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Individual health behaviour effects after experiencing an adverse health shock.

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Abstract

The study evaluates how individuals respond to health shocks on their health behaviour. This is done by using data from the CentERdata and acquiring a reference point out of the data of their health behaviour from before the health shock. The health behaviour after the health shock is then subtracted by the reference point to measure the effect. The health behaviour variables are transformed so that they can measure if the average behaviour change is positive or negative for the questionnaire population. Different type of health shocks are tested on eight different health behaviours these are smoking, alcohol consumption, abuse of substances, physical activity, sleep, vegetables, fruit and dieting. These health behaviours are aggregated to gain insight in the overall change of health behaviour. The results show that short term health behaviour change occurs mostly due to exogenous health shocks that have an immediate impact, such as experiencing a heart attack or a stroke. Other predictors that lead to change are the individual's emotional state and the severity of the health shock, tested by hospitalization.

1.0.0. Introduction:

It remains a difficult task to solve the problem of morbidity and mortality of chronic diseases that are mostly self-induced by peoples unhealth behaviour. When people do change their health behaviour this can be due to a wake-up call whereby a sudden change in their environment happened to conduct better behaviour. A wake-up call is defined as: "A thing that alerts people to an unsatisfactory situation and prompts to remedy it." The thing that alerts people to an unsatisfactory situation refers in this research to the experience of a health shock. Whereby "prompts to remedy it" refers to changing one's health behaviour. For example, receiving a heart attack can be a wake-up call to start a healthy diet or exercising to reduce the change of experiencing another heart attack in the future.

To gain better understanding as to why people have difficulty changing their health behaviour, a lot of models and theories are constructed to gain insight about this phenomenon of self-induced harm by unhealthy behaviour. Most models are constructed from the psychology and the (health) economic perspective. One of those health economic models uses the concept of effort, utility and the agency theory.

Such as the following formula (Baillon, Bleichrodt, Emirmahmutogluz, Jaspersen, & Peter, 2018) that is used to determine the maximum expected utility of an agent for financial and health outcomes due to effort:

$$\max_{e\in[0,\overline{e}]} U^r\,(e) \;=\; p(e)u(x_b,h_b;e) \;+\; (1-p(e))u(x_g,h_g;e).$$

The *x* measures financial outcomes and *h* health outcomes. Whereby *b* represents the bad outcomes and *g* the good outcomes. The *e* stands for effort and *p* measures the probability of the bad outcomes for financial and health. The interval of *e* is $[0,\overline{e}]$ where $\overline{e}$ is the maximum amount of effort an individual can put in. The amount of effort a person puts in will lead to the maximum utility derived from that specific amount of effort. For a rational agent the effort that is put in is e^r and leads to the equilibrium whereby the agent has a marginal benefit that is equal to the marginal costs. The first-order condition of the previous formula is

$$-p'(e^r)[u(x_g,h_g;e^r) \;-\; u(x_b,h_b;e^r)] \;+\; [p(e^r)u_e(x_b,h_b;e^r) \;+\; (1-p(e^r))u_e(x_g,h_g;e^r)] = 0.$$

The left side of the first-order condition shows the marginal benefit of prevention and is a marginally decreasing function of effort $-p'(e^r) < 0$. The right side represents the marginal cost of prevention for the rational agent in the brackets and is marginally increasing in effort $(1-p(e^r)) > 0$ and $p(e^r) > 0$. To denote that the second term implicates the marginal cost of prevention, the marginal utility of effort is shown as u_e in comparison to the absolute utility u. The rational agents put in the optimal amount of effort e^r based on the values of the probabilities of the bad outcome to reach the equilibrium state. The individual does not depart from the equilibrium state where marginal benefits equal marginal costs. Thus, the health preventive behaviour of the individual can now be determined.

Putting in effort for a healthy lifestyle is a useful concept for health-related cases as healthy behaviour is often associated with disutility at the present time for the agent. The research they conducted is to evaluate individuals that are in equilibrium created by probability weighing as not everyone is a rational agent. A caveat for that model is that in general a model does not account for changes over time and exogenous influences for the individual. The model constructs how people probability weight their decisions for the future and act on it to gain the most acceptable utility. After individuals made this decision, of what utility is acceptable to them, their behaviour after that decision remains constant.

It is difficult for individuals to assess certain risks in the future and how their health behaviour influences those risks. Risk averse people will be more likely to have a healthy lifestyle to reduce future health adverse events, while risk seeking people are more likely to experience the consequence of their health behaviour (Decker & Schmitz, 2016). The experience of a health shock acting as an information shock can for both groups be an event that influence perception of health behaviour risks and could cause health behaviour improvement afterwards. This research is done to account for that phenomenon of how people would react when new information can update their perception of risk $p(e)$. This is done by looking at people that experience exogenous shocks and how they would react toward those shocks by regarding their follow-up health behaviour. If there would be a significant change in health behaviour after the exogenous shock, then it could imply that people still update their risk perception towards preventive health behaviour and put more effort to achieve a new state of utility.

A relevant cognitive bias is that most people know and want to improve their health preventive behaviour, though they do not act as rational agents and have problems with self-control over time. A model that calibrated the limitation of self-control results on average to a loss of four to eight years of life (Strulik, 2018). When people would have perfect self-control this gain in life years could result in an increase in human capital and a reduction in medical spending. This is unlikely to happen, but it shows the potential of what could be gained if people would improve their health behaviour.

A health shock is determined as a negative experience that came unexpected for an individual and has a negative impact on the health state. The causal effect of experiencing a health shock can be a wake-up call for a person to improve its health behaviour. This research will test the effects of experiencing a health shock on the health behaviour for different individuals over time. The health behaviour before and after the health shock will be compared to test for a causal relationship. Individuals who received a health shock will be compared with individuals who did not received one. Furthermore, the individual health behaviour models will be evaluated to understand why individuals change health behaviour in the first place. Then the individual health behaviour models will be evaluated to gain more insight as to why there could be a causal relationship between a health shock and health behaviour change from the health economic and psychology perspective.

The main research question is: "*Does aggregated health behaviour change for individuals after experiencing a health shock?*".

This question will be answered based on empirical evidence and the interpretation of the results in light of the underlying framework of individual health behaviour theories. To reach inferences for the hypothesis an observational study is conducted by using a longitudinal survey to construct a model. The theoretical framework of individual health behaviour models is used to explain the results.

This study shows similarities with other papers (Smith, Taylor Jr, Sloan, Johnson, & Desvousges, 2001), (Falba, 2005), (Baji & Bíró, 2018). Main difference is that their papers only control for the behaviour smoking. Whereas in this research smoking is included but other types of health behaviour as well. Another difference is that the health behaviours are the dependent variables, while in their research they are mostly control variables. Despite the difference in scope, the findings are similar. Their results are that after a health shock the health behaviour is affected for individuals by processing new information from the health shock event. For smokers it indicates that the experience of a smoker related health shock (e.g. lung cancer, stroke, heart attack) has more effect on their health behaviour than for non-smokers. Based on these results people tend to update new information only when it is relevant for them. This principle could be useful for smoking cessation campaigns or for other health promotional events. The experience of a health shock can thus be seen as both an adverse event and an information shock for the individual. The following sequence is derived from the previous discussed studies to create a framework for the construction of the model in this research:

"Old beliefs about smoking → Experience smoke related health shock → Update beliefs about smoking → Implementation of new behaviour based on the newly acquired information".

There is empirical evidence that people indeed update their beliefs about smoking (Smith, Taylor Jr, Sloan, Johnson, & Desvousges, 2001). This research test the last part of the sequence, which is the implementation of (improved) health behaviour based on the experience of a health shock.

The insight gained from this research can further improve the understanding of individuals behaviour regarding their health. Which eventually could lead to better preventive health behaviour, to more human capital and better welfare for the society overall. Thereby unhealth behaviour causes a lesser sophisticated immune system for the body to combat acquired diseases. The understanding of mechanisms that improve health behaviour can be beneficial for society and give individuals a better quality of life. It also could benefit the healthcare system by reducing costs for medical spending on chronic diseases. To achieve these goals, understanding what drives people to improve their health behaviour is mandatory.

The contribution to existing literature is that most behaviour models try to set up a framework which explains individual health behaviour. Nonetheless all these frameworks are difficult to test and have overlaps with each other. This research tries to evaluate aspects of some frameworks as to empirically fit in the experience of adverse health events. This is done by first evaluating individual health behaviour models in Chapter 2. Followed by constructing hypothesises in the theoretical framework that will be tested. Then in Chapter 3 the acquiring of the data for this research is explained, and the methodology elaborates the construction of the model by determining the variables and what type of model is used. After that the results of the model are shown in Chapter 4 and compared with the different research questions constructed in the theoretical framework. The discussion, Chapter 5, shows caveats of the research and which improvements could be made. Lastly the conclusion, Chapter 6, is a summary of the research conducted and the conclusion of the findings.

2.0.0. Theoretical Framework

2.1.0. Introduction to the individual health behaviour models

Why people change their health behaviour is a complex question, because people are complex creatures and a lot of variables can influence why people behave the way they do. Luckily there are several models that try to explain health behaviour. The attention in the theoretical framework focus on the individual perspective as to why people change their behaviour. First the Rational Agent Theory is further explained with the addition of probability weighting on health preventive behaviour (Baillon, Bleichrodt, Emirmahmutogluz, Jaspersen, & Peter, 2018). Then this concept is integrated by constructing a reference point that lies the foundation for this research. Secondly similar studies to this research are evaluated. Then the individual psychology theories are interpret and how they fit in with the empirical research. Most common individual psychology theories are the Health Belief Model, Theory of Planned Behaviour and the Transtheoretical Model. These models are used to gain insight into why people behave the way they do from a psychological point of view and if the models can be compared across the questionnaire population for different behaviours. These models will be evaluated with regards to the research question that can identify the cause of the underlying health behaviour change and where the health shock does fit in the model.

2.2.0. Probability weighting

People have difficulty evaluating probabilities especially when they are uncertain. For example the consensus that smoking is health deteriorating is common knowledge among the population (Cutler & Glaeser, 2005). But what the exact probability of mortality and morbidity due to smoking remains uncertain. The adverse effects of unhealthy behaviour are difficult to evaluate for individuals and how this will lead to mortality and morbidity effects in the future. The formula discussed in the introduction adopts the concept of probability weighting instead of the Rational Agent Theory for effort. This transforms the formula to:

$$\max_{e \in [0,\bar{e}]} U^w(e) = w(p(e))u(x_b, h_b; e) + (1 - w(p(e)))u(x_g, h_g; e).$$

This formula includes the probability weighing for the perception of risk of the individual by $w(p(e))$, whereby w is the probability weighting function. This inclusion transfers to the first-order too, $U_e^w(e^w) = -w'(p(e^w))p'(e^w)[u(x_g, h_g; e^w) - u(x_b, h_b; e^w)] + [w(p(e^w))u_e(x_b, h_b; e^w) + (1 - w(p(e^w)))u_e(x_g, h_g; e^w)] = 0.$

The effort is now determined by probability weighting the optimal value of prevention (e^w) and influence both the left and the right side. The probability weighting in comparison to the Rational Agent Theory causes the marginal prevention to be differently evaluated. The individual can be more sensitive or less sensitive than the rational agent, measured by the probability. For example if the individual weights their probability too sensitive then the individual overvalues the reduction of probability for the bad outcomes. They found that people tend to be more insensitive towards the advantages of health preventive behaviour resulting in putting in less effort than rational individuals (Baillon, Bleichrodt, Emirmahmutogluz, Jaspersen, & Peter, 2018). The uncertainty and undervaluation of the effects of preventive behaviour explain why people's health behaviour is not optimally developed. When people develop their health preventive behaviour based on undervaluation of the probability to attain bad health outcomes it increases the risk of mortality and morbidity rate for the future. A health shock can be the new information that updates the previously developed health behaviour. Based on this argument the utility developed before the health shock serves as a reference point from which the effect of a health shock can be derived. This reference point (RP) before the health shock get subtracted by the disutility of the health shock $(-U^{HS})$ experience to gain a new reference point that is more rational.
The formula $RP_{t+1}(U_e^r(e^r)) = RP_{t-1}(U_e^w(e^w)) - (U(HS_t))$ is constructed as framework for this study. The individual is expected now to be more rational as the consequences of the health shock updates the perceived beliefs about the probabilities of preventive health behaviour. This deduction leads to the research question:

"Are health shocks the cause of putting in more effort into health protective behaviour?".

