Erasmus School of Economics

Bachelor Thesis- International Economics and Business Economics (IBEB)

I'm just not the dieting type of person

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Abstract

In the past decade there has been an increase in obese and obesity rate in the Netherlands. To address this issue, it is important to look at one of the reasons why the effort of dieting might not be effective. This paper discovered that one reason that leads to ineffective dieting is underreporting of dietary intake. Underreporting of dietary intake may occur when participants does not disclose their food consumption honestly when reporting their dietary intake in a journal or diet tracking apps. Since this information is private information, finding subjective truth is often difficult. In this paper, I tried to use the Bayesian Truth Serum method to test if this questioning method can significantly reduce truth telling when it comes to disclosing dietary intake and food habits. The Bayesian Truth Serum method has been proven in a theoretical setting to induced truth telling by incentivizing participants to tell the truth. After conducing and analyzing the survey done, I found out that the Bayesian Truth Serum method does not significantly outperformed the normal dietary intake assessment method when it comes to reducing dietary underreporting.

Key words: Behavioral economics, Bayesian Truth Serum, Underreporting, dietary intake

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1. Introduction

According to the data from the World Health Organization (WHO), a significant amount of people around the world live in countries where being obese and overweight cause more health problems than being underweight. The number of people that are obese almost tripled between 1975 and 2016 and as a result, being overweight and obese are causing more deaths than being underweight (WHO Fact sheet, 2018). The term overweight is defined as excessive amount of fat accumulation that can potentially impair health of an individual; this is commonly measured using the body mass index (BMI), a weight-for-height index (WHO Fact sheet, 2018). Evidently this problem can also be seen in the Netherlands, in 2017 48.7% of adult population is considered as overweight, including 13.9% being obese adult population (RIVM, 2017).

To tackle this issue, the Dutch government currently has many programs to encourage families and schools to make healthy changes to their diet and lifestyle habits. These healthy habits include both moderation of food intake and recommended amount of physical exercises. Funded by the Dutch Ministry of Economic Affairs and the Ministry of Public Health, Welfare & Sport, The Netherlands Nutrition Centre (Stichting Voedingscentrum Nederland) serves to encourage consumers, particularly in the Netherlands to develop and further maintain a healthy and sustainable eating habits. For a healthy diet it is advised to have 10% -25% of energy intake from protein, 40%-70% from carbohydrates, and 20%-40% of fats. How much calories to consume each day depends on the number of hours spent on exercise. For adults it is advised to complete at the minimum of 2.5 hours of moderate or high intensity physical activities in a week (Voedingscentrum, 2017).

The Netherlands Nutrition Centre facilitates people who wants to lose weight by providing them information on how to lose weight effectively. This is done through recommending amount of food intake and exercises tailored to individual gender and weight specifications. One out of the many effort done by The Netherlands Nutrition Centre include a smartphone app called “Mijn eetmeter”; the application facilitates people to track down their daily food intake (Voedingscentrum, 2017). Previous research has shown that an electronic food tracking app have an advantage over its handwritten counterpart as the manual hand-written data can be a hassle to code and this may lead to high individual cost (Burke, Conroy, Sereika, Elci, Styn, Acharya, Sevick, Ewing & Glaz, 2012). The paper concluded that within a six months period, participants who received self-monitoring app and daily feedback messages achieved 5% more weight loss compared to those using only the paper diary record and only the self-monitoring app. Thus, having a food tracking app which specifically caters to the Dutch population is likely to increase weight loss success within the population.

The increasing use of smartphone in the Netherlands facilitates the accessibility to smartphone apps. In 2017, 93% of people owned a smartphone in the Netherlands. The penetration of usage among the age 18 - 24 years old is almost stabilized, while there is growth

in usage amongst the older generation (Deloitte, 2017). This penetration allowed me to look further into the adult population that are living in the Netherlands and how food tracking apps may benefit those who wants to lose weight.

Behavioral weight loss program has two main components, the first one being self-monitoring of diet and the second being the self-monitoring of physical activities (Turner-McGrievy et al., 2012). The study done by Turner-McGrievy et al. (2012), was conducted over the period of 6 months with 96 overweight men and women as participants. Conducted from 2010 – 2011, participants chose their method of diet and physical activities and the were categorized by according to their chosen method of diet and physical activity. The result showed that physical app users self-monitored their exercise routine more frequently than non-app users. This result also suggested that physical app users were able to lose more weight than non-app users. On the other hand, the result of self-monitoring dietary intake suggested that frequency of self-monitoring did not differ between those using the app and those using the paper journal. This paper further focused on dietary self-reporting because weight loss tracking apps predominantly have "keep a food diary" feature and emphasized less on regular physical activities within a single weight loss app (Breton et al., 2011). Physical activity apps are available with automatic tracking features, such as counting the number of steps and heart rate using the smartphone sensors, allowing for an objective and accurate measurement for physical activity (Duarte et al., 2014). However, this kind of feature does not exist for individual dietary assessment, thus self-monitoring of dietary assessment is more prone of underreporting as evidently suggested by the paper of Turner-McGrievy et al. (2012).

People are generally bad at objectively reporting their dietary intake, especially because this process relies on memories and perception; this inevitably lead to only an approximate value being recorded (Fraser & Shavlik, 2004). Food tracking apps can be very beneficial if used correctly. However, users tend to underreport their dietary intake because they may find it difficult to assess their intake accurately. According to existing literature, it is natural for an individual to deviate from their habitual intake during a recording period, which may lead to increasing or decreasing of intake (Black et al., 1991). When it comes to underreporting, it is important to first understand the common characteristics of under-reporters, what is being under-reported and why do people under-report their dietary intake, to tackle the problem at hand (Macdiarmid & Blundell, 1998). Aside from focusing on general dietary underreporting, this paper will also focus on how to reduce the likelihood of underreporting when using food tracking apps. There is a focus on self-report food tracking app because as seen above there is an opportunity to reach greater proportion of the population and the app is more effective compare to written dietary assessment. The Bayesian Truth Serum (BTS) survey method will be used to incentivize users to assess their dietary intake more accurately.

The BTS survey is a scoring method that incentivized truth telling for respondents when answering multiple-choice questions regarding private matters (Weaver & Prelec, 2013) in this case their self-reporting behavior when reporting their dietary intake. Using the BTS method, participants will be rewarded a high score when they give an answer that is more common than what the group collectively predicted and answers that are less common than what the group predicted, will get a low score. The method of scoring in BTS will enable researchers to generate truthful reliable data without having previous extensive knowledge regarding the data being recorded; meaning that without having extensive knowledge of individual dietary habits and nutrition, researcher will still be able to use this truth telling method to induce underreporting of dietary intake. Bayesian Truth Serum has advantage over other survey methods because it does not reward the most common responses. Thus, participants are less likely to provide answers that they believe adhere to the mean of the population. The BTS has been achieving promising results in theoretical settings, such as answering questions regarding opinions, taste and behaviors (Weaver & Prelec, 2013). But so far, BTS has not been applied to assess truth telling when it comes to self-reporting of dietary intake. Thus, this paper aims to explore whether the BTS method can affect the likelihood of underreporting when tracking dietary intake, leading to the following research question:

Would the application of Bayesian Truth Serum method decrease underreporting when self-reporting dietary intake?

