastiness of food, the higher their BMI was ($\beta = .45$, $SE = .09$, $t = 4.82$, p
 13 $< .001$). Consistent with reports in the literature (Mungreiphy, Kapoor, & Sinha, 2011), age
 14 had a significant and positive effect on BMI ($\beta = .11$, $SE = .01$, $t = 17.23$, $p < .001$), but there
 15 was no significant effect of gender on BMI in this data set ($\beta = .17$, $SE = .20$, $t < 1$, ns). When
 16 we used the indirect measure of UTI belief as the predictor instead of the scale-based
 17 measure, a linear regression analysis again provided evidence of the association between the
 18 indirect UTI belief and BMI ($\beta = 1.82$, $SE = .25$, $t = 7.42$, $p < .001$).

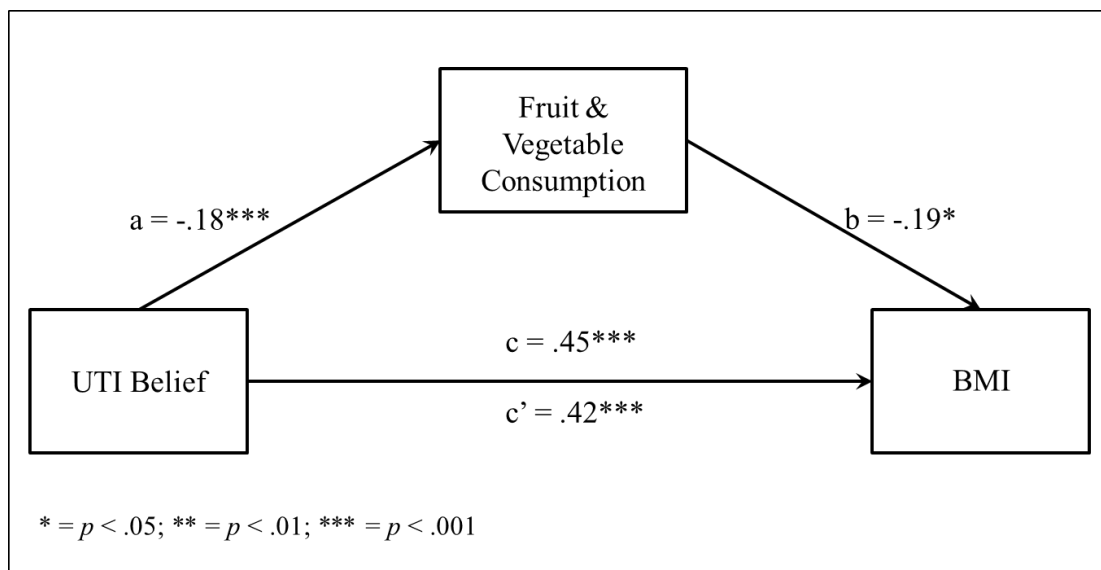
19 *Cross-Country Effect of the UTI belief.* We then conducted the same analysis for each
 20 country separately (see Table 2 for the descriptive statistics for variables in each country).
 21 Using the scale-based measure of the UTI belief, we found that the parameter estimates for
 22 the relationship between UTI belief and BMI were significantly positive in all countries
 23 except Hong Kong— Australia ($\beta = 1.08$, $SE = .25$, $t = 4.36$, $p < .001$), Germany ($\beta = .82$, SE
 24 $= .19$, $t = 4.33$, $p < .001$), the UK ($\beta = .68$, $SE = .24$, $t = 2.79$, $p < .01$), India ($\beta = .44$, SE
 25 $= .15$, $t = 2.94$, $p < .01$), and Hong Kong ($\beta = .52$, $SE = .32$, $t = 1.62$, $p < .11$). Because the

1 sample size of Hong Kong is smaller ($N = 218$) than the sample size required ($N = 782$) to
2 detect a small correlation ($r = .10$) with power of 80% and Type I error rate of 5% ($\alpha = 0.05$),
3 it is difficult to conclude whether the insignificant relationship that we observed in Hong
4 Kong reflects a true negative (i.e., there is actually no effect) or a false negative (i.e., Type 2
5 error). Nonetheless, it is informative that the size and direction of the parameter estimate for
6 Hong Kong was comparable to that for India and the UK.