If the hypothesis is to be found true then behaviour change is positive and it would imply that the health shock causes individuals to update their subjective probability weighting function as they now have experienced the consequence, a health shock, of their previously developed health preventive behaviour. When there is no change individuals remain incapable of valuing probabilities that led to the health shock in the first place and return to their previous state, $RP_{t-1}(U_e^w(e^w)) = RP_{t+1}(U_e^w(e^w))$. Lastly if the behaviour change is negative it can imply that people do update their probabilities. Potential reason can be that they become more pessimistic about the future, which in turn leads to neglecting health preventive behaviours.

2.3.0 Similar studies

The actual survival probabilities of people are found to be comparable on average with subjective health predictions about longevity. However these subjective health predictions are proof that people on the aggregated level are rational, but not individual. This makes the measure of subjective health a good predictor for change in health behaviour (Hurd & McGarry, 2002). The subjective health predictions about longevity till a certain age correlates with health shocks and can affect health behaviour. This makes subjective health predictions used by researches as dependent variable for health behaviours (Smith, Taylor Jr, Sloan, Johnson, & Desvousges, 2001).

There is a study on the effect of health shocks on subjective and objective survival rates, self-reported health and mental health before and after the health shock (Baji & Bíró, 2018). They use the health shocks cancer, stroke and heart attack and make a comparison between a group that did not encounter a health shock. Their first model focus on the difference between the subjective survival rate and objective survival rate. While the second model compares the mental health with self-reported health combined with smoking behaviour. The results show that people after receiving a stroke or heart attack become more optimistic which is translated into a better self-reported health. My research investigate if this can come due to the individuals having a wake-up call that lead to better health behaviour overall. The only health preventive behaviour they included is the smoking behaviour. They found that people who smoke and received a heart attack or are diagnosed with cancer reduced smoking behaviour, while for receiving a stroke there was no effect. This effect was only significant till 2 years after the diagnose.

These studies use only smoking behaviour as a measure for health behaviour (Smith, Taylor Jr, Sloan, Johnson, & Desvousges, 2001), (Falba, 2005), (Clark & Etilé, 2006), (Baji & Bíró, 2018). But there are more health behaviours than smoking, such as alcohol consumption, sleep, diet, physical activity and substance use. The effect of health shocks on those other health behaviours is not available. It would be interesting to see if their findings for smoking behave the same for those other behaviours. If this is the case then it can be concluded that health behaviour overall is influenceable by dismal health events. Another scenario can be that the type of health shock causes behaviour change. To evaluate this other health shocks are included and the health behaviours are also aggregated together. This method tests whether the type of health shock influences the whole health behaviour of the person. This leads to the main hypothesis:

"*Does aggregated health behaviour change for individuals after experiencing a health shock?"*.

2.4.0. Health Belief Model

The Health Belief Model (Janz & Becker, 1984) uses the concepts of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and lastly the perceived self-efficacy. Perceived indicates what the individual beliefs what can happen.

The constructs of the health belief model indicate:

- Perceived susceptibility: These are the beliefs about the perceived probability of catching a disease or getting ill.
- Perceived severity: The imagination of the individual when the illness or disease would occur and how they would cope with it. These feelings can be about the medical and clinical consequences, but can also be feelings about the social consequences.
- Perceived benefits: Beliefs about the merits that an individual can achieve when the new behaviour is adopted. For health behaviour a merit could be a reduction in morbidity of a disease. To achieve this the individual evaluates all the available options that can lead to a reduction of the disease as there needs to be a benefit of adopting the new behaviour.
- Perceived barriers: There can be hindrance due to the negative believes about changing one's behaviour such as, negative side effects, unpleasant when acting out, inconvenient or time consuming.
- Cues to action: Certain cues can trigger people to take action, these can be bodily events or environmental events. A bodily event can be acquiring an infection, and an environmental event can be that a peer receives an infection.

- Self-efficacy: Self-efficacy is the conviction that one can successfully execute the behaviour required to produce the desired outcomes. This is important for initiation and maintenance of behaviour change. People need to feel threatened by their current behaviour patterns which is the perceived susceptibility and severity. They also need to believe that changing themselves will result in a desired outcome at an acceptable cost which is the perceived net benefit. Lastly, they need to be competent to overcome the perceived barriers to take action.
- Other variables: Diverse demographic, sociopsychology and structural variables.

Perceived benefits and perceived barriers can be described as a cost-benefit analysis whereby the subtraction of perceived barriers from the perceived benefits results in the net value. The net value determines if the individual will change their behaviour. When the perceived benefits are higher than the perceived barriers it gives a positive motivation to change behaviour. When it is negative or zero there is no incentive to take action or motivation to change behaviour. This concept is the same for the Rational Agent Theory whereby a trade-off of utility values combined with probabilities are weighted from the individual perspective.

Cues to action are exogenous incentives or triggers that can influence the behaviour. These cues can be interventions that are internal or external adopted. For example internal cues to action could be a fever and external could be peer support.

The capability of the person to change the behaviour is measured by self-efficacy. In the Health Belief Model, it remains unclear if self-efficacy is considered by the perceived barriers. When a person haves a low perceived probability of maintaining their new behaviour, it can demotivate the individual to start the behaviour in the first place and this can be described as a perceived barrier.

The demographic variables age, gender, ethnicity, personality, socioeconomics and knowledge can affect the perceptions if the individual indirectly.

2.4.1. Where does the experience of a health shock fit in the Health Belief Model?

The received health shock is an event and thus fits in the model by cues to action. This event is marked at time *t*. After the health shock at time *t+1* the individual can update their perceived values. The individual needs time to adjust to the consequences of the health shock and think about what it can do to prevent this event in the future. Perceived susceptibility is the combination of perceived threat and perceived severity. The perceived threat after the health shock is likely to increase as the threat already once happened and is now more likely to happen again. Thereby the severity of the health shock is now known and the individual can give an accurate value of severity to the event as before it was only a perceived value. The perceived benefits of preventive health behaviour will likely increase as the prevention of another health shock can be more beneficial. The perceived barriers to change behaviour will likely lower when the individual experience a wake-up call. Self-efficacy can be neglected in short term measurement as it is highly likely that it is a character trait and remains constant in this research. When testing for a causal relationship between a health shock and health behaviour change the demographic variables should also be included as predictor variables to give a more accurate view. It is assumed that the long-term trend of perceived beliefs on health behaviour for individuals remain mostly constant whereas the health shock could impact the trend of perceived beliefs significantly in that particular period. The Health Belief Model is used to test if individuals bases their health behaviour on perceived values and if the health shock (cue to action) leads to a significant health behaviour change. This results in the hypothesis:

"*Does the effect of experiencing a health shock on health behaviour support the Health Belief Model?*".

If the hypothesis is true it could provide support for the Health Belief Model that the perceived beliefs in the past are not correctly constructed, and the health shock could potentially modify the individual perceived values after it. This will be the case if there is to be found a significant positive effect for the health behaviour after the health shock. A caveat is that if this is the case the cues to action do not immediately impact the individual's behaviour, but is an intermediate step to update the beliefs that would then lead to the individual's behaviour. Therefor the change in health behaviour is measured a year after the health shock.

The following hypothesis is based on the perceived threat of individuals:

Hypothesis: Does perceived severity play a role by affecting health behaviour measured by longitude of hospitalization?

The perceived threat is a combination of severity and susceptibility whereby the severity is experienced mostly when hospitalized. The amount of days in a hospital can measure the impact of the perceived severity. This test whether longer periods of hospitalising leads to a better improvement towards health behaviour change. If the hypothesis holds the severity of diseases and health shocks are not evaluated well by the individual if they change their health behaviour which results in an underestimated perceived threat.

2.5.0. Theory of Reasoned Action and Theory of Planned Behaviour

Theory of Planned Behaviour (Ajzen, 1991) is an extension to the Theory of Reasoned Action (Fishbein & Ajzen, 2010) with an additional construct: perceived control over performance of the behaviour. The theory focuses mostly on the intention part of individuals with attitude and subjective norm being the main determinants to the intention of performing behaviour. The intention can eventually lead to the observed behaviour.

Whereas the subjective norm is determined by normative beliefs created due to the surrounding social environment. Social expectation plays a role in this and can motivate the individual to comply to these norms or discourage them.

Attitude is determined by behavioural beliefs and evaluations of behavioural outcomes. Behavioural beliefs measure the beliefs about outcomes or attributes of doing the concerned behaviour, which are evaluated by the outcome possibilities of that behaviour. This is mostly evaluated individually. Fishbein tested whether the attitude between an object and a behaviour are different. The result was that attitude towards a behaviour which the behaviour was directed to is significant more present than attitude towards an object. This called the principle of compatibility. This information is useful as it shows that people evaluate overall the behaviour more than the result of the object. For example, the object is obesity the behaviour towards that is eating unhealthily. Thus, people can evaluate their behaviour towards an object or goal better than the result of a stand-alone object or a certain health state. This attitude towards behaviour over objects is present in the Theory of Planned Behaviour as combining the two contains the attitude part of the model.

2.5.1. Fitting of experiencing a health shock in the Theory of Reasoned Action and Theory of Planned Behaviour

The normative beliefs remain constant when experiencing a health shock, but the motivation to comply could be improved after a health shock. This means that the environment of the individual can influence improving the health behaviour after the adverse event. To test this effect the inclusion of having a partner is included in the model to account for the social effect of improving health behaviour.

In the situation of incurring a health shock the attitude part is more apparent to undergo change, because the behavioural beliefs get updated by the health shock and the outcome of the behaviour before the health shock gets revaluated. Whether this may change the health behaviour of the individual that experience a health shock is to be questioned. The attitude towards a certain behaviour after a health shock can be tested if unhealthy behaviour is the result that led to the health shock. The following hypothesis controls for health shock related behaviour:

"Is the type of behaviour change related to the type of health shock?".

This hypothesis is constructed to evaluate if there is a relationship between behaviour that based on empirical evidence causes a certain health shock. For example the probability of receiving lung diseases are increased by smoking.

2.6.0. The Transtheoretical Model/Stages of Change

The Transtheoretical Model (Prochaska & Velicer, 1997) uses the concept of stages that individuals go through before their behaviour change is completely maintained. This means that the behaviour becomes habitual and requires no conscious effort to be carried out. The decision for individuals to change behaviours also gets evaluated by a cost-benefit analysis. This makes the inclusion of the Transtheoretical Model useful to discuss as the concept of cost-benefit decision making is used in previously discussed models as well, the Health Belief Model and the Rational Agent Theory. The model is previously used for the health behaviours: smoking, alcohol consumption, substance abuse, mental disorders and eating behaviour. These behaviours all are included in this research except mental disorders. First the stages will be described and then how the different stages are influenced.