The following Section will provide the theoretical background to further understand the research question addressed. There are two parts in section 2, the first provides insights into dietary underreporting and factors related to it, and the second part introduces and explains the BTS method, its assumptions and how this can theoretically induce truth telling when assessing individual dietary intake. Section 3 describes the experiment conducted and the necessary questions used to obtain the necessary data. Then in section 4, analysis and results of the experiment will be further discussed. The discussion in section 5 provides and explains the outlined results of section 4 while addressing further concerns and limitations of the study. Lastly, section 6 will provide conclusion and recommendations for further studies.

2. Literature Review

2.1 Underreporting of Dietary Intake

Accurate assessment of habitual food intake is a crucial part when it comes to tackling obesity, thus an invalid dietary intake is problematic. A valid dietary record is described as “when subject ate as s(he) would have done had s(he) not been under observation and recording it accordingly” by Ortega, Perez-Rodrigo & Lopez-Sobaler (2015). Underreporting of food intake becomes a serious problem when there is there is a tendency to record below individual’s the

habitual intake. Invalid dietary intake may arise from different behaviors, especially intentional underreporting and unintentional underreporting (Black et al., 1991). These two processes are not mutually exclusive of another; different factors such as profile characteristics and the type of food also plays significant role depending on the method of dietary intake assessment (Bingham, 1991).

2.1.1 Who is underreporting?

The paper by Macdiarmid & Blundell (1998) has analyzed exactly 12 papers assessing this very topic of "who is underreporting?", as a result they found out that certain characteristics and behaviors have been associated with underreporting. Within the 12 papers, groups categorized by gender and body mass index (BMI) consistently differ in result. However, it should be noted that dietary intake assessment and the methods used of identifying suspected within the 12 papers varies, thus direct comparison may be problematic. When first looking at the variable gender; 11 out of the 12 studies agreed that women are more susceptible to underreporting than men. Among young adult population, women tend to report their dietary intake significantly lower than what they needed to sustain a stable body weight (Haraldsdottir & Sandstorom, 1994). The case of underreporting among women due to social pressure associated to looking more 'feminine' and they are more concerned about their body weight as compare to men. Due to social pressure women tend to report dietary intake that they perceived to be socially acceptable (Scholler, 1990).

The second variable analyzed in the paper by Mcdiarmid & Blundell (1998) is the effect of body weight on underreporting. Underreporting is found to be more common among overweight and obese individuals. However, the effect of body weight is rather inconsistent across the 12 papers. The paper by Lisser et al. (1989) found that lean women have the same likelihood to underreport their dietary intake as obese women, suggesting that underreporting is not restricted to people that are overweight and obese. The distinction between obese, overweight and normal weight participants were measured using BMI. The BMI is a simple calculation using a person's height and weight. A BMI of 30 or greater is considered obese and a BMI of 25 - 29.9 is considered overweight, while a BMI of 18.5 - 24.9 is considered normal (Voedingscentrum, 2018). The paper by Yuker et al. (1995) found that obesity is highly stigmatized in Western society, thus obese individuals faces higher social pressure to lose weight. Society's attitudes towards obese individuals could be a trigger for overweight individuals to underreport their dietary intake (Hill et al., 1992).

Aside from the two main factors discussed above, although not consistently analyzed within the 12 studies; other characteristics associated with underreporting which have been proven to be significant include: age, education, and dietary restrained (Mcdiarmid & Blundell, 1998). The first variable, age was approximately found in half of the studies. In general, underreporting was associated with increased age. However, this effect is commonly associated with other characteristics, such as BMI. The second variable, education was found in 4 out of the 7 studies. It was found that underreporting is correlated with lower levels of education, the paper

by Mcdiarmind & Blundell (1998) suggested that this finding was not a surprise since literacy is required for most dietary intake assessments. The third variable, dietary restraint (when individual consciously tries to control their food intake) was found to be related to underreporting of dietary intake in 5 different studies. The paper by Bingham et al., (1995) found that invalid dietary reporters have significantly higher dietary restraint.

2.1.2 What is being underreported?

The issue of which type of food is more likely to be underreported is divided into two sections. First, we discuss whether underreporting is macronutrient specific? Next, we discuss whether there are certain foods that are heavily underreported? Regarding the first issue, the paper by Mcdiarmind & Blundell (1998) found that protein is typically being accurately reported or over-reported as compare to food consisting of carbohydrates and fats. Carbohydrate (sugar) are commonly underreported in 6 dietary studies analyzed. While the effect of fat intake is unclear; 2 out of 3 studies suggests that fat tends to be over-reported and one study suggests otherwise. However, it should be noted that there can be inter-relatedness in macronutrients intake, thus it is difficult to prove inverse relationships between some macro-nutrients. Regarding the second issue "are there certain foods that are heavily underreported?" first the paper by Mcdiarmind & Blundell (1998) addresses the discrepancy between what people think of dieting and how diet is analyzed in research. Diet is recognized in terms of nutrients in a research setting, while people generally view diet in terms of different food groups. Understanding this distinction allows us to specifically looks at certain food groups concerning underreporting. Sweet food that are high in fat (e.g. cakes, biscuits, and pastries) tend to be underreported. The paper by Bingham et al. (1995) found that female under-reporters generally consumed significantly less breakfast cereals, milk products, eggs, and fats (e.g. butter). When participants were asked to predict how accurately they would record their dietary intake, it is found that 19% would reduce fatty food and 43% thought that they would increase their fruits and vegetables intake (Mela & Aaron, 1997). From the paper of Mela & Aaron (1997) it can be concluded that health image of certain food groups influenced over and underreporting of diet. Thus, food having good health image are likely to be over reported and those food having bad health image tends to be underreported.

Concerning the second issue, three studies found that snacks are particularly prone to underreporting (Mcdiarmind & Blundell, 1998). The first reason was that snack food tends to be identified as having a negative image, which lead to omission when recording dietary intake. This negative image may stem from the individual prior belief that eating three meals a day is more justifiable. Secondly, eating snack is described as secondary activity; thus, snack can be easily forgotten during the recollection of dietary intake or is seen to be a hassle to record. Many researchers have concluded why different subgroups of population and why specific type of food is more likely to be under-reported, in the next section the paper will further explore different

behavioral patterns of under-reporters to further understand psychological and behavioral factors of underreporting.

2.1.3 Why do people underreport?

The discipline of psychology in this case is important in the process of a valid data collection and understanding the motivation behind inaccurate and accurate reporting of dietary intake (Mcdiarmind & Blundell, 1998). In this paper, there are two categories under behavioral underreporting: intentional and unintentional underreporting. The paper by Mcdiarmind & Blundell (1997) asked participants if they have omitted food during their study period and as a result, almost half (46%) of participants admitted in changing their diet. Intentional underreporting can be explained by two main categories. The first is related to individual concern who admitted feeling embarrassed to record all their dietary intake. These behaviors are associated with individuals having dietary restraint. Bias in reporting of dietary intake may come from individuals wanting to conform to a socially desirable image to avoid criticism (Herbert et al., 1995). The second is related to 'hassle', inconvenience, and the amount it takes to complete a dietary intake assessment. Participants admitted to not recording some food (e.g. snacks and condiments) they have consumed because it is troublesome (Mcdiarmid & Blundell, 1997). According to their paper published in 1998, people faced a dilemma between having a busy lifestyle and the time-consuming nature of dietary recording. Since participants were likely to opt for a short cut, it is important to take account the possibility of deliberate underreporting when looking at underreporting in dietary intake assessment.