7 To test for possible across-country differences in the relationship between the UTI
8 belief and BMI, we used Fisher's Z test to compare the sizes of the beta coefficients across
9 countries. The results show that the relationship between the UTI belief and BMI in Australia
10 was the strongest and significantly different from other countries (all z s > 6.12 , all p s $< .001$),
11 followed by Germany (all z s > 3.50 , all p s $< .001$). The relationship in the UK was stronger
12 than that in India ($z = 6.75$, $p < .001$) and marginally stronger than the relationship in Hong
13 Kong ($z = 1.85$, $p = .06$). The relationship between the UTI belief and BMI in Hong Kong
14 was not significantly different from the relationship in India ($z = 1.40$, $p = .16$).

15 *Mediation through Healthy Food Consumption.* Using PROCESS Model 4 (Hayes
16 2017), and aggregating across countries, we next examined whether the association between
17 the scale-based measure of UTI belief and BMI was mediated by reported healthy food
18 consumption. Bootstrap analysis with 5,000 samples revealed the predicted effect (a x b
19 indirect effect = .03, bootstrap $SE = .02$, bias-corrected bootstrap CI [.0048; .0641]).
20 Participants with a stronger UTI belief were less likely to consume fruit and vegetables daily
21 (a path, $\beta = -.18$, $t = -8.27$, $p < .001$, 95% CI [-.2207; -.1361]). This, in turn, affected their
22 BMI such that lower fruit/vegetable consumption was associated with higher BMIs (b path,
23 $\beta = -.19$, $t = -2.40$, $p = .02$, 95% CI [-.3441; -.0348]). When we used the indirect measure of
24 UTI belief as the predictor, we found similar mediation results (a x b indirect effect = .06,
25 bootstrap $SE = .03$, bias-corrected bootstrap CI [.0053; .1259]).

FIGURE 1: MEDIATION ANALYSIS STUDY 1



Discussion. Study 1 used both indirect and explicit measures of UTI beliefs and showed that individuals' UTI belief has important associations with their healthy food practices and BMI across different countries. This is despite the cultural differences in UTI strength that have been previously described (Werle et al., 2013), and hence constitutes an important replication and extension of past findings. At a country level, people vary in how strongly they subscribe to the UTI belief. Overall, however, looking at Table 2, we note that the strength of the UTI belief across countries is fairly weak, and sometimes the opposite prevails (i.e., negative UTI). The scale-based measures of the UTI belief fluctuate around the mid-point of the scale, and the indirect measures are all negative except among Hong Kong respondents. This is generally consistent with previous literature suggesting that the UTI belief (in France; Werle et al., 2013), as well as subjective judgments of health and taste in food (Haasova & Florack, 2019), tend to be weak overall (Cooremans et al., 2017). Nevertheless, we found the UTI belief to be associated with BMI through healthy food consumption across a diverse set of European and Asian-Pacific countries. This is important

1 because it is initial evidence that variations in the strength of the UTI belief lead to variations
2 in the amount of healthy food (fruits and vegetables) consumed, which has consequences for
3 BMI. While the variations in the strength of the UTI belief are interesting, our focus is on
4 highlighting the striking similarity in their downstream consequences for healthy food
5 consumption, BMI, and health in general. At the same time, our exploratory analysis of the
6 cross-cultural differences in the strength of the relationship between the UTI belief and BMI
7 also reveals interesting findings. Although they were all significant (except Hong Kong), the
8 UTI belief had a weaker relationship with BMI in Asian countries (India and Hong Kong)
9 than in Western countries (Australia, Germany and UK). This is consistent with prior
10 research, which shows that while consumers in Western countries (e.g., Europe) are mainly
11 driven by taste in their food choices, Asian consumers are more concerned with health
12 (Januszewska, Pieniak, & Verbeke, 2011; Prescott et al., 2002). As the desire for taste, rather
13 than health, is the main reason why it is difficult for those who hold a UTI belief to follow a
14 healthy diet, we similarly show that Asian consumers are less susceptible to the influence of
15 the UTI belief than their Western counterparts.

16 A limitation of this study, however, is that the UTI belief, fruit and vegetable
17 consumption, and BMI were all measured in the same survey, and thus the results may suffer
18 from common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Furthermore,
19 fruit and vegetable consumption was measured with just one questionnaire item. We directly
20 address these limitations in study 2.

21

22 3.2 Study 2: Survey Panel Study

23

24 3.2.1 Method

25

1 The first goal of study 2 was to tease apart the mediating roles of vegetable and fruit
2 consumption in order to better understand what type of healthy food consumption is more
3 important in the relationship between UTI belief and BMI. Also, to overcome the limitations
4 of common method bias in study 1 and in a response to a call for addressing the possibility of
5 reverse-causality in the relationship between the UTI belief and BMI (Mai & Hoffmann,
6 2015), study 2 measured individuals' UTI belief, fruit and vegetable consumption, and their
7 BMI independently at three different moments in time separated by 30 months.