For behaviour to become maintained based on the Transtheoretical Model individuals need to go through the following stages:

1. Precontemplation is when the individual has no intention to change their behaviour within the next 6 months, the time periods can differ per behaviour. This can be due to being uninformed of the better behaviour or cons outweigh the pros of changing one's behaviour. Thereby these people tend to avoid information about the behaviour change as they are reluctant for change in this period.
2. Contemplation is when the individual tends to take action within the next 6 months. The individual is open for information about changing their behaviour and come to the conclusion that now the pros outweigh the cons to improve their behaviour.
3. Preparation is the stage where the person prepares him/herself to change their behaviour within the next 30 days and has make plans to do so. They are likely to sign up for behaviour change interventions such as seeing a counsellor to improve their behaviour or reading books about how to change their behaviour.
4. Action stage is where the new behaviour is conducted and does this for less than 6 months. This is the stage that is best used for measuring behaviour change.
5. Maintenance of the behaviour is that the action stage extends to more than 6 months of the newly adapted behaviour. They also gain more confidence in their new behaviour to retain it.
6. Termination is the fully substitution of the old behaviour with the new behaviour and does not relapse to the old behaviour with full confidence. The new behaviour is become a habit and it takes unconscious effort to perform the newly adapted behaviour.

Between the period of precontemplation and contemplation individual events can happen. These events are processes that the individual can undergo that would incentive them to thinking about changing their behaviour. These processes are: conscious raising, dramatic relief and environmental re-evaluation. Conscious raising is becoming aware of how the old behaviour influences the life of the individual. Dramatic relief is the emotional response by individuals induced by their own health behaviour. When the emotional response is negative it can lead to adaptation of their behaviour to soften the emotional distress. Environmental re-evaluation occurs when the individual questions his impact of its behaviour on his direct surroundings (Prochaska, DiClemente, & John, 1992).

2.6.1. Fitting of experiencing a health shock in the Transtheoretical Model

The Transtheoretical Model is used as a framework to construct the model of behaviour change of this research by time period. The Transtheoretical Model previously is tested on the behaviours: substance abuse, eating behaviour, smoking cessation, weight loss interventions and alcohol consumption. The health shock only matches the stage in the precontemplation stage towards the contemplation period as before the health shock the individual did not change their health behaviour. The health shock can cause the events of consciousness raising, dramatic relief and environmental re-evaluation. The consciousness raising event can occur because the health shock causes the individual to become aware of what the consequences of their previous health behaviour was. Dramatic relief can happen due to the experience of a health shock and can cause emotional turmoil. The emotional reaction in turn can incentivize individuals to change their health behaviour to lower the change of experiencing the health shock again with the corresponding emotional turmoil. Lastly the environmental re-evaluation after a health shock can stimulate the individual to change their behaviour to meet the social expectations of their surroundings. For example, dying early without seeing your children grow up can be a stimulus to quit drinking alcohol when an ulcer inflammation occurred. The health shock can fit in the process of change between the precontemplation and the contemplation stage and let people re-evaluate if they want to change their behaviour after the health shock. This period of re-evaluation based on the Transtheoretical Model is six months and is taken into account for the construction of the model. It supports the underlying idea that behaviour change is best tested after the health shock occurs at least one year after the health shock. It leads to the construction of the dependent variable of health behaviour change $(HB_{t+1} - HB_{t-1})$, whereby time (t) is in years.

3.0.0. Introduction Data and Methodology

In this section the variables included in the constructed model will be discussed. First the source of the questionnaire will be introduced. Secondly the methodology describes how the model is constructed. Then the dependent variables will be explained followed by the independent variables. The individual variables will be handled separately and will be checked by four criteria: why the variable is included in the model, the question and answers out of the questionnaire, the transformation of the variable and lastly how the variable can sometimes cause certain biases.

3.1.0. Data

The institute that collected the data is CentERdata and created a Longitude Internet Studies for the Social (LISS) sciences for the Measurement and Experimentation in the Social Studies (MESS) project. The data consists 4500 households with 7000 individuals and the sample is drawn from the population register by Statistics Netherlands. The participants complete a questionnaire every year for the same topic and this process is repeated since October 2007 until December 2018. The data that is collected from the questionnaire is from the LISS panel. Two sources are used the health data and the background variables. The health data describes the answers from the questionnaire on the health topic. Background variables describe the main characteristics of the participants of the project. These participants are the same for the two sources and have the same code. The period used is October 2007 till December 2018. The background variables and health data are combined from all the available years to form a panel. The data is free to use with a created account and have downloadable versions for SPSS and Stata. This study is conducted with the Stata programme. The data collected is very descriptive as for each concept multiple questions are asked and answered. The sample size is large enough that the study can give accurate results.

3.2.0. Methodology:

The base model constructed to answer the hypothesises is: $HB_{i,t+1} - HB_{i,t-1} = \beta_1 HS_{i,t} + \beta_2 AgeCategory_{i,t} + \beta_3 Emotion_{i,t-1} + \beta_4 Job_{i,t-1} + \beta_5 PreHS_{i,t-1} + \beta_6 Spouse_i + \beta_7 SurviveAge75_{i,t-1} + \beta_8 SubjectiveHealth_{i,t-1} + Constant.$

The individual is represented by *i*, and it shows that the regressions are clustered by the same individual over time. The time at *t* is the potential point where an individual can experience a health shock. The type of health shock is noted by $HS_{i,t}$ and is a categorial variable with absolute values between [0,11], whereby each value represents a type of health shock and zero when no health shock happened. $HB_{i,t+1} - HB_{i,t-1}$ is a continuous variable that represents the change in type of health behaviour and is the dependent variable. The difference is taken to measure the effect of health shock on health behaviour. The $\beta's$ are the coefficients of the different variables. Having a *Job* or *Spouse* are dummy variables, same as the *PreHS* that measures whether the individual already had to cope with previous advert health events. *AgeCategory*, *SurviveAge75* and *SubjectiveHealth* are ordinal variables.

To find causality between health shocks and health behaviour change, the health shocks that are included are selected on the characteristic of uncertainty. That means that individuals could not predict the time of when the health shock could occur, otherwise they could adjust their health behaviour before the event. This would result into no significant change in the tested period. The *PreHS* also helps in this regard as previously occurred adverse health events improves on average the likelihood for individuals to get ill again.

To solve for omitted variable bias, control variables are included to increase the validity of the model. These include the *AgeCategory*, *Emotion, PreHS*, *Job*, *Spouse*, *SurvivalAge75* and *SubjectiveHealth*. These are further discussed in Section 3.4. To take the difference of health behaviour also support the reduction of omitted variable bias, because the time-invariant omitted variables are removed over time which influences the health behaviour and the chance of obtaining a health shock. The model is based on what causes the individual to change their health behaviour, not what their new behaviour will be.

The year the questionnaire is filled in is at time *t*. It is important to note that the behaviour change could already happened at time *t*, because the question asked about the health shock refers to a time period of one year before the questionnaire. Health behaviour change after experiencing a health shock can happen at the interval [t, t+n]. A year is a long period of time, the uncertainty of behaviour change due to a health shock in the same year is difficult to assess therefor the health behaviour effect is grasped at time *t+1*. To gain accurate results a reference point is used before the effect of a health shock could take place on health behaviour and is measured at time *t-1*. This implies that the effect on health behaviour compared to the health shock is measured at time [(t+1) -(t-1)]. This can even be an advantage as observed behaviour change can come later in effect due to the processes that individuals make before changing their behaviour. Another advantage is that they could change their behaviour for a month, but now the year later (t+1) it can be checked if they also maintained their behaviour change. Table 1 shows the flow of events regarding health behaviour.

Table 1: The different events based on the years before and after a health shock. The health shock and the information update are in the same period. The year after the health shock the individual can choose based on the new information to implement different behaviour. The last stage is the maintenance stage where it becomes more apparent if the individual could retain their newly adopted behaviour.

Time (Years)	Event
[t-1]	Old behaviour
[t]	Health shock
[t]	Information update
[t+1]	Implementation of new behaviour
[t+2]	Maintenance of new behaviour

3.3.0. Dependent variables:

The dependent variable are the stand-alone health behaviours: smoking, diet, fruit, vegetables, physical activity, sleep, substance abuse and alcohol consumption. The aggregated health behaviour is also a dependent variable determined by summing the values of all the stand-alone health behaviours. Thus, there are nine models constructed whereby one is with the aggregated health behaviour change and eight with the stand-alone health behaviour change. This is done to test if health shocks affect all the health behaviours combined and what the causal relationship between specific health shocks and stand-alone health behaviour variables are. The health behaviour variables are all category variables with values of the answers that the individuals had given to the questions about their behaviour. These values are denoted numerically so that they can be transformed to the change in behaviour. As the data from health is received per year the difference in behaviour effect will be $(HB_{t+1} - HB_{t-1})$, with (t) being the year of experiencing a health shock. The $RP_{t-1}(U_e^w(e^w))$ is used as a reference point to their last behaviour known behaviour before the health shock and transformed to (HB_{t-1}). Not only will the behaviour change be evaluated but also if the change in behaviour is positive or negative. By constructing the model like this the categorial values are being subtracted and can give negative, zero or positive values. A negative value indicates that the behaviour change has and a positive value indicates that the behaviour change has improved on average after the health shock. Zero denotes that the individual did not change their behaviour over that time period. Categorial variables that are not dummies can have larger positive values than one and smaller negative values than minus one. To give all the behaviour changes the same weighted value, all the values that are outside of [-1,1] are transformed to (-1) if they are smaller than (-1) and (1) if they are larger than (1). The disadvantage of this method is that the magnitude of certain behaviour changes is neglected, but it gives a better estimate when aggregating all the single behaviour variables together.

3.3.1. Smoking:

Smoking behaviour is an addictive behaviour due to the substance nicotine. Even though the negative consequences of smoking on health and the difficulty of smoking cessation are generally well known it remains legalised and easy obtainable in most countries. Smoking is characterised as a silent killer as the negative consequences of tobacco are mostly presented at a much later stage in life. The most common consequences are the increase risk of developing coronary heart diseases, cancers and lung diseases. The negative effects are also influenced by the number of cigarettes smoked per day and the amount of years smoked (Conner, 2015). The benefit of smoking is that it acts as a stimulant and gives the individual a better emotional state as it increases the mood, but it can also reduce stress while lightning a cigarette that satisfies the urge of nicotine.

To determine if people can change their smoking behaviour the question used in the questionnaire to evaluate smoke behaviour is: *"Do you smoke now?"*. With the answers being *"yes"* (1) or *"no, I stopped" (2)*. As an example, to show how the transformation is done for smoking to determine the change in smoking behaviour over time. Is that there are three possible options of behaviour change. The first one is that the individual goes from smoking to non-smoking, second is from non-smoking to smoking and lastly to remain smoking or not smoking. If the behaviour is improved, thus from smoking to non-smoking the values denoted by this behaviour change is positive. If the behaviour remains constant after receiving a health shock the value is zero and for a negative change a negative value.

3.3.2. Diet:

In the Western World the food options are diverse, and this diversity remains stable throughout the whole year. Overall the Western population does not need to worry about food shortage. The main problem about diet in the Western World compared to Third World countries is not food shortage but rather psychological diseases such as anorexia and overindulge in consuming more food than the body needs to perform its daily activities which can cause obesity. Thereby with all the available options it's more attractive to eat high fat food or junk food rather than fruit and vegetables which are considered less attractive to consume. The expiration date of fruits and vegetables are shorter than the less healthy conserved food which makes conserved food more convenient to use. Secondly healthy food products require effort and knowledge to prepare before eating in a correct and in a tasty manner.

The question to evaluate if the person started to improve his eating habit is: *"Do you follow a diet to achieve this target weight?"*. This is a follow-up question to the question if the person wants to change its weight and if so by taking a diet. The answers to this question are *"yes"* (1) or *"no"* (2) and thus diet is a dummy variable. As following a diet takes discipline and are mostly done to achieve a better healthy weight or reduce the amount of unhealthy food, following a diet in comparison to the year before is therefore an improvement in healthy behaviour and receives a positive value. The component of the question that refers to target weight makes this an accurate variable to predict change in healthy behaviour.