The second behavioral category is unintentional underreporting, it occurred in aspects where participants have no direct control, but still contribute to their dietary intake accuracy. These for example may include: lack of attention, poor memory and literacy problems (Mcdiarmind & Blundell, 1998). Inaccuracies in underreporting can be stem from people genuinely not remembering how much food they have eaten. The chapter by Thompson & Subar (2013) have noted that intellectual capacity of participants contributes to a more accurate dietary intake data. Thus, underreporting is more prone for people having lower educational background.

2.1.4 Ways to Reduce Underreporting of Dietary Intake

Underreporting of dietary intake are not solely caused by factors mentioned above, since methodological issues in data collection can contribute to inaccuracy in dietary intake assessment (Mcdiarmind & Blundell, 1998). Methodological factors that may induce errors include: using food tables and coding of dietary intake. Food tables is a dietary assessment method of putting a check on different food consumed from an extended food list. While the coding of dietary intake entails transferring written data of dietary intake in a data base. When it comes to using dietary record for assessment, data can be a burden to transfer and it leads to

high individual cost, unless dietary record are collected electronically (Thompson & Subar, 2013). This paper focused on two types of dietary assessment methodology. The first one being dietary record assessment, the dietary intake application developed by The Netherlands Nutrition Center, “mijn eetmeter” uses the same type of assessment and food tracking apps have been proven to reduce error in dietary data collected. Having the same type of dietary assessment as a food tracking app would allow results of this paper to serve as recommendation on how food tracking apps can be further improved to reduce dietary underreporting. The second dietary assessment methodology is brief dietary assessment instrument or also known as “screeners”. This second dietary assessment Brief dietary assessment instruments are useful in situation where total diet or quantitative accuracy is not required (Thompson & Subar, 2013). Example of these include brief assessment assessing fruit, vegetable, and fat intake. In the case of underreporting, using “screeners” researcher can focus on specific foods or nutrients that are prone to underreporting.

2.2 Bayesian Truth Serum

Although underreporting of dietary intake has many components as seen above, one behavioral aspect that plays a role is not answering questions honestly when asked about their dietary intake. To tackle this problem, this paper will the combined questioning method of “screeners” and Bayesian Truth Serum. The aim of this combined questioning method is to analyze if participants would significantly give more honest answers when the Bayesian Truth Serum questions are present and ultimately reducing underreporting of dietary intake.

2.2.1 What is Bayesian Truth Serum?

The Bayesian Truth Serum (BTS) was first introduced in a paper by Prelec (2004), it served as a method for evoking subjective information, specifically designed for situations where subjective truth is not known. Example of subjective information, includes: participants intention, past behavior and preferences. Researcher in this case were in no positions to judge what is the “correct” answer because the ground truth is unknown, meaning it concerns subjective or individual truth. The method uses “informational scoring” to bring out truthful answers from a sample of rational participants (value-maximizing participants).

The BTS elicits better answers from participants due to two main forces (Weaver & Prelec, 2013). The first force is by decreasing participant’s intentional inattentiveness and carelessness behavior when responding. When responding the BTS survey, participants are not just required to provide answers about their own intentions and behaviors, but also about predictions regarding answers given by other participants. When doing so, participants will require greater thought processes, thus increasing participant’s level of engagement when answering these questions. The second force is by providing incentive (from scoring and can be monetary compensation) that rewards truth telling when answering questions about private matters (Weaver & Prelec, 2013). Using the informational score (iscore), the BTS assigns high scores to an

answer where its frequency is greater than participant's predicted frequency. Thus, answers that are "surprisingly common" will get rewarded. Under certain assumptions, personally truthful answers will maximize expected scores. Every answer is assigned a score and the score is determined by actual responses, along with the average prediction of participant. An example of a BTS question:

Answer this the two-part question below:

1. Within a day, I smoke more than three cigarettes. Is this applicable to you?

    a. True

    b. False

Out of the 150 participants, how many will answer "true":

(insert a scale from 1-150)

After choosing a personal answer in the first part of the question, participants will have to predict the distribution of how the rest of the participants would answer in the second part of the question. BTS question works at an individual binary questions (Weaver & Perlec, 2013). After collecting a participant's answer and their estimate in percentages of how other participants will answer, the iscore is implemented. The iscore then calculated to evaluate the answer, since there is no available answer key for each participant if they are telling the truth or not (Prelec, 2004). The function for the answer *k* would be:

$$\text{iscore} = log\ \frac{\bar{x}_k}{\bar{y}_k}$$

- $\bar{x}_k$is the actual frequency of answer *k* or $\bar{x}_k = \frac{1}{n}\sum_{r=1}^{n} x_k^r$
- $\bar{y}_k$ is the geometric average of predicted frequencies for answer *k* or $\bar{y}_k = (\prod_{i=1}^{n} y_k^r)^{\frac{1}{n}}$

The prediction score is the second component of the BTS scoring system. This score gives penalty as proportioned to the predictions between the actual distribution of the answers and participant's prediction of the distribution (Perlec, 2004). To put it in simple terms, the score assigns zero value to the best prediction score, this occurs when the prediction matches the actual frequency and inaccurate answer will be penalized. The prediction score is an asymmetric estimate of the difference between two probability distributions.

$$\text{Prediction score} = \alpha \cdot \sum_k \bar{x}_k \cdot log\ \frac{y_k^r}{\bar{x}_k}$$

The zero-sum game is created when α is set equal to 1 and assigning equal weights to score the equation. Under the zero-sum game, the average of all BTS scores will be equal to zero. The BTS result in "Pareto-dominate expected score" when α approaches zero, thus at least one individual will receive a positive score.

BTS score = information score + prediction score

The BTS score transforms a survey into a competitive zero-sum game, thus the strict Bayesian Equilibrium of the game is truth telling. Participants who believe that others will give personally truthful answers will maximize their score by giving personally truthful answers; this provides perfect Bayesian predictions of the distribution of answers (Perlec, 2004). BTS uses subjective correlations between a person's opinion and the opinion of others, like other Bayesian mechanisms (Weaver & Prelec, 2013). According to Dawes' Bayesian interpretation of BTS: participant's personal preferences and opinions act as a private signal mechanism which inform participants regarding answers that will be more likely to be 'surprisingly common' and thus more likely to receive high iscores (Weaver & Prelec, 2013). The BTS method can seem to be counter-intuitive when it comes to truth telling incentives if different answers can be truthful for different people. In practice, the paper by John, Loewenstein and Prelec (2012) found that the Bayesian Truth Telling incentive has a positive impact on revealing self-admissions unethical research practices among academic researchers. The paper found that relative to the control group, the more people disclosed their questionable research practice under the BTS group.