8 To address both goals, we relied on data from a subset of 5000 participants from a
9 stratified representative national sample of households in the Netherlands (Longitudinal
10 Internet Studies for the Social Sciences; www.lissdata.nl; available to all academic
11 researchers on request). From these 5,000 households, varying yet partially overlapping
12 subsamples are contacted every month to complete an online survey with questions relevant
13 to social scientists. As the data is from a secondary source and no ethics approvals for
14 questionnaire research among adults are required in the Netherlands
15 (<https://www.lissdata.nl/faq-page#n5512>), we did not obtain a separate ethics approval for
16 this study. Nevertheless, the data collection process by LISS abides by the European General
17 Data Protection Regulation, and all the households provided their informed consent before
18 starting the questionnaire and serving as a panel member.

19 One member in each household provides all the data for the entire household and
20 updates household information at regular time intervals. In addition to existing household and
21 respondent characteristics, ten core studies are repeated annually, including Economic
22 Situation, Family and Household, Religion and Ethnicity, Health, among others. This annual
23 data collection is designed to follow changes in the life course and living conditions of the
24 panel members. In addition to the ten core studies, depending on the demand, other more
25 specific studies are assembled and sent out in additional waves of data collection (like Wave

1 1 below).

2 Our data come from three separate waves of data collection that were conducted over
 3 30 months apart. Wave 1 (LISS Lifestyle Study; April 2016) included three items that
 4 measured the UTI belief based on Raghunathan et al. (2006): “Eating healthy means
 5 sacrificing taste,” “Things that are good for me rarely taste good,” and “There is usually a
 6 trade-off between healthiness and tastiness of food,” (1 = “I definitely do not agree” to 5 = “I
 7 definitely agree.”). An overall measure of UTI belief was computed as the average of the
 8 three items (Cronbach’s $\alpha = .79$). The mediators, fruit and vegetable consumption, were
 9 collected from the second wave. This Wave 2 (LISS Core Health Study, November and
 10 December 2017) provided us with two separate items that measured respondents’ vegetables
 11 and fruit consumption: “Do you eat raw or cooked vegetables?” and “Do you eat fruit?” on 1
 12 = “Never” to 6 = “Everyday” (Pearson’s $r = .29$, $p < .001$). The dependent measure, BMI,
 13 was collected from the third wave. Specifically, Wave 3 (LISS Core Health Study, November
 14 and December 2018) included updated data of the household member’s height and weight.
 15 Using these measures, we calculated their BMI (kg/m^2). Matching the data files of Wave 1,
 16 Wave 2, and Wave 3 yielded 917 unique respondents (49.3 % female; $M_{\text{age}} = 60.7$ years, SD
 17 = 14.24). Nine participants (< 1%) indicated unrealistic heights or weights (e.g., 776 kg) and
 18 thus were not included in subsequent analyses. The remaining 908 participants had an
 19 average BMI of 26.2, $SD = 4.26$, $CI [26.0; 26.5]$ which is in line with the national average
 20 according to the WHO².

21 *Statistical Approach.* This study was set up to tease apart the mediating role of
 22 vegetable and fruit consumption in the relationship between the UTI belief and BMI. Hence,

² National average = 26.1, $CI [25.4; 26.8]$ in 2016 according to the WHO World Health Organization (2017) Mean body mass index trends among adults, crude (kg/m^2) estimates by country, Global health observatory data repository.
<http://apps.who.int/gho/data/view.main.BMIMEANADULTCv?lang=en>

1 the hypothesis was specified before retrieving the data. To test the prediction, we analyzed
 2 the data following the procedure in study 1 and that of Mai and Hoffmann (2015). The pre-
 3 specified analytical plan was to conduct a linear regression to test the relationship between
 4 the UTI belief and the delayed measure of BMI, and two separate mediation analyses
 5 (PROCESS Model 4, Hayes 2017) to examine the mediating roles of vegetable and fruit
 6 consumption respectively.