A bias to this question is that it mainly focuses on a targeted weight change of the individual. There does not necessarily need to be a diet to achieve a target weight. Physical activity is another choice for individuals to achieve their target weight, which is not taken into account in this question. The variable is still included as is measures people that are actively trying to change their health behaviour.

3.3.3. Fruit and Vegetables:

Diet only controls for people who consciously make the effort to change their diet the reason for changing their diet outside of target weight remains unknown in the questionnaire, but the assumption is that it is to improve their health. Fruit and vegetables as noted before are generally less attractive for people to consume but are important for a healthy diet. Even if people do not consciously change their diet, they still can change their food consumption. To verify for this effect fruit and vegetables are taken separately to test for causality after receiving a health shock. Fruit and vegetables consumption are health preventive behaviours that reduce the change of experiencing a stroke and heart diseases (Ness & Powles, 1997). The questions in the questionnaire are: *"Do you eat raw or cooked vegetables?"* and *"Do you eat fruit?"*. With the answers being: *"never"* (1), *"1 to 3 times per month"* (2), *"1 time per week"* (3), *"2 to 4 times per week"* (4), *"5 to 6 times per week"* (5) or *"every day"* (6). To obtain easier interpretable results for the deterioration or improvement in consuming fruit and vegetables, the answers 4, 5 and 6 are given the same value as those answers are considered healthy consumption. For moderate healthy consumption the answers 2 and 3 are given the same value and 1 remains the worst possible consumption. The values are transformed so that an improvement of consuming fruit or vegetables are given a positive value and a deterioration effect a negative value.

3.3.4. Physical activity:

With more convenience at home and the trend of more people performing stationary work, working at an office, the amount of physical activity on average is reduced for the population in the First World countries. A main cause are the technical advantages which contribute to the overall reduction of physical activity. For example, ordering groceries online that are delivered at home, and more convenient ways of transport contribute to the overall reduction of physical activity. This is a problem as regular physical activity gives a lot of health benefits such as reduced cardiovascular morbidity and mortality rate, lower blood pressure and better metabolism. Thereby having enough exercise improves the physiological state as well by improving self-esteem, reduced risk of becoming depressed, lower stress levels and anxiety (Conner, 2015).

The question asked to measure physical activity are *"If you look back on the last seven days, on how many of those days did you perform a strenuous physical activity such as lifting heavy loads, digging, aerobics or cycling?"* and *"On the days that you performed a strenuous physical activity, how much time did you usually spend on this activity?"*. Answers to this question are in days, hours and minutes. These questions and answers are the same for moderate activity. The WHO states that the threshold of enough physical activity is performing at least 150 minutes moderate intensity aerobic exercise or 75 minutes of heavy vigorous intensity exercise. The WHO benchmark of enough physical activity to be healthy is used for this variable. The vigorous or strenuous physical activity is valued double the time of that of moderate physical activity. Therefor the value of moderate physical activity is divided by two and added with the strenuous activity to compare the value with the WHO benchmark of at least doing 150 minutes moderate physical activity. When the weekly amount of physical activity is below the WHO benchmark the value received is a zero and when the individual haves a value equal or above its noted as a one. Comparing the year before and after the health shock if the individual improved its physical activity it receives a positive value.

The question is asked for the last seven days and when asked in the winter season people tend to go out less which can lower the physical activity than in the spring season. This can bias the results as people can change their physical activity a lot of times in the year. However, it still can be a good value to measure and be compared as the questionnaires are mostly done around the same time of the year.

3.3.5. Alcohol consumption:

There remains a bit of a debate about what amount of alcohol consumption is optimal as moderate alcohol consumption correlates to positive health outcomes, but other empirical research suggests that no alcohol consumption is preferable. Most researchers agree that overindulgence in alcohol consumption results in high risk-taking behaviour which results in accidents, injuries, suicides, criminal behaviour, domestic violence and risky sexual behaviour. This is caused by the prefrontal cortex in the brain that regulates risk taking behaviour, alcohol weakens this part of the brain which results in underestimating risks. These are the direct effects of drinking too much alcohol while the long-term disadvantages of consuming alcohol are more health-related outcomes such as high blood pressure, heart disease and cirrhosis of the liver (Standridge, Zylstra, & Adams, 2004). Drinking behaviour can be binge drinking (consuming half the recommended weekly consumption in a single session), being addicted to alcohol and moderate alcohol consumption. Moderate drinking is determined as drinking less than 14 glasses for men and less than 7 glasses of alcohol for women per week.

The question used out of the questionnaire is: *"How much alcohol did you consume over the last 12 months on average?"*. The answers used are *"almost every day"* (1), *"five or six days per week"* (2), *"three or four days per week"* (3), *"once or twice a week"* (4), *"once or twice a month"* (5), *"once every two months"* (6), *"once or twice a year"* (7) and *"not at all over the last 12 months"* (8). The values are transformed to drinking every day, drinking weekly, drinking per month and zero or almost no alcohol. Drinking alcohol systematically can have bad influence on the health of the individual, but moderate or no drinking does not have to affect the health. Consuming alcohol once or twice a year receives the same value as not drinking at all over the last 12 months. Behaviour improvement has occurred when the individual starts drinking less compared to the time before the health shock and that behaviour change receives a value of one.

The variable however does not consider the type of drink (alcohol percentage) when consuming alcohol which can bias the results as people who consume high percentage alcohol drinks every day are less healthy than consuming a medium alcohol percentage drink every day.

3.3.6. Sleeping:

For people to function well in the day a good night sleep is required. However, many people struggle to get a good night sleep. There are 90 distinct sleep disorders that are mostly characterised by symptoms of, excessive daytime sleepiness, difficulty initiating or maintaining sleep, and abnormal events occurred during sleep. Having a bad night sleep does not affect the longevity health state but having sleeping disorder can cause negative effects to the health state. Health consequences include increased risk in hypertension, diabetes, obesity, depression, heart attack and a stroke (Conner, 2015). Not only does a bad sleep pattern cause increased risk to these diseases, but it affects the physiological state in negative manner as well.

The question in the questionnaire used to test whether peoples have problems with sleep is *"Do you regularly suffer from sleeping problems?"*. The variable is a dummy as the answers are *"yes"* (1) and *"no"* (0). The question is asked at the moment the participant fills in the questionnaire and it's unclear over what time period the persons needs to answer this question. This can confuse the participant to give an accurate answer to this question, because if the person had sleeping problems two months ago and now does not have sleeping problems both answers can be justifiable to fill in.

Sleeping problems can arise when someone has experienced a health shock, because of worry or pain of the experienced health shock. Thus, the experience of a health shock can have a negative effect on sleep behaviour instead of leading to an incentive to improve their sleeping pattern from before the health shock.

3.3.7. Substance abuse:

The use of drugs can be beneficial on a healthy or hedonic matter. Problems arises when individuals start to get dependent on the drugs and eventually get addicted. The most used recreational drugs are in most countries illegal. These are cannabis, amphetamine-type simulants (XTC), cocaine and heroin. Whereby cannabis is categorized as a soft drug and amphetamine simulants, cocaine, and heroin as hard drugs. The consequences of hard drugs are that they are more addictive and have a higher increase in mortality and morbidity risk. Some hard drugs like heroin are intravenous injected for which needles are required. Sharing needles can cause infectious diseases among the users such as hepatitis and HIV.

Substance abuse is measured over the last month when the questionnaire is filled in for that particular year. This can be problematic as most of the other variables of health behaviour are evaluated over the last year. However, as substances can be highly addictive such as hard drugs it is less likely that an individual that used last month stopped using the year after. There are questions for five types of substances in the questionnaire: sedatives, soft drugs, XTC, hallucinogens and hard drugs. The question: *“Did you use one or more of the following substances over the past month?”* is used to evaluate substance use. The answers to the question of use of the substances are *“never”* (1), *“sometimes”* (2) and *“regularly”* (3). The five types of drugs are transformed to a categorical variable that contains a different value for every substance to see which substances a person uses in a year and one value for the use of more than one substance. The improvement in behaviour is when individuals go from user to no user and would then receive a positive value.

Substances can be used to improve the health or quality of life of the individual, as cannabis for example can be used to relieve pain or reduce stress. This could bias the effect of what positive or negative is for a person health, but overall the consensus is that there are more negative health effects to substance use than positive health effect especially when a person is addicted or a regular user.

3.4.0. Independent variables:

3.4.1. Health Shocks:

Health shocks that are included are angina, heart attack, stroke, diabetes, lung, cancer, broken hip, fracture, benign tumour, other health shocks and more than one health shock received in the particular year. The health shocks are split up in diagnosable health shocks and immediate impact health shocks. The diagnosable health shocks are first encountered by a physician being diabetes, cancer and benign tumour. These diseases can have a huge impact on the individual's lifestyle, because they need to adjust their lifestyle to the disease. The quality of life and life expectancy lowers when one of these diseases occur. The immediate impact health shocks are heart attack, angina, stroke, broken hip and fracture as these shocks have an immediate effect on the individual wellbeing and are experienced unexpectedly . Table 2 shows the percentages of individuals that received the shocks.

Table 2: The amount and percentages of people that received a health shock over all the years that they filled in the questionnaire. This table represents the health shocks after the transformations. As the occurrence of a broken hip or thigh bone happens the low sample size can skew the results in the model.

Health Shocks:	Observations	Percentage of people (n=9998)
No diseases or problems	9741	97.43%
Angina	251	2.51%
A heart attack	224	2.24%
A stroke or brain infarction	83	0.83%
Diabetes	235	2.35%
Chronic lung disease	185	1.85%
Cancer or malignant tumor	278	2.78%
A broken hip or thigh bone	35	0.35%
Another fracture	291	2.91%
Benign tumour	256	2.56%
Other afflictions	1718	17.18%
More than one health shock	279	2.79%

The health shocks are put together in a categorical variable. When a person experience one or more health shock in the same year the variable receives a value of *"one or more health shocks"*. Otherwise the amount of different combinations of health shocks would be too much to evaluate. The category other health shocks is included because these people cannot be in the healthy group as that would bias the results between comparing the healthy individuals with the individuals that received a health shock. The independent variable is the categorical variable of experiencing a health shock. The health shocks are derived from the question: *"Has a physician told you this last year that you suffer from one of the following diseases/problems? More than one answer possible."* The answer per different health shock are *"no"* (0) and *"yes"* (1).

It is important to note that the question refers to the physician's diagnosis and the time period of last year. The reference to the physician makes the question more valid, because the individual does not speculate about their health shocks themselves. The time period which the question refers to is last year and makes the exact time of receiving the health shock unknown. The individual could have gotten the diagnosis a month ago or 11 months ago. The health shocks are determined at time (t) which is the time that the questionnaire is filled in. Combining the health shocks in a categorical variable is done by giving the usable health shocks a different number so that they can be distinguished from each other. The usable health shocks are angina (1), a heart attack (2), a stroke (3), diabetes (4), lung (5), cancer (6), a broken hip (7), another fracture (8), benign tumour (9), other health shock (10), more than one health shock (11) and with (0) being no health shock received in that particular year.

It can be possible that an individual has experienced more than one health shock, which could bias the results. To solve for this problem people that have more than one health shock firsts need to be identified. This is done by summing the nine health shocks for each individual and by making a value of what the highest value of health shock per person is. Then the summed-up values are subtracted by the highest value of a person's health shock, because if the value is 0 it is known for sure that they either have 0 health shocks or have only one health shock. All the values that are not 0 are thus people that experienced more than health shock in the same year and gain the value 10.