The BTS method may be able to help with the underreporting issue addressed earlier by making participants in the BTS group think further when asked about personal information. In the questionnaire the aim of the researched was disclosed to all participants. Having the extra BTS questions, aside from the dietary assessment questions will allow participants to answer these dietary assessments questions more honestly. Since there will be more incentive for participants to tell the truth, while also keeping in mind what others may answer.

2.2.3 Assumptions of the BTS

In practice, several assumptions of the BTS theorem have not been tested. The first assumption entails that participants predicts the distribution answer of a question like a Bayesian statistician; meaning that participants begin with their prior belief and update this belief according to their own preference and updating it according to Bayes's rule (Weaver & Perlec, 2013). This assumption implies that people with the same preference will have the same predicted frequency. When the Nash Equilibrium is created, all participants will have to assume that all participants behave rationally and will provide a truthful response. The second assumption entails that the sample of participants must be large enough, thus no predicted frequency has a meaningful impact on the sample frequency (Weaver & Prelec, 2013). This second assumption is dependent on the researcher to collect a large enough sample that not one single observation can significantly influence the results.

2.2.4 BTS and Underreporting of Dietary Intake

This paper will particularly focus on brief dietary assessment instruments, which are also known as "screeners". These assessments were used for the experiment questionnaire because

the BTS method does not require assessment of total diet or precise quantitative accuracy when estimating participant's dietary estimates. Since the control questions will be in the form of binary variables, underreporting in this case will be determined based how much participants follow the daily recommended intake of certain food group, as determined by the Netherlands Nutrition center.

Hypothesis:

H1. Bayesian Truth Serum method significantly decrease underreporting relative to the dietary assessment method

3. The Experiment

The experiment consists of 2 between-subjects conditions. The first is the control condition consisting of only dietary intake assessments and the second is the BTS condition consisting of dietary intake assessment and BTS questions. Questionnaires were mostly distributed to economics students studying at the Erasmus School of Economics via email and some questionnaires were collected digitally in public places in Rotterdam, the Netherlands. Majority of the participants have lived in the Netherlands for at least one year. The questionnaire was carried out using an online survey tool called Qualtrics and participants were randomly distributed across the two conditions. The beginning of both surveys consists of general instruction, a description of the purpose of the research, and a short description of BTS for the BTS group. More details on both questionnaires can be found in appendix A.

3.1 The Questionnaire

There are two versions of the questionnaire, participants either fill the control or the BTS condition. In total there are 13 binary questions; the first 6 questions contain statements concerning participant's attitudes toward their habitual dietary intake, their opinion towards food tracking app, and how familiar participants are with the Netherlands Nutrition Center dietary guidelines (refer to appendix A). The next 7 questions contain dietary intake questions concerning participant's daily dietary habit, especially focusing on food groups that are prone to underreporting and those that are essential for a healthy diet (refer to appendix A). The BTS condition consists of two-part questions for all the 13 control questions. In the BTS condition, in addition to the previously presented questions, participants were asked to estimate the frequency of answers given by the rest of the population participating in the survey, for each question. In addition, participants were asked to answer 7 basic demographic questions.

The attitude of participants is of importance because previous studies have found that these are associated with validity of dietary intake. Secondly, two questions asked about participant's attitude towards food tracking apps and if they have used them before; these are variables of interest in this study because previous studies found that food tracking app can improve validity

of dietary intake data. Aside from this, smartphone applications are widely accessible for the general population studied. Lastly, one question asked if participants are familiar with the Netherlands Nutrition Center dietary guideline because the next 7 questions were asked based on this guideline. All participants are analyzed the same way because we can later distinguish if participants are aware/ not aware of a certain daily dietary guideline specifically from the Dutch government. Below are the first 6 questions found in the control condition (all questions/ statements are binary questions):

1. I am familiar with the dietary guideline of the Netherlands Nutrition Center (Voedingscentrum)
2. I have tried to use a food tracking app to track my dietary intake
3. Using a food tracking app to track my dietary intake is a hassle
4. Being healthy is important to me
5. I often restrict my food consumption
6. I do feel pressure to go on a diet

The second set of statements consists of 7 questions about participant's daily dietary habits. Each question asked about a certain food group and amounts stated in the questions are based on the daily recommended food intake from the Netherlands Nutrition Center. The target population for this study is adult from age 18 and above and living in the Netherlands. Thus, the adequate amount of different food groups in the questions asked were based on the recommended intake for the lowest age group, which is 18 years old. Some questions mentioned "at least" for the recommended amount because many of the participants are above the age of 18. The first 3 questions in this section are more of a general question for water, fruit and vegetable intake and the 4th question is about choices of snack. The first 3 questions serve as a general view of how much healthy components are in included in participants' diet daily. The 4th – 7th question specifically asked about food groups that are more likely to be underreported according to previous studies (Mcdiarmind & Blundell, 1998). Not all daily dietary intake guideline by the *Voedingcentrum* are present below, only those food groups that tends to be underreported are present (refer to Voedingcentrum.nl for the complete guideline). Below are the second set of statements/ questions in the control condition (all are binary questions):

1. I drink at least 1.5 liters of water daily
2. I consume at least 2 portions of fruits daily
3. I consume at least 250 grams of vegetables a day
4. I would choose nuts over chips to snack on
5. I consumer one portion of either fish/legumes/ meat per day
6. I consume more than 40 grams of cheese (1.5 slice) daily
7. I consumer more than 40 grams (3.5 tablespoons) of butter or oil daily

In the BTS condition, for each question, participants had to estimate the frequency of answers by other participants within the population. The BTS score was then calculated for each

participant according to the formula for the BTS score. The second part questions for all the above questions are as such:

Think about the rest of the respondents participating in the survey. What percentage of them do you think are going to answer 'True' and how many are going to answer 'False'?

(Insert a scale of 0-100 for both answers)

The last set of questions for both conditions are the demographic questions. Participants were asked general demographic questions of age, gender, nationality, and level of current or highest attainable educations. Aside from these, they were also asked about how long they have lived in the Netherlands, their height, and weight. Demographic are of importance to this research because previous studies have found gender as a pertinent caused of dietary underreporting (Thompson & Subar, 2013). Previous research has demonstrated that age and level of education may play some role but not as significant as gender. The questions related to nationality and how long have you lived in the Netherlands are of importance because questions were based on guidelines from the Netherlands Nutrition Center. Lastly, participants were asked about their weight and height because those are needed to calculate BMI of participants. BMI is of interest because previous studies have found correlation between BMI and dietary underreporting (Mcdiarmind & Blundell, 1998).

3.2 The Incentives

The BTS method may provide process to design an effective incentive. This is done by letting participants know about how the information scoring (iscore) works; telling them that it is a performance incentive system that rewards truthfulness. For both conditions, participants had the chance to win an online coupon reward. In the control condition, only one participant received an online coupon reward by a random draw, given that participants provide their email address at the end of the survey. In the BTS condition, those in top 5% of score according to their BTS score and had given their email addresses have the chance to win an online voucher reward. Since the BTS condition requires participants to spend more of participants' response time, participants had higher chance of winning a reward relative to participants under the control condition. A small price in both cases was necessary because to incentivized participants to take the survey seriously.