7

8 3.2.2 Results and Discussion

9

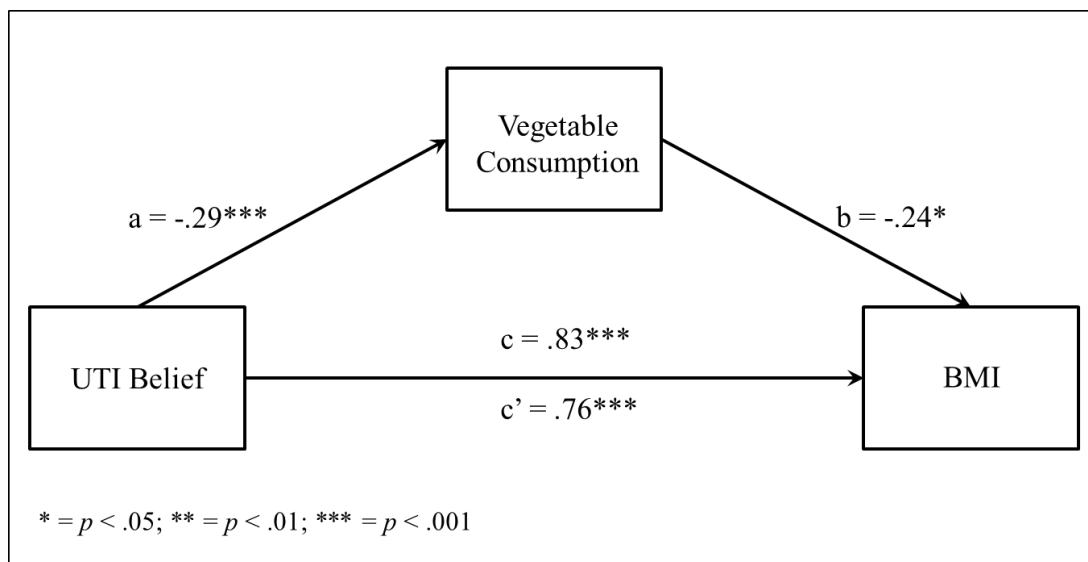
10 *Association between UTI belief and BMI.* We ran a linear regression ($F(3, 905) =$
 11 $12.15, p < .001, R^2 = .039$) on respondents' BMI in 2018 with their individual UTI belief of
 12 2016 as the predictor, controlling for their gender (male = 0, female = 1) and age in 2018. As
 13 predicted, there was a positive and significant relationship between UTI belief and BMI, such
 14 that the more people believed in a trade-off between the healthiness and tastiness of food, the
 15 higher their BMI was ($\beta = .83, SE = .17, t = 4.96, p < .001$). Consistent with reports in the
 16 literature (Mungreiphy et al., 2011), age had again a significantly positive relationship with
 17 BMI ($\beta = .023, SE = .01, t = 2.32, p = .021$) and gender had a marginal relationship with BMI
 18 ($\beta = -.52, SE = .28, t = -1.83, p = .067$), with women having a lower BMI than men.

19 *Mediation through Vegetable versus Fruit Consumption.* Using PROCESS Model 4
 20 of Hayes (2017), we tested whether the relationship between the UTI belief (2016) and BMI
 21 (2018) was mediated by self-reported vegetable, and fruit, consumption (2017), respectively.
 22 First, UTI belief had a significantly negative relationship with vegetable consumption (a path,
 23 $\beta = -.29, se = .046, t = -6.40, p < .001, 95\% \text{ CI } [-.38; -.20]$), and in turn, vegetable
 24 consumption had a negative relationship with BMI (b path, $\beta = -.24, se = .12, t = -2.00, p$
 25 $= .046, 95\% \text{ CI } [-.48; -.0046]$). Bootstrap analysis (using 5000 samples) confirmed a

1 significant mediation (a x b indirect effect = .071, bootstrap se = .038, bias-corrected
 2 bootstrap CI [0.0019; 0.15]). Controlling for vegetable consumption, the direct relationship
 3 between UTI belief and BMI remained significant (c' path, $\beta = .76$, se = .17, $t = 4.44$, p
 4 $< .001$, 95% CI [.43; 1.10]. Overall, these results suggest that a stronger belief in UTI is
 5 associated with an increase in BMI through reduced vegetable consumption.