The models constructed haves dependent variables that measure the difference in time $(HB_{t+1} - HB_{t-1})$. The model assumes that the health shock occurs at time *t* not a time *t+1* or *t-1*. To make sure the model does not put the health shock at time *t+1* or *t-1* the health shock variable is subtracted, $HS_t - HS_{t-1}$, to find the health shock in the past that now give a negative value (-1). These are transformed to experiencing no health shock (0). This also controls for people that experienced the same health shock back to back and now depicts a value that those people didn't receive a health shock (0). This is done because experiencing the same health shock year after year would bias the result for the tested health behaviour. In that case the health behaviour would occur at the same time the individual acquires the second health shock and thus overlap.

3.4.2. Pre-Health shock:

The dummy pre-health shock controls whether the individual had a health shock before the health shock at time *t* and *t-1*. If a health shock occurred before this, it could indicate that the individual already adapted their behaviour. To control for this effect the question out of the questionnaire: *"Do you suffer from any kind of long-standing disease, affliction or handicap, or do you suffer from consequences of an accident?"*. The respondent can apply with answers *"yes"* (1) or *"no"* (0). If a person responds *"yes"* it indicates that the respondent already adapted their health behaviour to cope with the previous health shock and would result in a different effect than people that did not received a health shock in the past. The control variable is lagged so that the effect doesn't correlate with the health shock received at time *t*.

3.4.3. Age category:

Age category is a controlling ordinal variable and measures different reactions on health behaviour by age group. Age is an indicator of how flexible an individual is to change their behaviour as for example older individuals have more difficult changing their behaviour than younger individuals. People decrease their risk seeking behaviour until middle age and can be beneficial for health protective behaviour. From the middle age onwards if their socio-economic status is well established they can seek in risk taking behaviour, but if they are not then the risk aversion further increases (Decker & Schmitz, 2016). Another problem is that elderly people are the least likely to adopt health protective behaviour, but they can still benefit from them (Levy & Myers, 2004). The advantage of age category as a control variable over age as a continuous variable is that the each age group haves their own characteristics and can adapt their health behaviour differently.

3.4.4. Hospitalization

Hospitalization is first used to test if hospitalization haves a causal effect on health behaviour just like the health shocks on health behaviour. Secondly it is used to separate the people in two groups to verify if there is a difference in severity of the health shock for individuals that stayed longer in a hospital than individuals who had a short period of time stayed in the hospital.

Hospitalization is constructed from hospital stay in days from the follow up question: *"How long did you spend in hospital the last time?"* with answers being 0 to 500 days. This is a follow up question to the question *"Did you spend any time at the hospital or a clinic over the last 12 months?"*. To make hospital stay a health shock the question is transformed to hospitalization by making a dummy. The value 0 represents people that have stayed in the hospital for less than three days and the value 1 represents people that have stayed in the hospital for at least three days (Van Kippersluis, García-Gómez, O' Donnell, & Van Doorslaer, 2012).

3.4.5. Mental Health:

Emotional state is first used as an independent variable for the health shock models lagged at one year $(Emotion_{t-1})$ to have an emotional reference point. The mental health state of individuals controls for the influence that it can have on change in health behaviour, because having a good mental health state reduces the incentive to change health behaviour (Ferrer & Mendes, 2018). Secondly the change in emotional state $(Emotion_{t+1} - Emotion_{t-1})$ is used to answer the hypothesis about the effect of the change in emotional state on health behaviour further discussed in Appendix A.

To construct the control variable of mental or emotional state of individuals the equal space method is used (Chen & Wang, 2014). This makes emotional state a continuous variable with an interval of [0,1]. First the scores of each emotional state are computed by the formula: $s_j = \{h_k(j, p_1, \ldots, p_k)\}$. The s_j is the score, *k* is the number of categories, p_k is the probability of the category, h_k is the assigned value of the category and *j* is the category wherefor the score is determined. Mental health is a combination of measurements of the emotional states, being anxious, down, depressed, calm and happy. The question asked for the emotional states is: *"The past month I felt…"*. With the answers for the five emotional states being: *“never”* (1), *“seldom”* (2), *“sometimes”* (3), *“often”* (4), *“mostly”* (5) and *“often”* (6). There are 6 answers for each emotional state and are ordinal. For each answer the probability is 0.2, whereby the worst possible state receives a value of 0. For example the answer “seldom” to the question “happy” receives a value of 0.2 (0.2*1) and mostly 0.8 (0.2*4). Questions that negatively affect mental health (being anxious, down, depressed) gain opposite scores. Thus being never depressed gains a score of 1 (0.2*5). All the scores get added for each emotional health state and divided to gain the individuals mental health score, $S = \frac{(s_{anxious}+s_{down}+s_{depressed}+s_{calm}+s_{happy})}{5}$.

For the measure of behaviour change this implies that $(Emotion_{t+1} - Emotion_{t-1})$ is equal to the change in mental health scores $(S_{t+1} - S_{t-1})$. When there is an improvement in mental health the score is negative value and when mental health deteriorates the score is a positive value.

3.4.6. Job:

Job is included as a control variable as it measures indirectly method of income and the social environment of individuals. The variable job is lagged and a dummy. The reaction from individuals that have a job can differ from individuals who are unemployed after the occurrence of a health shock. The health shock can cause a person to be (temporary) unemployed after a health shock and can lead to trouble of working again. For people that were unemployed before the health shock the impact of the health shock can be less severe. Being employed increases peoples social interactions, (physical) activity and responsibility on average compared to being unemployed. These are all factors that contribute to a good mental health state and to good health behaviour (Janlert, Winefield, & Hammarström, 2014). The inclusion of the dummy having a job controls for these effects.

3.4.7. Spouse:

The control variable spouse is lagged at one year and a dummy. Having a partner can be a reason for the individual to cope better with a health shock than without a partner. The partner can support with behaviour improvements for the person that received a health shock. The health of the individual is not only important for itself but also for the spouse and the social environment. Empirical evidence supports that the social environment of the individual can benefit in health behaviour improvements (Zimmerman & Connor, 1989). For behaviour to change it is easier to do with someone checking on you and making agreements with the person. Having a spouse is included over having children and other social environment variables as living with a partner day to day could also grasp the effect of having children or not. Receiving feedback directly from a partner on health behaviour is more likely than receiving that from children as they can leave the house when they are old or are too young to understand the importance of health behaviour. Also the effect that children could have on health behaviour could already be included partly in having a spouse. Not only does the health shock have an impact on the individual who experience the shock, but there can be spill-over effects to other family members too, eventually even to next generations of family members (Fadlon & Nielsen, 2019). This supports the theory that there is more to behaviour change than only on the individual level.

3.4.8. Subjective health:

Subjective health is introduced to serve as a reference point for the individual that subjectively evaluated their own health state. It controls for health behaviour change in individuals that already find themselves to be healthy and have probably a less incentive to improve their health behaviour, while individuals that find their health poor have a greater incentive to perform health improvement behaviour. The subjective part serves as a control variable, as for behaviour change to happen, the individuals personally need to know their health state before performing their behaviour change in the direction they want.

The question used to measure subjective health form the questionnaire is: *"How would you describe your health generally speaking?"*. The possible answers are *"poor"* (1), *"moderate"* (2), *"good"* (3), *"very good"* (4) and *"excellent"* (5). The variable is transformed by combining poor and moderate while also combining very good and excellent so that now three answers are used. This value will be lagged, because an individual who haves perfect health and experience a health shock will not be inclined after the health shock to improve their health behaviour as the health behaviour before the experience was already at its maximum.

3.4.9. Dying before age 75:

The proposition that individuals who do not have the ability to extent life by much, value health differently than individuals who can. People who are convinced that their life expectancy to the next available age is minimum can evaluate putting effort into improving health behaviour as neglectable. They can gain a higher utility in their remaining life by putting effort into other areas than to improve their health behaviour. This certainly the case for the elderly as they are the group that are the least likely to change their health behaviour. However when the elderly report a positive subjective health they are more likely to change their health behaviour (Levy & Myers, 2004). People who subjectively rate their life expectancy low can be more incentivised to improve their healthy behaviour to extent their life expectancy. The perception of the individual to die before the age of 75 can control for the effect of the will to live. If people have given up on life due to not having a social environment or just being old, changes are that there are no incentives to change behaviour after receiving a health shock.

The question asked in the questionnaire is: *“How would you rate your change of living to be 75 years or older?”*. The respondents could give their answer between the range of 0 to 10 with 0 being no change at all and 10 means absolute certain. This variable is transformed after making a histogram of the choices and making this variable into four categories, 0-4 being high change of dying, 5-6 being moderate change of dying, 7-8 being low change of dying and 9-10 being certain of survival until age 75. The variable is lagged as if at t a health shock occurred their perception on surviving till age 75 can change. Dying before the age of 75 is used for subjective health in the present and what the consequences of current behaviour are for the future. It also is used as dependent variable in the paper: “*Do smokers respond to health shocks?*” to evaluate how smokers react to health shocks and is found to have a significant effect on dying before the age of 75 (Smith, Taylor Jr, Sloan, Johnson, & Desvousges, 2001).

3.4.10. Socio Economic Status:

Socio-economic status is included in most individual health behaviour models because it predicts that having a higher socio-economic status results in a higher consumption of health and perform better health behaviour on average than the lower socio-economic status individuals. Socio-economic status is measured by wealth earnings and education. This results in higher life expectancy for individuals in a higher economic status. This is partly due that a better socio-economic status incentivises the person to live longer as their prospects of a wealthy longevity are more advantages. Another reason is that high socio-economic individuals already have overall better health behaviour than the lower socio-economic status individuals (Van Kippersluis & Galama, 2019). Empirical research was done to construct an education gradient that measures the relationship between the education and health behaviour accurately. The gradient is constructed by income, health insurance, family background that account for 30% explanatory power of the gradient. Knowledge and cognitive ability contains also 30% power and social networks 10% (Cutler & Lleras-Muney, 2010). Therefor education was first included in the models as a control variable to grasp the socio-economic effect on health behaviour. The variable education was eventually removed from the models as there was not enough explanatory power that educated people reacted differently to a health shock. An explanation for this finding could be that the education effect already took place before the health shock and is constant when taking the difference. Another problem with the inclusion of socio-economic status would be that when a health shock occur for the higher socio-economic status individuals, their increase in health behaviour will be relatively lower as they cannot further improve their health behaviour with the same magnitude as the group of lower socio-economic status. In the end there is chosen to not include socio-economic status as a control variable for the model. The model focus on the short-term period from before to after a health shock and the socio-economic status effect should already been measured at the reference point (t-1).

4.0.0. Introduction results:

In this section the results are discussed and explained. There are six different type of models constructed to evaluate the change in behaviour due to the experience of a health shock. The first model is the base model whereby the whole population from the questionnaire is used that have at least three years of participation to the questionnaire after each other. This time period of at least three years is used for all the models, except the placebo model. The second model differs in type of health shock as it uses hospitalization instead. The third model and fourth model is where a separation in the questionnaire population takes place to control for the severity of the health shocks. The third model describes the individuals that have at least stayed three days in the hospital and the fourth model a hospitalization of less than three days. In Appendix A the models incorporate the emotional change instead of the health shock to test for the effect of mental health state on behaviour change. Lastly to verify if the method used to construct the models is valid a placebo model is constructed. This model uses the health shock (HS_{t+2}) instead of the health shock (HS_t) while the rest remains the same as the base model. If there would be significance for the (HS_{t+2}) it could imply that the method used for model construction is debatable. For all the different type of constructed models at the end of the section the results are shown for the aggregated behaviour model. Each model is evaluated for their significance levels, signs and characteristics. The interpretation of the coefficient for the shocks is as follows. Coefficient of a health shock increases or decreases the individual's type of health behaviour change compared to the individuals that did not experienced that health shock, ceteris paribus. The coefficient are between the values [-1,1] as that is the interval. The interval is larger for the aggregated model whereby the sum of behaviour is used [-8,8].