4. Data, Analysis and Results

4.1 Description of Data

A total of 290 results are collected for this study. Participants are primarily in the age range of 18 – 25 with some participants age higher than 30 years old. 147 participants are female and 143 of the participants are male, thus there is almost equal distribution of gender. Proportion are almost similar across the two conditions, with 141 participants in the control condition and 149 participants in the control + BTS condition.

In both conditions, the distribution of gender is similar. However, the distribution of education level is different between the two conditions since there are more bachelor students that participated in the BTS condition. When it comes to distribution of country of origin, there are more Dutch participants in the control condition, and equal distribution of European and higher distribution of non-European in the BTS condition.

Average age is similar for both conditions. However, there is more variability in the Non-BTS condition group. For the variable indicating the number of years living in the Netherlands, participants in the BTS condition have lower mean and less variability in the number of years compare to the Non-BTS condition. For the last variable BMI, the mean and variability of participant's BMI for both conditions are similar.

4.2 Analysis and Results

This section describes and mentions which test were used to analyze the findings from the survey data with regards to the hypothesis formed. We hypothesized that participants in the BTS group will significantly decrease their tendency to underreport dietary intake compare to participants in the control group. Thus, participants in the BTS group are less likely to underreport their dietary intake.

Expressed as:

H0. Bayesian Truth Serum method does not significantly decrease underreporting relative to the dietary assessment method

H1. Bayesian Truth Serum method significantly decrease underreporting relative to the dietary assessment method

4.2.1 Testing the BTS Assumption

Table 2 was used to test one of the major BTS assumptions. This assumption entails that those who provided a certain response were likely to give a higher prediction for their own answer relative to the other alternative. The BTS question will only be applicable to the second

set of question, about participant's daily dietary habits because this part is similar to questions from a food assessment questions. Thus, participant's attitude questions will not be subjected to the BTS assumption. The first column of table 2 indicated the question number. The second column shows the possible response for each question. In the next two columns, for every question, the average prediction who answered either true (A) or false (B) are given. As an example: for question 1 in table 2, those who have answered "true" predicted that 61% of the rest of the participants will answer "true". While, those who have answered "false" predicted that 46% of the rest of the participants will answer "true". The difference between the two predictions made is 15% as provided in the fourth column. A positive value in the fourth column indicates that predictions of A% from A respondents > prediction of A% from B respondents. In this case, the BTS assumption holds as can be seen in Table 1.

Table 1: *results of testing BTS assumption for each question*

Questions	*Reponses*	*Average prediction of A%*	*Average predication of A% from A respondents – average predication of B% from B respondents*
1	A- True	61	15
	B- False	46	
2	A- True	52	11
	B- False	41	
3	A- True	52	10
	B- False	42	
4	A- True	41	6
	B- False	35	
5	A- True	66	15
	B- False	51	
6	A- True	54	5
	B- False	49	
7	A- True	60	18
	B- False	42	

4.2.2 Descriptive Statistics

Descriptive statistics of data from both conditions were calculated to increase familiarity with the data and its trends. Table 2 shows the descriptive statistics of participants in the first set of questions regarding their attitudes towards diet and dietary intake. For the first two variables in Table 2, the use of BTS questioning does not applied since both are not subjective truth but are facts. For the remaining 4 variables, for 3 of the variables the percentage of "true" answers increased in the BTS condition. Since 3 of the 4 variables aside from attitude_health variables have a negative statement regarding participant's attitude towards health.

Table 2: *Descriptive statistics for first set of questions*

	Control		*BTS*	
Variable	Frequency of answering "True"	% of "True" answer	Frequency of answering "True"	% of "True" answer
Nutrition_NL	64	43	48	34
Tracking_app	65	44	70	50
Tracking_hassle	99	66	114	81
Attitude_health	145	97	141	100
Restrict_food	77	52	70	50
Pressure_diet	53	36	52	37
Observation	149		141	

Variables in Table 3 below indicate the second set of questions regarding the standard dietary recommendation from the Netherlands Nutrition Center. Looking at the frequency in the Table 3, The percentage of "true" answers under the BTS condition is lower relative to the control condition for all variables.

Table 3: *Descriptive statistics for second set of questions*

	Control		*BTS*	
Variable	Frequency of answering "True"	% of "True" answer	Frequency of answering "True"	% of "True" answer
Water_daily	121	81	104	74
Fruit_daily	75	50	65	46
Veg_daily	92	62	53	38
Healthy_snack	83	56	70	50
Protein_daily	85	57	77	55
Cheese_daily	47	32	34	24
Oil_daily	58	39	43	31
Observation	149		141	

4.2.3 Binomial Logistic Regression

To test whether there is a relationship between daily dietary intake assessment questions with participants' attitude toward dietary intake and participants' characteristics under both conditions, seven binomial logit regressions were conducted. A binomial logic regression is chosen in this case due to the nature of all dependent variables; all are binary variables.

Regressions were conducted to see which questions regarding attitude and demographic of participants significantly affect participants' daily dietary intake. The significance between both control and BTS conditions was determined by calculating the interaction term or coefficient of all the independent variables.

The results of these binomial regressions can be found in table 4 and table 5. The independent variables that are significant differ for each model. Based on table 5, results show that the last model, with *oil_daily* as the dependent variable, does not have any significant coefficient. Thus, we focused the analysis on the first six models. There is no one variable that is significant for all the seven models. However, two variables: *years_NL* and *BMI* are significant in five out of the seven models at either 1% or 5% significance level. The variable years_nl is negatively correlated with *water_daily*, *fruit_daily*, *veg_daily*, *healthy_snack*, and *protein_daily*. This suggests that having lived in the Netherlands for longer than a year makes participants less likely to follow daily recommended intake of water, fruits, vegetables, snack, and protein. The variable *BMI* can be interpreted in two ways. In three of the models, *BMI* is negatively correlated with *fruit_daily*, *veg_daily* and *healthy_snack*. This suggests that having a higher BMI make participants less likely to follow the daily recommended intake of fruits, vegetables and healthy snack. While in the other two models, *BMI* is positively correlated with *protein_daily* and *cheese_daily*. This suggests that having a higher BMI make participants more likely to follow the daily recommended intake of protein and cheese. After *BMI* and *year_NL*, the variable *female* is significant in four out of the seven models. Similar to *BMI*, the variable *female* can be interpreted in two ways. In three of the models, *female* is negatively correlated with *healthy_snack*, *protein_daily* and *cheese_daily*. This suggests that being female makes participants less likely to follow the daily recommended intake of healthy snack, protein, and cheese. While in one model, *female* is positively correlated with *fruit_daily*. This may suggest that being female makes participants more likely to follow the daily recommended intake of fruits.