6 For fruit consumption, in contrast, we did not find this mediating role. Although there
 7 was also a significant negative relationship between UTI belief and fruit consumption (a path,
 8 $\beta = -.22$, se = .051, $t = -4.37$, $p < .001$, 95% CI [-.32;-.12]), fruit consumption was not related
 9 to BMI (b path, $\beta = -.17$, se = .11, $t < -1.57$, $p = .12$, 95% CI [-.39; .042]). Bootstrap analysis
 10 (5000 samples) also found no significant mediation (a x b indirect effect = .038, bootstrap se
 11 = .03, bias-corrected bootstrap CI [-0.011; 0.10]). (See also Web Appendix B for more details
 12 on the analyses)

13 FIGURE 2: MEDIATION ANALYSIS STUDY 2



17 *Discussion.* By testing the relationship between individuals' UTI belief and delayed
 18 measures of their BMI using a large and representative national sample, we found substantial

1 new evidence for our theorizing, while extending earlier research findings (Mai &
2 Hoffmann, 2015; Cooremans et al., 2017) showing a similar relationship between the UTI
3 belief and BMI. Study 2 further specifies the underlying mechanism of the association
4 between the UTI belief and BMI by showing that vegetable consumption rather than fruit
5 consumption mediates this process. Though fruit consumption seems less related to the UTI
6 belief than vegetable consumption, the absence of a significant mediation through fruit
7 consumption is mainly due to the weak association between fruit consumption and BMI. This
8 might be due to the fact that many of our respondents were likely to consider fruit juice as
9 part of the fruit category, and fruit juice often contains low amounts of dietary fiber and high
10 amounts of sugar.

11 In addition, study 2 provides initial evidence against reverse causality. While our
12 mediation analysis remains correlational, the fact that the UTI belief was measured in 2016,
13 vegetable consumption in 2017, and BMI in 2018, renders it impossible for BMI (in 2018) to
14 be driving the belief about the trade-off between health and taste in food in 2016. We did not
15 find a significant effect of UTI belief in 2016 on a change in BMI between 2016 and 2018.
16 This may have been because the changes in BMI in two years' time are not large enough to
17 have a statistically significant effect, particularly in a largely middle-aged sample ($M_{age} =$
18 60.7 years). However, the exact pattern of results, including the mediation by vegetable
19 consumption, was obtained when regressing respondents' BMI from 2017 (measured in
20 Wave 2 LISS Core Health Study, November and December 2017) on the UTI belief from
21 2016. Hence, we are confident that our findings of an association between the UTI belief and
22 BMI through vegetable consumption are robust and stable across time.

23

24 4. General Discussion

25

1 The prevalence of obesity continues to increase around the world, and has gained
2 much necessary attention from policy makers and the general public. The present research
3 examined the role of the UTI belief as one of the drivers of obesity. In two survey studies,
4 using samples from European and Asian-Pacific countries, we demonstrated that the UTI
5 belief is associated with adults' BMI. We further show that the UTI belief is positively
6 associated with BMI through a reduction in the consumption of healthy food—in particular,
7 vegetables.

8 To ensure that our measure of the UTI belief was reliable, we relied on the scale-
9 based UTI measure developed by Raghunathan et al., (2006) and used it consistently across
10 both of our studies. In both studies, the Cronbach's alpha for this measure was higher than
11 0.70. Importantly, we assessed the validity of the scale-based measure of the UTI belief by
12 comparing it with individual-level correlations between the perceived healthiness and
13 tastiness of 20 food items. This more indirect measure of the UTI belief was strongly
14 correlated with the scale-based measure and yielded similar and stable cross-country results
15 on BMI. Our other key measures of fruit and vegetable consumption and height and weight
16 were less susceptible to reliability issues as they measure specific daily habits and physical
17 attributes rather than a latent psychological construct.

18 One possible limitation of this research is that we assessed the UTI belief using
19 explicit measures. Even the more indirect measure of UTI in study 1 consisted of explicit
20 questions. While this practice follows some of the recent research on UTI (e.g., Mai &
21 Hoffmann, 2015; Cooremans et al., 2017), interesting questions remain regarding whether
22 implicit and explicit beliefs in UTI converge and whether they may differentially influence
23 outcomes related to food consumption and BMI. Concerning the first question, the literature
24 generally suggests that implicit and explicit beliefs are governed by different processes: while
25 implicit beliefs are the result of spontaneous associations and intuitions, explicit beliefs tend

1 to arise from rules and reasoning (Strack & Deutsch 2004). In the specific context of the UTI,
2 some research has indeed looked into the interplay of implicit and explicit beliefs
3 (Raghunathan et al. 2006; Werle et al. 2013). Here, the evidence suggests that for the UTI
4 belief, there is in fact a significant positive correlation between implicit and explicit beliefs
5 (Werle et al. 2013). Further, Raghunathan et al. (2006) showed that people in general hold
6 stronger UTI beliefs at an implicit level than an explicit level, such that unhealthy food was
7 intuited to taste better even among those who happened to explicitly disagree with the UTI.
8 This suggests that although implicit and explicit beliefs might differ, our explicit measure of
9 UTI is a more conservative test of the relationship between UTI belief and BMI.