4.1.0 The base health behaviour model

The model constructed to test the same hypothesis as the main hypothesis but for the stand-alone health behaviour variables is:

"Do specific health behaviours change for individuals after experiencing a health shock?".

$$HB_{i,t+1} - HB_{i,t-1} = \beta_1 HS_{i,t} + \beta_2 AgeCategory_{i,t} + \beta_3 Emotion_{i,t-1} + \beta_4 Job_{i,t-1} + \beta_5 PreHS_{i,t-1} + \beta_6 Spouse_i + \beta_7 SurviveAge75_{i,t-1} + \beta_8 SubjectiveHealth_{i,t-1} + Constant.$$

The results from Table 3 show that there are 15 shocks to be found significant whereby 12 have negative impact on the health behaviour and only 3 positive effects. This is not completely surprising as health shocks immediately negatively impact the health and could lead to an impairment of ability to improve health behaviour. Chronic lung disease is a good example as it induces a reduction in physical activity, increase in substance abuse and more sleep problems.

Smoking behaviour is reduced when someone haves a broken hip or experienced more than one health shock and smoking behaviour increases when individuals have had a fracture. These findings are not to be expected as broken hip and fracture are both health shocks that are unrelated to smoking behaviour. It seems that the age category of 25-34 is an age period where people tend to quit smoking compared to the age reference group of 15-24. The age group of 15-24 is the period that most individuals start smoking (Chen & Millar, 1998).

Positive alcohol behaviour change occurs by other health shocks. It is also interesting that the age categories are all significant positively and that alcohol behaviour change occurs when people get older compared to the age group 15-24 as the coefficient increasing per age group.

Change in substance abuse is mainly determined by the emotional state lagged at one year. When the initial emotional state is high they are less likely in the future to consume substances. This seems unlikely at first glance, but when someone haves a score of a perfect emotion state (value 1) at time *t-1* it can imply that this state can only worsen in the future and eventually lead to increase in substance abuse. There is support that people that have emotional or mental problems tend to access substances more than people that have a good emotional state (Quirk, 2001). The link between emotion and substance abuse makes the reference point of the emotional state lagged at one year a good predictor if the individual starts to decrease the use of substances.

Physical activity negatively impacts the health behaviour change after occurrence of the health shocks, broken hip and chronic lung diseases. Broken hip impairs the individual for physical activity until it is healed, the period of healing a broken hip can take multiple months. Receiving a stroke increases on average the physical activity of individuals. A stroke can lead to physical barriers, but the behaviour change is measured after one year of the stroke and it results in behaviour increase of physical ability. It is recommended after a stroke to increase physical activity as it reduces the changes of receiving a stroke again (Saunders, Greig, & Mead, 2014). This result can be seen as a wake-up call to the individuals that leads to improving their health behaviour, because of the negative experience received.

Sleep problems have similar results to physical activity as health shocks can negatively impact a person's sleep behaviour. Chronic lung diseases make it harder to breath and can result in difficulty sleeping (Dancey, Tullis, Heslegrave, Thornley, & Hanly, 2002).

The results for fruit consumption are questionable as angina leads to a reduction of fruit consumption. It would be expected to see the opposite effect that having angina increase the fruit consumption (Ness & Powles, 1997). The results for the link between having a fracture and eating less vegetables is not supported. The only causality regarding fractures and vegetable consumption is the reduction of risk of a hip fracture (Benetou, et al., 2016).

Starting a diet for a diabetes persons would seem to be logical relation at first, but the results show that people with diabetes on average quit their diet. After considering the question from the questionnaire they asked specifically for a diet to gain their desired target weight. Explanation for this finding is that individuals probably stop their previous diet that was based on acquiring a target weight. People with diabetes are more likely to change their diet because of diabetes and not to reach their subjective target weight.

The result that behaviour change does not occur after receiving a cancer diagnose coincide with previously empirical research. There are small effects found for quitting smoking and reduced alcohol consumption, but people tend to return back to their previous behaviour after a while (Williams, Steptoe, & Wardle, 2013).

Table 3: Panel data results for the relationship between the change in health behaviours and health shocks.

	(1) Smoking	(2) Alcohol	(3) Substances	(4) Physical Activity	(5) Sleep	(6) Vegetables	(7) Fruit	(8) Diet
No Health shock								
Angina	0.065	0.005	0.017	-0.052	-0.047	-0.047	-0.077**	0.049
	(0.042)	(0.066)	(0.031)	(0.050)	(0.037)	(0.040)	(0.037)	(0.032)
Heart	0.047	-0.008	0.003	-0.020	-0.069	-0.002	0.054	-0.043
	(0.058)	(0.068)	(0.035)	(0.067)	(0.044)	(0.052)	(0.045)	(0.031)
Stroke	0.108	0.039	-0.007	0.207**	-0.026	-0.038	-0.077	0.063
	(0.078)	(0.101)	(0.051)	(0.094)	(0.079)	(0.094)	(0.112)	(0.048)
Diabetes	0.066	-0.034	-0.006	-0.055	-0.006	-0.030	0.059	-0.081*
	(0.044)	(0.056)	(0.014)	(0.056)	(0.033)	(0.034)	(0.045)	(0.044)
Lung	0.038	-0.035	-0.066*	-0.106*	-0.118**	0.085	0.002	-0.003
	(0.048)	(0.062)	(0.037)	(0.063)	(0.051)	(0.056)	(0.056)	(0.039)
Cancer	0.035	0.026	-0.006	0.026	-0.067	0.009	0.004	0.027
	(0.043)	(0.064)	(0.031)	(0.057)	(0.045)	(0.037)	(0.029)	(0.029)
Broken hip	0.466*	-0.229	0.000	-0.208*	0.017	0.100	-0.100	-0.205
	(0.250)	(0.187)	(0.004)	(0.126)	(0.158)	(0.094)	(0.096)	(0.127)
Fracture	-0.078**	-0.022	0.028	0.072	0.012	-0.074**	-0.008	0.044
	(0.034)	(0.039)	(0.025)	(0.048)	(0.034)	(0.038)	(0.039)	(0.029)
Tumor	-0.022	-0.095	0.004	-0.047	-0.039	0.008	-0.027	-0.004
	(0.042)	(0.065)	(0.031)	(0.062)	(0.037)	(0.034)	(0.038)	(0.032)
Other	-0.002	0.032*	-0.011	-0.011	-0.042***	-0.013	-0.024*	0.015
	(0.015)	(0.018)	(0.008)	(0.019)	(0.013)	(0.012)	(0.014)	(0.012)
Health shock>1	0.081**	0.091	-0.029	-0.101*	-0.000	0.022	0.025	-0.004
	(0.040)	(0.064)	(0.035)	(0.058)	(0.043)	(0.038)	(0.040)	(0.041)
Age category:								
Age 15-24								
Age 25-34	0.073***	0.059***	0.010	-0.017	0.025**	-0.008	-0.005	0.009
	(0.027)	(0.018)	(0.009)	(0.015)	(0.010)	(0.011)	(0.014)	(0.009)
Age 35-44	0.012	0.054***	-0.001	0.024*	0.005	-0.006	-0.012	0.008
	(0.023)	(0.016)	(0.008)	(0.014)	(0.009)	(0.010)	(0.012)	(0.008)
Age 45-54	0.015	0.067***	0.010	0.007	0.002	0.001	-0.004	0.003
	(0.022)	(0.016)	(0.008)	(0.013)	(0.009)	(0.009)	(0.012)	(0.008)
Age 55-64	0.014	0.088***	0.007	0.022*	0.016*	-0.005	-0.006	0.013*
	(0.021)	(0.015)	(0.008)	(0.013)	(0.009)	(0.009)	(0.012)	(0.007)
Age 65 or older	0.008	0.108***	0.014	0.005	0.019*	-0.014	-0.005	0.017*
	(0.022)	(0.018)	(0.009)	(0.017)	(0.011)	(0.012)	(0.013)	(0.010)

Lagged emotion state	-0.000	-0.009	-0.049***	0.033	-0.067***	-0.029*	-0.058***	0.001
	(0.022)	(0.025)	(0.012)	(0.023)	(0.016)	(0.016)	(0.018)	(0.014)
No job								
Job	-0.015**	0.019**	0.006	0.018**	-0.008	-0.001	-0.001	0.009*
	(0.008)	(0.009)	(0.004)	(0.008)	(0.006)	(0.006)	(0.006)	(0.005)
No previous HS								
Previous HS	-0.002	-0.005	-0.005	-0.016**	-0.003	-0.002	-0.001	0.007
	(0.007)	(0.008)	(0.003)	(0.008)	(0.006)	(0.005)	(0.006)	(0.005)
No spouse								
Spouse	-0.011	-0.013*	-0.005	0.002	0.002	-0.002	-0.002	0.007*
	(0.007)	(0.007)	(0.004)	(0.006)	(0.005)	(0.005)	(0.006)	(0.004)
Expectation 75 year:								
No change								
Mediocre change	-0.001	-0.018	-0.010	0.005	0.010	-0.010	0.020*	-0.013
	(0.012)	(0.015)	(0.008)	(0.015)	(0.009)	(0.012)	(0.012)	(0.008)
Above average	-0.014	-0.012	-0.012*	0.014	0.013	0.003	0.016	-0.021***
	(0.011)	(0.014)	(0.007)	(0.014)	(0.009)	(0.011)	(0.011)	(0.008)
Absolutely certain	-0.021*	-0.014	-0.009	0.016	0.012	-0.013	0.005	-0.017*
	(0.012)	(0.016)	(0.008)	(0.016)	(0.009)	(0.012)	(0.012)	(0.009)
Subjective Health:								
Bad								
Normal	0.022**	-0.009	-0.009	-0.031***	-0.001	-0.002	0.002	0.013*
	(0.010)	(0.012)	(0.006)	(0.011)	(0.008)	(0.008)	(0.009)	(0.007)
Good	0.019	-0.023	-0.012*	-0.059***	0.011	0.000	0.009	0.014*
	(0.012)	(0.014)	(0.006)	(0.014)	(0.009)	(0.010)	(0.011)	(0.008)
Constant	0.038	-0.031	0.051***	-0.023	0.020	0.036**	0.041**	-0.015
	(0.026)	(0.023)	(0.013)	(0.021)	(0.015)	(0.015)	(0.018)	(0.012)
Observations	12229	22951	22946	22909	22798	22889	22889	22889
R-squared	0.006	0.004	0.003	0.002	0.004	0.001	0.001	0.002

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1*

4.2.0. Hospitalization as a shock

The results of the following model are in Table 4 and are based on the formula:

$$HB_{i,t+1} - HB_{i,t-1} = \beta_1 Hospitalization_{i,t} + \beta_2 AgeCategory_{i,t} + \beta_3 Emotion_{i,t-1} + \beta_4 Job_{i,t-1} + \beta_5 PreHS_{i,t-1} + \beta_6 Spouse_i + \beta_7 SurviveAge75_{i,t-1} + \beta_8 SubjectiveHealth_{i,t-1} + Constant.$$

Hospitalization replaces the health shocks to evaluate the impact of the longitude stay at a hospital. The hypothesis:

"Does the longitude of hospital stay influence the health behaviour change of individuals?"

is constructed to test if there is a severity effect. Hospitalization is a dummy with values shorter than three days and at least three days in the hospital. There is no effect found that hospitalization of at least three days compared to hospital stay of less than three days result in behaviour change. Hospitalization measures the coping of individuals in the hospital and can be linked to severity. The dummy variable alone does not measure the effect of severity for people with hospital stay of longer than three days. People can be hospitalized but the reason for it does not necessarily have to be for a severe illness.