Three of the variables: *nutrition_nl*, *tracking_hassle,* and *restrict_food* is significant in three out of the seven models. The variable *nutrition_nl* is positively correlated with *fruit_daily*, *veg_daily* and *healthy_snack*. This suggests that being familiar with the recommendations from the Netherlands Nutrition Center make participants more likely to follow the daily recommended intake of fruits, vegetables and healthy snack. The second variable that is significant in three models (i.e. water, fruits and healthy snack intake), *tracking_hassle* is negatively correlated. This suggests that thinking that tracking app is a hassle makes participants more likely to negatively deviate from the daily recommended intake of water, fruits and healthy snack. The third variable that is significant in three models, *restrict_food* is positively correlated with *fruit_daily*, *veg_daily* and *healthy_snack*. This suggests that participants who are more likely to restrict their dietary intake are more likely to follow the daily recommended intake of fruits, vegetables and healthy snack.

Table 4: *Binomial Logistic Regression*

	Water_daily		*Fruit_daily*		*Veg_daily*		*Healthy_snack*	
Nutrition_nl	0.186	(0.626)	1.377***	(0.000)	0.748**	(0.030)	0.769**	(0.024)
Tracking_app	0.789**	(0.019)	0.226	(0.428)	0.295	(0.306)	0.262	(0.357)
Tracking_hassle	-0.744*	(0.063)	-0.817***	(0.009)	-0.308	(0.321)	-0.532*	(0.085)
Attitude_health	-0.084	(0.947)	1.278	(0.306)	0.707	(0.508)	Omitted	
Restrict_food	0.473	(0.143)	0.691**	(0.013)	0.624*	(0.025)	0.806***	(0.003)
Pressure_diet	-0.098	(0.787)	-0.196	(0.523)	0.010	(0.975)	0.049	(0.873)
Age	0.037	(0.395)	0.058	(0.146)	0.050	(0.192)	0.084**	(0.027)
Female	-0.388	(0.254)	0.512*	(0.090)	0.274	(0.362)	-0.521*	(0.082)
Country (2)	-0.695	(0.276)	0.058	(0.913)	-0.590	(0.299)	0.418	(0.439)
Country (3)	-0.210	(0.735)	-0.946*	(0.076)	-1.562***	(0.005)	-0.783	(0.137)
Years_nl	-0.077**	(0.015)	-0.052*	(0.064)	-0.069**	(0.017)	-0.054*	(0.051)
Education (2)	0.413	(0.420)	0.570	(0.179)	-0.000	(0.999)	-0.425	(0.306)
Education (3)	-0.299	(0.675)	1.368**	(0.023)	-0.344	(0.545)	-1.099*	(0.060)
BMI	0.005	(0.919)	-0.087*	(0.086)	-0.145***	(0.003)	-0.100**	(0.040)
Condition	-0.436	(0.170)	0.148	(0.600)	0.149	(0.599)	-0.231	(0.406)
Constant	2.289	(0.239)	-1.122	(0.540)	2.646	(0.118)	1.641	(0.239)
Observations	289		289		289		285	

p-value in parentheses

*$p < 0.1$** $p < 0.05$, *** $p < 0.01$

Other variables that are also significant are *country (3), education (2)* and *education (3)* and *age*. The variable *country (3)* is negatively correlated with *fruit_daily* and *veg_daily*. This suggests that coming from non-European countries make participants less likely to follow the daily recommended intake of fruits and vegetables. The effect of *education (2)* is negatively correlated with *protein_daily*. This suggests that currently or having a bachelor's degree makes participants less likely to follow the daily recommended intake of protein. The variable education (3) is positively correlated with *fruit_daily* and negatively correlated with *healthy_snack*. This may suggest that currently doing a master or having a master's degree makes participants less likely to follow the daily recommended intake of healthy snack. While also makes participant more likely to follow the recommended daily intake of fruits. Lastly, the variable age is positively correlated with *healthy_snack*. This suggests that increase in age makes participants more likely to follow the daily recommendation intake of healthy snack.

Table 5: *Binomial Logistic Regression*

	Protein_daily		*Cheese_daily*		*Oil_daily*	
Nutrition_NL	0.364	(0.280)	0.187	(0.606)	0.294	(0.374)
Tracking_app	0.575**	(0.047)	0.148	(0.629)	0.062	(0.897)
Tracking_hassle	0.014	(0.964)	-0.070	(0.828)	-0.056	(0.851)
Attitude_health	1.032	(0.438)	Omitted		-0.451	(0.672)
Restrict_food	-0.113	(0.680)	-0.332	(0.254)	-0.388	(0.151)

Pressure_diet	0.204	(0.504)	-0.338	(0.314)	0.279	(0.352)
Age	0.037	(0.332)	0.046	(0.233)	0.053	(0.134)
Female	-1.052***	(0.001)	-0.784**	(0.013)	-0.431	(0.142)
Country (2)	-0.571	(0.285)	0.024	(0.966)	-0.540	(0.295)
Country (3)	-0.471	(0.366)	-0.379	(0.504)	0.099	(0.842)
Years_nl	-0.060**	(0.030)	-0.016	(0.575)	-0.020	(0.431)
Education (2)	-1.129**	(0.011)	-0.204	(0.615)	0.122	(0.765)
Education (3)	-0.524	(0.396)	-0.083	(0.885)	0.337	(0.541)
BMI	0.120**	(0.018)	0.097**	(0.043)	0.022	(0.629)
Condition	-0.081	(0.772)	-0.230	(0.438)	-0.208	(0.453)
Constant	-2.485	(0.192)	-3.025**	(0.031)	-1.338	(0.412)
Observations	289		285		289	

p-value in parentheses

* $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

4.2.4 T-test

To test the two-hypotheses formulated earlier, two sample t-test was calculated to analyze whether there is a significant difference of self-reported dietary intake between the two condition; the control and BTS condition. Indicator of underreporting of dietary intake in this context is seen when participants are not following the daily recommended intake by The Netherlands Nutrition Center. Not following th daily recommended intake in this case can be interpreted in several ways. The guideline from the *Voedingscentrum* is indicator of healthy eating behavior. With some form of underreporting present, participants could say that they are eating healthier than they actually do; which indicate that they would answer yes for all the dietary intake assessment. On the other hand, some participants may follow al of the daily dietary guideline which means that they are not underreporting.

In table 6, Seven t-tests were calculated to compare the equality of means between the responses of daily dietary intake (second set of questions in the experiment) under the two conditions. Two-tailed p-value for all seven t-tests were used to determine if there are mean differences between the two conditions. Based on 5% significant level, the H0 cannot be rejected. This is the case because all the *p* values as indicated in table 9 are all greater than 0.05. Thus, based on the data collected, it can be concluded that Bayesian Truth Serum method does not decrease underreporting significantly relative to the dietary assessment method.

Table 6: *Two sample t-test*

Variable	Condition	*N*	*M*	*SD*	*t*	*p*
Water_daily	Non-BTS	149	0.812	0.392	1.521	0.129
	BTS	141	0.738	0.442		
Fruit_daily	Non-BTS	149	0.503	0.502	0.720	0.4722
	BTS	141	0.461	0.500		
Veg_daily	Non-BTS	149	0.617	0.488	-0.491	0.623

	BTS	141	0.645	0.480		
Healthy_snack	Non-BTS	149	0.557	0.498	1.031	0.303
	BTS	141	0.496	0.502		
Protein_daily	Non-BTS	149	0.570	0.497	0.416	0.678
	BTS	141	0.546	0.499		
Cheese_daily	Non-BTS	149	0.315	0.466	1.412	0.159
	BTS	141	0.241	0.429		
Oil_daily	Non-BTS	149	0.389	0.489	1.509	0.132
	BTS	141	0.305	0.462		

5. Discussion

The following section will discuss various possible extensions and limitations regarding the study conducted. Section 5.1 discuss an overview of the findings and relating it to the literature review in section 2. While, in section 5.2 we discuss the general limitations regarding data collection and sample selection biased.