10 Concerning the second question, regarding whether implicit and explicit beliefs might
11 converge or dissociate in the effects, research has generally assumed and shown that both
12 implicit and explicit beliefs operate in parallel and guide consumption behavior at the same
13 time (Strack and Deutsch 2004). While some research shows that implicit and explicit beliefs
14 have additive power in predicting behavior, recent research finds that implicit and explicit
15 beliefs may in fact interact to influence consumption behavior (Mai and Hoffmann 2015; Mai
16 et al. 2019). For instance, Mai et al. (2015) show that an explicit belief in nutrition self-
17 efficacy translates into intentions to eat healthy only when people exhibit a smaller implicit
18 belief in UTI. Consequently, measuring UTI at an implicit level in a follow-up study could
19 provide a more complete picture of the dynamics between UTI, healthy food consumption,
20 and BMI.

21 Collectively, the present research makes several theoretically interesting and
22 substantively meaningful contributions. We contribute to the literature on lay beliefs by
23 showing the far-reaching influence of the UTI belief on BMI. While prior research on UTI
24 has provided initial evidence on the possible relationship between the UTI and BMI, cultural
25 differences in adoption of the UTI have raised several unanswered questions (Cooremans et

1 al., 2017; Mai & Hoffmann, 2015; Werle et al., 2013). The present research fills this gap by
2 showing the predictive power of UTI belief on BMI using multinational samples and teasing
3 apart the different mediational roles of vegetable and fruit consumption. Even though the
4 prevalence of the UTI belief varies across countries, as shown by Werle et al. (2013), our
5 study suggests that the relationship between UTI belief and BMI does not.

6 On the practical front, the UTI belief and its related self-control dilemmas make
7 eating healthy a struggle for many people around the world. Policymakers should take heed
8 of this as part of their extensive efforts in trying to influence consumers towards healthier
9 food consumption. The present research provides direct implications to policymakers as to
10 what intuitive belief systems they should advocate, and the types of practices that should be
11 implemented or discouraged. People's beliefs determine their actions, and thus one way to
12 induce people to eat healthier would be by changing their beliefs about the relationship
13 between the healthiness and tastiness of food. For instance, policymakers can focus more on
14 advertising and promoting the tastiness of healthy food. In support, recent research indicated
15 that vegetable intake can indeed be increased by emphasizing their tasty and enjoyable
16 attributes (Turnwald et al., 2019). In contrast to this pleasure-oriented approach,
17 policymakers generally adopt a more cognitive approach toward encouraging healthy eating.
18 For example, current popular strategies focus on providing nutritional information and
19 pointing out which types of foods are "good" or "bad" for health (Marty et al. 2018).
20 Providing children with an external reward for eating something healthy also fits this
21 category. Our findings question the efficacy of such strategies depending on the country,
22 because we have found cross-country differences in both the adoption of the explicit UTI
23 belief and its relationship with BMI. Although Asian consumers may hold stronger belief in
24 UTI, their UTI belief is less strongly associated with BMI than their Western counterparts,
25 which is in accordance with their concern with health (vs. taste). This should encourage

1 policymakers to be careful in their choice of pleasure-oriented and cognitive approaches
2 toward encouraging healthy eating. While the pleasure-oriented approach that emphasizes
3 taste might be more effective in Western countries, a more cognitive approach that focuses on
4 health might work better for Asian countries. Finally, another implication is that policy
5 makers should be cautious when promoting the consumption of fruit to stimulate weight loss.
6 In our results, the consumption of fruit did not lead to a decrease in body weight. This might
7 be caused by the fact that for many children and adults fruit juice seems to be the leading
8 source in total fruits (Lorson, Melgar-Quinonez, & Taylor, 2009). Recommendations from
9 the *Dietary Guidelines for Americans* already specify that no more than half of fruit intake
10 should be obtained from fruit juice or at least half should come from whole fruits³, but
11 stressing this even more and also in other countries seems advisable. Further research is
12 definitely needed, but for now inducing increased consumption of vegetables seems to be the
13 more efficacious route to decrease body weight.

³ Dietary Guidelines for Americans, 2015-2020, <https://health.gov/dietaryguidelines/2015/>

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