The only interesting finding of Table 4 is that for substance abuse hospitalization haves an effect. Reason for this can be that users are hospitalized due to substance abuse and longer hospital stay can result as a deterrent effect that lead to the use of less substances.

Table 4: Panel data results for the relationship between hospitalization and health behaviours.

	(1) Smoking	(2) Alcohol	(3) Substances	(4) Physical Activity	(5) Sleep	(6) Vegetables	(7) Fruit	(8) Diet
Hospital stay less than 3 days								
Hospital stay at least 3 days	0.012	0.029	0.022*	0.006	0.008	-0.007	0.002	-0.008
	(0.021)	(0.025)	(0.013)	(0.026)	(0.016)	(0.019)	(0.019)	(0.017)
Age category:								
Age 15-24								
Age 25-34	-0.013	-0.014	0.080**	0.010	0.117***	-0.069	-0.036	0.023
	(0.086)	(0.066)	(0.034)	(0.066)	(0.038)	(0.045)	(0.052)	(0.042)
Age 35-44	-0.026	0.058	0.037	0.050	0.056	-0.078*	0.022	0.008
	(0.079)	(0.062)	(0.034)	(0.066)	(0.041)	(0.045)	(0.054)	(0.041)
Age 45-54	0.038	0.070	0.068**	-0.010	0.022	-0.024	0.031	0.011
	(0.077)	(0.060)	(0.033)	(0.064)	(0.038)	(0.043)	(0.052)	(0.042)
Age 55-64	0.041	0.106*	0.047	0.011	0.041	-0.035	0.027	-0.003
	(0.077)	(0.058)	(0.031)	(0.060)	(0.036)	(0.042)	(0.051)	(0.038)
Age 65 or older	-0.011	0.024	0.061*	-0.018	0.038	-0.027	0.025	0.024
	(0.079)	(0.064)	(0.035)	(0.067)	(0.038)	(0.048)	(0.052)	(0.042)
Lagged emotion state	0.012	-0.021	-0.094**	0.106	-0.057	-0.026	-0.095	0.027
	(0.057)	(0.083)	(0.042)	(0.081)	(0.053)	(0.059)	(0.063)	(0.050)
No job								
Job	0.001	-0.022	0.002	0.037	-0.040*	0.044**	-0.009	0.010
	(0.023)	(0.033)	(0.016)	(0.034)	(0.023)	(0.022)	(0.025)	(0.022)
No previous HS								
Previous HS	-0.031	0.037	-0.010	-0.042	0.007	-0.019	-0.009	-0.024
	(0.022)	(0.029)	(0.013)	(0.027)	(0.019)	(0.019)	(0.021)	(0.017)
No spouse								
Spouse	0.030	-0.057**	-0.025	0.013	-0.019	-0.015	-0.006	0.011
	(0.021)	(0.029)	(0.016)	(0.028)	(0.019)	(0.020)	(0.021)	(0.017)
Expectation 75 year:								
No change								
Mediocre change	0.066**	0.042	-0.053*	0.026	-0.031	0.002	-0.029	-0.002
	(0.030)	(0.044)	(0.028)	(0.042)	(0.028)	(0.033)	(0.031)	(0.026)
Above average	0.015	0.030	-0.046*	0.055	-0.020	0.042	-0.035	-0.035
	(0.028)	(0.042)	(0.025)	(0.040)	(0.030)	(0.030)	(0.032)	(0.025)

Absolutely certain	0.020	0.050	-0.035	0.069	-0.031	0.017	-0.036	-0.027
	(0.033)	(0.046)	(0.027)	(0.047)	(0.031)	(0.032)	(0.034)	(0.031)
Subjective Health:								
Bad								
Normal	0.017	-0.022	-0.020	-0.101***	0.011	-0.009	0.010	-0.016
	(0.023)	(0.035)	(0.019)	(0.035)	(0.024)	(0.023)	(0.027)	(0.021)
Good	0.002	0.005	-0.027	-0.203***	0.028	-0.021	0.021	0.002
	(0.041)	(0.050)	(0.023)	(0.047)	(0.032)	(0.034)	(0.037)	(0.028)
Constant	-0.039	0.000	0.091**	-0.036	0.009	0.040	0.085	0.004
	(0.081)	(0.082)	(0.045)	(0.075)	(0.048)	(0.056)	(0.062)	(0.053)
Observations	1286	2234	2234	2230	2215	2228	2228	2228
R-squared	0.015	0.011	0.022	0.010	0.011	0.006	0.005	0.004

Standard errors are in parenthesis

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

4.3.0. Base model given longer hospitalization

This model is depicts in Table 5 and combines aspects from the previous constructed models that uses the formula:

$$HB_{i,t+1} - HB_{i,t-1} = \beta_1 HS_{i,t} + \beta_2 AgeCategory_{i,t} + \beta_3 Emotion_{i,t-1} + \beta_4 Job_{i,t-1} + \beta_5 PreHS_{i,t-1} + \beta_6 Spouse_i + \beta_7 SurviveAge75_{i,t-1} + \beta_8 SubjectiveHealth_{i,t-1} + Constant, \textit{ if hospitalization = at least three days.}$$

In this model the questionnaire population is split up whereby this model only includes the individuals that have at least three days of hospitalization to answer the following hypothesis:

"Does the severity of health shocks influence the change in health behaviour?".

The results from Table 5 show that the individuals react differently on average to health shocks when their hospital stay is at least three days and have experienced a health shock. There are to be found 12 significant health shock influence on the health behaviour, whereby 7 are positive effects and 5 negative effects. The signs change mostly from negative to positive behaviour change compared to the first model for the behaviours: smoking, alcohol and fruit. While the negative impact of health shocks on physical activity and sleep remains the same. Especially for smokers longer hospitalization seems to impact the behaviour the most positively for smoking related health shocks, such as heart attack, receiving a stroke, chronic lung disease and more than one health shock. This hypothesis is to be found more valid than the previous models as the results are more in line with how people would react to health shocks (Smith, Taylor Jr, Sloan, Johnson, & Desvousges, 2001), (Falba, 2005), (Baji & Bíró, 2018). Another similar finding is the increase of fruit consumption after receiving a heart attack can protect people to gain another heart attack in the future (Ness & Powles, 1997). People react to health shocks positively if the severity of the health shock is at least three days and they know how to reduce risk of the same health shock in the future. While the negative changes results from impairments that certain health shocks can transmit to individuals for the long run. The health shocks influence sleep behaviour and physical activity the most negatively.

4.3.1. Base model given shorter hospital stay

The formula that is constructed for the other group is:

$$HB_{i,t+1} - HB_{i,t-1} = \beta_1 HS_{i,t} + \beta_2 AgeCategory_{i,t} + \beta_3 Emotion_{i,t-1} + \beta_4 Job_{i,t-1} + \beta_5 PreHS_{i,t-1} + \beta_6 Spouse_i + \beta_7 SurviveAge75_{i,t-1} + \beta_8 SubjectiveHealth_{i,t-1} + Constant, \textit{ if hospitalization = less than three days.}$$

This group have a hospital stay of less than three days and show 14 significant health shocks, whereby 11 are negative effects towards health behaviour and only 3 positive, depicts at Table 6. The results show that if hospital stay is shorter it influence people to be less proactive to change their health behaviour in a positive manner. Smokers that have a shorter period of time in the hospital are less prone to change their behaviour positively than people that have a longer hospital stay. It is noted that people with a broken hip change their alcohol consumption, substance use and fruit consumption significant but as this group is relatively small compared to the other health shocks these results can be taken with a grain of salt. The only significant positive change is that sleep problems are reduced for people with a stroke or experienced more than one health shock and that vegetable consumption increases after diagnosed with cancer. The results compared to the other group can be due to that a shorter hospital stay results in less pondering about the health shocks. This argument can explain the increase in sleep behaviour too.

4.4.0. Interpretation results for hypothesises

Now that all the models for the stand alone behaviour are discussed the hypothesis:

"Is the type of behaviour change related to the type of health shock?", can be answered.

The behaviours that are related to a type of health shock influence that particular health behaviour afterwards. Positive behaviour change occurs when the behaviours that increase the risk of receiving that type of health shock could have led to the experience of that health shock. Then a wake-up call or learning moment happens that results in the positive behaviour change. Negative behaviour changes are mostly due the type of health shock that causes a limitation for the individual.

The results also give answer to the hypotheses:

"Are health shocks the cause of putting in more effort into health protective behaviour?" and

"*Does the effect of experiencing a health shock on health behaviour support the Health Belief Model?".*

There is support for the Health Belief Model and the probability weighting theory that individuals update their perception of severity after receiving a health shock that could increase the probability of changing their health protective behaviour. The re-evaluation of beliefs of their previous health behaviour after the health shock can lead to a new net value of utility too. The perceived benefits need to be larger now than the perceived barriers of changing behaviour compared to before the health shock. This could result in putting more effort in health protective behaviour to reduce the risk of receiving the same health shock. There are already models that try to integrate health shocks or health events in the determination of health behaviour (Boudreaux, Bock, & O'Hea, 2012). These results support the implementation of health shocks or health events in health behaviour models.

Table 5: Panel data results for the relationship between the change in health behaviours and health shocks grouped by hospitalization at least three days.

	(1) Smoking	(2) Alcohol	(3) Substances	(4) Physical Activity	(5) Sleep	(6) Vegetables	(7) Fruit	(8) Diet
No Health shock								
Angina	0.145	0.206	0.151	-0.241**	0.012	-0.154	0.058	0.081
	(0.111)	(0.220)	(0.105)	(0.115)	(0.028)	(0.097)	(0.069)	(0.129)
Heart	0.309***	0.039	-0.020	0.080	-0.080	0.085	0.167**	-0.025
	(0.089)	(0.108)	(0.046)	(0.117)	(0.068)	(0.079)	(0.080)	(0.056)
Stroke	0.261*	0.136	-0.041	0.274	-0.198	0.097	0.116	0.112
	(0.157)	(0.135)	(0.028)	(0.217)	(0.131)	(0.168)	(0.172)	(0.098)
Diabetes	0.234	-0.060	-0.018	-0.056	0.034	0.208	0.047	-0.196
	(0.221)	(0.309)	(0.028)	(0.273)	(0.031)	(0.183)	(0.036)	(0.180)
Lung	0.290**	0.259*	-0.025	0.139	-0.477***	0.069	0.322**	-0.146
	(0.141)	(0.153)	(0.084)	(0.186)	(0.155)	(0.205)	(0.140)	(0.113)
Cancer	0.055	-0.072	-0.036	0.006	-0.040	-0.111**	-0.011	0.084
	(0.041)	(0.076)	(0.039)	(0.102)	(0.074)	(0.055)	(0.035)	(0.060)
Broken hip	0.356	-0.025	-0.019	-0.222	0.003	0.143	-0.170	-0.154
	(0.263)	(0.247)	(0.023)	(0.156)	(0.285)	(0.157)	(0.159)	(0.155)
Fracture	-0.014	-0.112	0.011	0.065	0.062	-0.127	-0.019	0.067
	(0.123)	(0.134)	(0.042)	(0.097)	(0.082)	(0.122)	(0.116)	(0.075)
Tumor	-0.125	0.232	-0.128	-0.022	-0.002	0.008	-0.063	0.103
	(0.127)	(0.233)	(0.092)	(0.236)	(0.131)	(0.137)	(0.091)	(0.090)
Other	0.008	0.028	-0.069*	-0.049	-0.085	-0.002	0.051	0.057
	(0.047)	(0.064)	(0.040)	(0.070)	(0.054)	(0.049)	(0.055)	(0.045)
Health shock>1	0.326***	0.044	-0.073	-0.288***	-0.126	0.086	-0.024	-0.018
	(0.114)	(0.162)	(0.081)	(0.097)	(0.091)	(0.088)	(0.090)	(0.075)
Age category: Age 15-24								
Age 25-34	0.090	-0.021	0.025	-0.094	0.060	-0.138	-0.251*	0.035
	(0.266)	(0.105)	(0.067)	(0.132)	(0.088)	(0.118)	(0.143)	(0.060)
Age 35-44	-0.040	0.097	0.065	-0.003	0.017	-0.058	-0.253*	0.092
	(0.252)	(0.098)	(0.069)	(0.135)	(0.095)	(0.115)	(0.146)	(0.059)
Age 45-54	0.046	0.117	0.085	-0.066	0.031	-0.042	-0.124	0.019
	(0.251)	(0.104)	(0.065)	(0.130)	(0.094)	(0.111)	(0.144)	(0.061)
Age 55-64	0.008	0.085	0.048	-0.037	0.048	-0.044	-0.203	0.036
	(0.247)	(0.095)	(0.060)	(0.125)	(0.088)	(0.108)	(0.141)	(0.053)