5.1 General Discussion

Coming back to the problem addressed in the introduction regarding the increasing rate of obese and obesity population in the Netherlands. Underreporting in the form of deviation from recommended dietary intake is evidently present in the experiment conducted. When comparing the general data obtained, the who, what, when and why of underreporting is similar to previous studies done by Mcdiarmind & Blundell (1998). Being informed about daily recommended intake according to the Netherlands Nutrition Center (*Voedingscentrum*) in this case is important because then participants have better understanding of the intuition behind daily recommendations set. In the paper by Mcdiarmind & Blundell (1998), the variable gender and BMI significantly increases the likelihood of dietary underreporting. This is evident from looking at the significant values of variable *female* and *BMI* in binomial logistic regression conducted. Being female in this case, is negatively correlated with the daily consumption of protein, cheese and healthy snack. This finding adheres to the paper reviewed in Mcdiarmind & Blundell (1998) regarding healthy food image. From this finding we can conclude that being female increases underreporting especially in food groups that have bad reputation. The underreporting of cheese intake may be due to the bad reputation of cheese being quite high in fat content. However, in the case of underreporting of protein intake, female participants reported that they eat less portion of protein than recommended. This may be that protein is perceived to be rather manly. Lastly, while healthy snack does not have a bad image, it can be that female participants care less about consuming healthy snack such as nuts.

Another variable that adheres to the paper reviewed in Mcdiarmind & Blundell (1998) is the variable *BMI*. The variable BMI is negatively correlated with daily intake of fruits, vegetables and healthy snack. All this food group has a positive image; thus this adhere to the result that people

that have higher BMI tend deviate from the recommended amount of fruits, vegetables and healthy snack. This may suggest that people that have higher BMI tends to eat less healthy food. The variable BMI is also positively correlated with the daily consumption of protein and cheese. This may also be due to the image of both food groups. Relating it to the perception that protein is seen to be more "manly", male participants are also more likely to have higher BMI than female participants due to male population generally having more muscle mass relative to female.

As suggested in previous study by Thompson & Subar (2013), reporting dietary intake is seen to improve participant's adherence towards daily dietary recommended intake. This can be seen in two of the binomial regression models since using tracking app is positively correlated with daily water and protein intake. Another variable that adhere to the paper by Thompson & Subar (2013) is *tracking_hassle*, this variable suggests that people viewing tracking app as a hassle are more likely to deviate negatively from daily recommended food intake. Another attitude that may contribute underreporting is if participants feel the need to restrict their food intake. Based on three regression models (i.e. fruit, vegetables and healthy snack intake), participants that restricts consumption are likely to deviate negatively from daily recommended intake of vegetables, fruit, vegetables and healthy snack. This is similar to previous research finding regarding intentional under-reporter (Mcdiarmind & Blundell, 1998). This may be an example of intentional underreporting since the feeling pressure regarding diet may stem from social influences or pressure surrounding dieting.

Aside from attitudes of participants, other influences such as country of origin and how long participants have lived in the Netherlands also significantly affected the likelihood of underreporting. In this case, participants are seen to underreport when they do not answer a yes for the dietary intake assessment. For two of the regression models (i.e. fruit and vegetable intake), being from out of Europe is negatively correlated. This can be interpreted as: non-European nationals consume less fruit and vegetables based on the daily recommended guideline. The number of years living in the Netherlands is negatively correlated for five out of the seven regression models. This may imply that people living longer in the Netherlands tend to deviate negatively from the daily recommended water, fruits, vegetables and healthy snack intake. In terms of food category, the consumption of water, fruits, vegetable, snacks, protein and cheese have significant coefficients. Particularly, for fruits, vegetables, snacks and protein, more coefficients are significant at 10% level or less. As previous study found, these food groups tend to be more prone to underreporting than other food groups. This is seen from the different variables that significantly explain these dependent variables.

The data collected can support the first assumption of the BTS, that is those who provided a certain response were likely to give a higher prediction for their own answer relative to the other alternative (Weaver & Prelec, 2013). However, when it comes to reducing underreporting using a truth telling mechanism, the BTS in this case has insignificant result. Thus, we cannot say that the BTS method significantly reduces underreporting relative to a normal dietary assessment

method. This is evidently seen from the t-test result in section 4.2.4 and from all the insignificant correlation of variable *condition* in all seven binomial logistic regressions. The variable *condition* implies if participants follow the control or BTS condition.

5.2 Limitations

Although the study can provide some insight and some of its results adhere to previous research conducted regarding dietary underreporting, there are some major limitations to the study. The first limitation that needs to be addressed is sample selection bias and representativeness of the population studied. Since questionnaires were distributed mainly by email to economics students studying at the Erasmus University of Rotterdam, this population is not representative of the general Dutch population. This is evident by looking at the descriptive statistics obtained for the set of demographic question. Most participants are still in their early 20s and the average BMI indicate that most participants are within the normal weight range. Thus, the population studied does not consisted of the overweight population group in the Netherlands, which was the intended target when starting this research. The population is biased because most participants are studying a similar discipline.

The second limitation that needs to be addressed is the complexity of the topic, underreporting of dietary intake. To conclude that there is underreporting, often researcher must compare dietary intake pattern over a time frame. Due to the survey method used, comparing the control and BTS condition, this comparison was not executed. This might be possible, but time and resource limitation need to be taken account. The third limitation that needs to be addressed is that the Bayesian Truth Serum method in this study is limited to asking binary questions due to the number of participants collected. Participants become limited in their answer when compared to indicating truthfulness with a scale as an example. The last limitation of the study may be the lack of current references used in the topic of dietary underreporting. It would have been beneficial to have reference on dietary underreporting when using smartphone app, but papers published regarding this topic is limited.

6. Conclusion

The aim of the study was to test if the BTS method could reduce the underreporting of self-reporting dietary intake. The result of this study found that the BTS condition does not significantly different compared to the control condition or the dietary assessment questions. Based on the two-sample t-test conducted on daily dietary intake questions and comparing the two experiment conditions, the *p*- value is not significant at 5% level. Thus, it can be concluded that the BTS condition does not reduce underreporting when self-reporting dietary intake. Despite the conclusion reached, the current study was able to find similar results on causes of dietary underreporting as previous studies have shown. The two main variables found in this case that significantly influence participant's self-reporting of dietary intake is gender and BMI. Referring to the main issue stated in the introduction regarding the increasing rate of overweigh population, particularly in the Netherlands. In the population studied, the percentage of

overweight participants is not as large compare to the general Dutch population. Thus, it is recommended for further research to expand sample size and get more participants from different age groups and different BMI levels, to determine whether the results of this study are valid for the general Dutch population.

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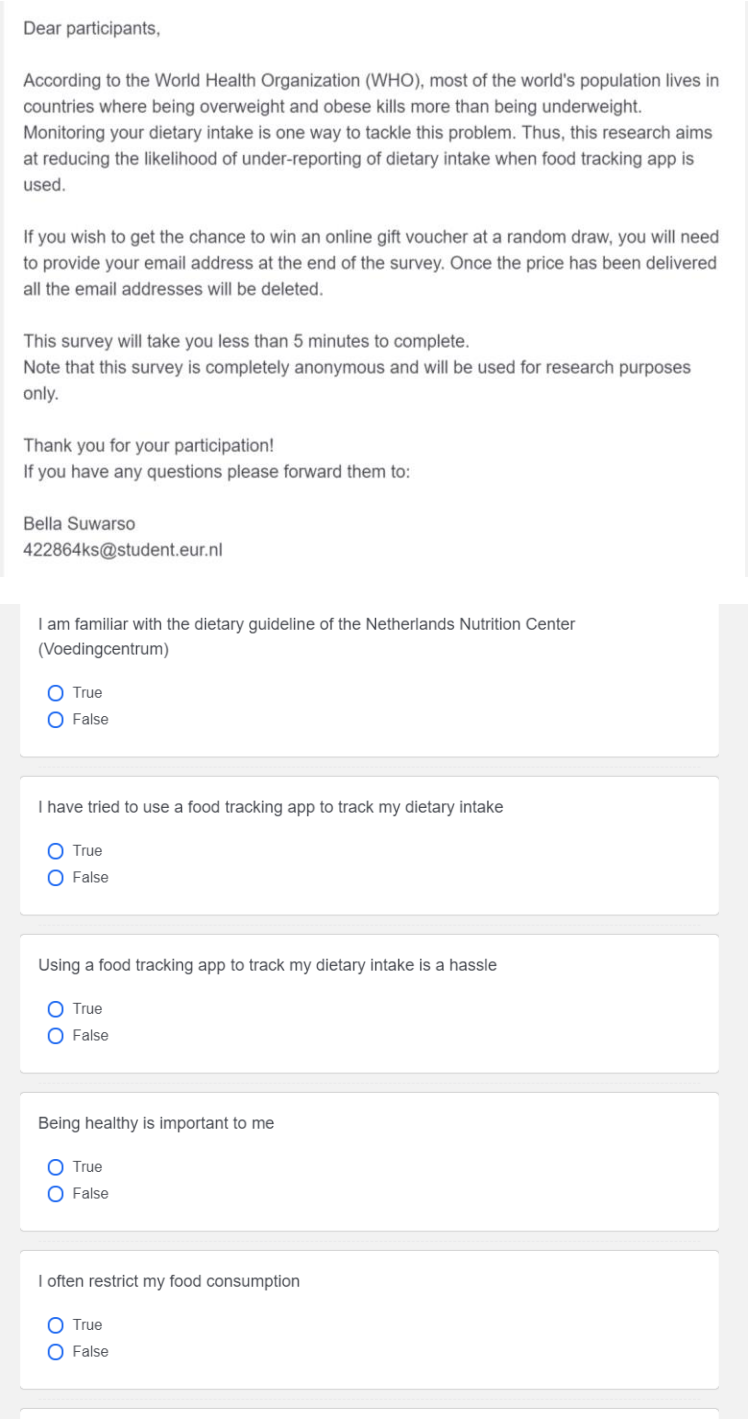
Appendix A

Non-BTS Questionnaire (partial) as seen by participants



Dear participants,

According to the World Health Organization (WHO), most of the world's population lives in countries where being overweight and obese kills more than being underweight. Monitoring your dietary intake is one way to tackle this problem. Thus, this research aims at reducing the likelihood of under-reporting of dietary intake when food tracking app is used.

If you wish to get the chance to win an online gift voucher at a random draw, you will need to provide your email address at the end of the survey. Once the price has been delivered all the email addresses will be deleted.

This survey will take you less than 5 minutes to complete.
Note that this survey is completely anonymous and will be used for research purposes only.

Thank you for your participation!
If you have any questions please forward them to:

Bella Suwarso
422864ks@student.eur.nl

I am familiar with the dietary guideline of the Netherlands Nutrition Center (Voedingcentrum)

- True
- False

I have tried to use a food tracking app to track my dietary intake

- True
- False

Using a food tracking app to track my dietary intake is a hassle

- True
- False

Being healthy is important to me

- True
- False

I often restrict my food consumption

- True
- False

BTS Questionnaire (partial) as seen by participants

Dear participants,

According to the World Health Organization (WHO), most of the world's population lives in countries where being overweight and obese kills more than being underweight. Monitoring your dietary intake is one way to tackle this problem. Thus, this research aims at reducing the likelihood of under-reporting of dietary intake when food tracking app is used.

For each question you answer you will receive an "information score" . The sum of all information scores will then be calculated to come with your overall "truth score"

Truth scoring was recently invented by an MIT professor and published in the academic journal of science. This truth score rewards truthful answers. People who tells the truth scores higher overall, even though only you will know if you have answered truthfully.

The top 5% of scorer will receive an online gift voucher. If you to wish to win an online gift voucher you can leave your email at the end of the survey. Only those at top 5% of scorer will be contacted on the 28th of June 2018. Once the prize has been delivered all email addresses will be deleted

This survey will take you less than 10 minutes to complete.
Note that this survey is completely anonymous and will be used for research purposes only.

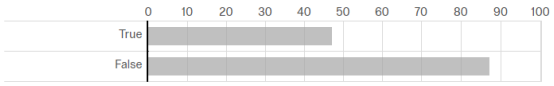
Thank you for your participation!
If you have any questions please forward them to:

Bella Suwarso
kbella.suwarso@gmail.com

I drink at least 1.5 liters of water daily

- True
- False

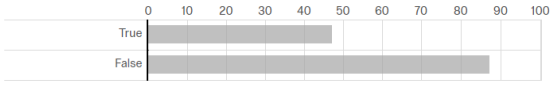
Think about the rest of the respondents participating in the survey. What percentage of them do you think are going to answer 'True' and how many are going to answer 'False'?



I consume at least 2 portions of fruit daily

- True
- False

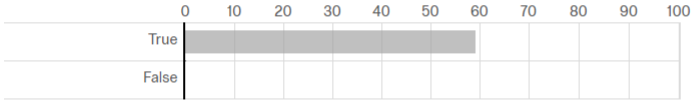
Think about the rest of the respondents participating in the survey. What percentage of them do you think are going to answer 'True' and how many are going to answer 'False'?



I am familiar with the dietary guideline of the Netherlands Nutrition Center (Voedingcentrum)

- True
- False

Think about the rest of the respondents participating in the survey. What percentage of them do you think are going to answer 'True' and how many are going to answer 'False'?



I have tried to use a food tracking app to track my dietary intake

- True
- False

Think about the rest of the respondents participating in the survey. What percentage of them do you think are going to answer 'True' and how many are going to answer 'False'?