Age 65 or older	0.003	-0.043	0.047	-0.077	0.057	-0.009	-0.155	0.041
	(0.248)	(0.099)	(0.066)	(0.133)	(0.086)	(0.111)	(0.140)	(0.059)
Lagged emotion state	-0.059	-0.031	-0.238***	0.107	-0.094	-0.099	-0.196**	0.060
	(0.098)	(0.140)	(0.075)	(0.130)	(0.095)	(0.103)	(0.099)	(0.085)
No job								
Job	-0.022	0.022	0.022	-0.005	-0.023	0.065	0.040	0.003
	(0.038)	(0.054)	(0.028)	(0.055)	(0.040)	(0.042)	(0.042)	(0.038)
No previous HS								
Previous HS	0.006	0.039	-0.004	-0.077	-0.022	-0.012	-0.010	-0.023
	(0.034)	(0.054)	(0.026)	(0.052)	(0.031)	(0.037)	(0.037)	(0.032)
No spouse								
Spouse	0.066*	-0.021	-0.041	0.014	0.001	0.002	-0.010	0.020
	(0.036)	(0.048)	(0.031)	(0.046)	(0.035)	(0.037)	(0.036)	(0.033)
Expectation 75 year:								
No change								
Mediocre change	0.069	0.059	-0.010	0.024	-0.064	-0.003	-0.073*	-0.009
	(0.054)	(0.068)	(0.043)	(0.061)	(0.045)	(0.051)	(0.044)	(0.044)
Above average	0.037	0.027	-0.013	0.064	-0.053	0.012	-0.022	-0.040
	(0.054)	(0.064)	(0.035)	(0.058)	(0.050)	(0.048)	(0.046)	(0.043)
Absolutely certain	0.035	-0.025	0.040	0.060	-0.092	0.014	-0.068	-0.022
	(0.057)	(0.073)	(0.042)	(0.073)	(0.057)	(0.057)	(0.051)	(0.058)
Subjective Health:								
Bad								
Normal	0.015	-0.035	-0.036	-0.095*	0.003	0.022	0.036	0.005
	(0.041)	(0.057)	(0.030)	(0.054)	(0.042)	(0.042)	(0.041)	(0.034)
Good	0.027	0.010	-0.035	-0.241***	-0.005	-0.008	0.071	-0.013
	(0.061)	(0.084)	(0.044)	(0.085)	(0.060)	(0.063)	(0.064)	(0.047)
Constant	-0.072	-0.019	0.195**	0.085	0.097	0.057	0.305*	-0.073
	(0.251)	(0.139)	(0.081)	(0.148)	(0.107)	(0.122)	(0.155)	(0.069)
Observations	481	805	805	802	801	802	802	802
R-squared	0.127	0.025	0.058	0.030	0.037	0.024	0.044	0.020

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1*

Table 6: Panel data results for the relationship between the change in health behaviours and health shocks grouped by hospitalization shorter than three days.

	(1) Smoking	(2) Alcohol	(3) Substances	(4) Physical Activity	(5) Sleep	(6) Vegetables	(7) Fruit	(8) Diet
No Health shock								
Angina	0.033	0.025	0.050	0.062	-0.021	0.112	0.039	0.116
	(0.073)	(0.197)	(0.102)	(0.149)	(0.098)	(0.147)	(0.104)	(0.077)
Heart	-0.179*	0.081	0.074	-0.234	-0.179*	-0.110	-0.132	-0.008
	(0.095)	(0.182)	(0.126)	(0.144)	(0.098)	(0.105)	(0.107)	(0.020)
Stroke	0.158	0.241	0.143	0.127	0.047**	-0.144	-0.003	0.009
	(0.191)	(0.268)	(0.140)	(0.130)	(0.023)	(0.136)	(0.210)	(0.018)
Diabetes	-0.052	-0.063	0.242	0.210	0.035	-0.264	-0.028	-0.246
	(0.032)	(0.041)	(0.195)	(0.212)	(0.023)	(0.226)	(0.026)	(0.211)
Lung	-0.122	-0.087	-0.030	-0.028	-0.211*	-0.003	-0.195*	0.142
	(0.105)	(0.181)	(0.126)	(0.171)	(0.126)	(0.123)	(0.105)	(0.109)
Cancer	0.108	0.123	-0.084	0.016	-0.014	0.148*	-0.040	0.001
	(0.107)	(0.189)	(0.057)	(0.126)	(0.077)	(0.078)	(0.075)	(0.060)
Broken hip	-0.179**	-0.013	0.009	-0.067	-0.012	-0.209**	0.045	-0.056
	(0.086)	(0.078)	(0.073)	(0.120)	(0.055)	(0.099)	(0.121)	(0.091)
Fracture	-0.051*	-0.011	-0.057	-0.206*	-0.129	0.096	-0.049	-0.066
	(0.027)	(0.142)	(0.054)	(0.124)	(0.094)	(0.109)	(0.056)	(0.099)
Tumor	-0.066*	0.062	-0.053*	0.011	-0.065*	0.032	0.001	-0.029
	(0.039)	(0.052)	(0.027)	(0.053)	(0.038)	(0.038)	(0.046)	(0.032)
Other	0.031	0.038	-0.013	0.009	0.218**	-0.002	0.062	-0.052
	(0.069)	(0.096)	(0.093)	(0.119)	(0.106)	(0.065)	(0.064)	(0.101)
Health shock>1								
Age category:	-0.045	0.005	0.082**	-0.005	0.115**	-0.060	0.019	0.016
Age 15-24	(0.098)	(0.087)	(0.038)	(0.085)	(0.046)	(0.051)	(0.059)	(0.053)
Age 25-34	-0.028	0.051	0.011	0.013	0.062	-0.129**	0.104*	-0.030
	(0.090)	(0.083)	(0.041)	(0.085)	(0.046)	(0.053)	(0.062)	(0.049)
Age 35-44	0.003	0.063	0.043	-0.006	0.027	-0.049	0.061	0.005
	(0.086)	(0.079)	(0.038)	(0.083)	(0.042)	(0.051)	(0.059)	(0.050)
Age 45-54	0.019	0.125	0.033	-0.007	0.031	-0.077	0.097*	-0.028
	(0.085)	(0.076)	(0.037)	(0.078)	(0.041)	(0.049)	(0.057)	(0.047)
Age 55-64	-0.056	0.081	0.056	-0.024	0.004	-0.064	0.047	0.005
	(0.087)	(0.090)	(0.044)	(0.087)	(0.050)	(0.060)	(0.062)	(0.051)
Age 65 or older	0.042	0.007	-0.030	0.109	-0.066	-0.009	-0.040	0.013

	(0.074)	(0.107)	(0.053)	(0.106)	(0.063)	(0.076)	(0.081)	(0.068)
Lagged emotion state								
No job	-0.013	-0.047	-0.009	0.080*	-0.047	0.035	-0.054*	0.016
	(0.032)	(0.043)	(0.019)	(0.047)	(0.029)	(0.027)	(0.031)	(0.027)
Job								
No previous HS	-0.023	0.028	-0.018	-0.039	0.036	-0.008	0.011	-0.036
	(0.028)	(0.036)	(0.016)	(0.037)	(0.023)	(0.024)	(0.028)	(0.022)
Previous HS								
No spouse	0.011	-0.067*	-0.011	0.008	-0.013	-0.014	-0.003	0.007
	(0.028)	(0.037)	(0.019)	(0.038)	(0.022)	(0.025)	(0.027)	(0.022)
Spouse								
Expectation 75 year:	0.037	0.035	-0.083**	-0.001	-0.012	0.003	-0.020	0.012
No change	(0.041)	(0.057)	(0.035)	(0.057)	(0.035)	(0.046)	(0.047)	(0.037)
Mediocre change	-0.032	0.036	-0.074**	0.025	-0.001	0.050	-0.056	-0.023
	(0.039)	(0.056)	(0.033)	(0.057)	(0.034)	(0.044)	(0.047)	(0.035)
Above average	-0.005	0.094	-0.083**	0.017	-0.001	0.017	-0.032	-0.020
	(0.048)	(0.061)	(0.036)	(0.066)	(0.034)	(0.047)	(0.051)	(0.039)
Absolutely certain								
Subjective Health:	0.033	-0.007	0.006	-0.095**	0.027	-0.020	0.006	-0.038
Bad	(0.032)	(0.047)	(0.026)	(0.048)	(0.029)	(0.030)	(0.039)	(0.031)
Normal	0.011	0.018	-0.002	-0.178***	0.062	-0.023	0.020	-0.019
	(0.061)	(0.063)	(0.028)	(0.063)	(0.039)	(0.043)	(0.049)	(0.040)
Good		-0.966***	-0.052**	-0.072	-0.021	-0.058	0.089**	-0.029
		(0.063)	(0.025)	(0.060)	(0.033)	(0.036)	(0.040)	(0.034)
Constant	0.020	-0.027	0.073	-0.028	-0.015	0.061	0.031	0.046
	(0.093)	(0.099)	(0.051)	(0.095)	(0.051)	(0.074)	(0.077)	(0.069)
Observations	742	1316	1316	1315	1308	1314	1314	1314
R-squared	0.037	0.019	0.031	0.015	0.036	0.023	0.014	0.015

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

4.5.0. The placebo model

Table 7 shows the results of the formula: $HB_{i,t+1} - HB_{i,t-1} = \beta_1 HS_{i,t+2} + \beta_2 AgeCategory_{i,t} + \beta_3 Emotion_{i,t-1} + \beta_4 Job_{i,t-1} + \beta_5 PreHS_{i,t-1} + \beta_6 Spouse_i + \beta_7 SurviveAge75_{i,t-1} + \beta_8 SubjectiveHealth_{i,t-1} + Constant.$

The placebo model test the following hypothesis:

"*Is the method of constructing the models a valid strategy?*".

This model is constructed to evaluate if the other models are valid in construction by method. The variable health shock ($HS_{i,t}$) is replaced with the variable health shock that occurs a year later after the health behaviour change ($HB_{i,t+1} - HB_{i,t-1}$) at time *t+2* ($HS_{i,t+2}$). If there is to be found too many significant effects for the health shocks the method used could be invalid. The placebo model found 6 significant levels, whereby 3 are a broken hip. This can be explained by the low number of individuals that experienced a broken hip. The other two findings are for the health shock chronic lung disease and for experiencing a stroke. However compared to the other models these findings are more arbitrary and there is no support for these findings. The arbitrary findings can be because they are false positive due to the large amount of variables used. The eight dependent variables multiplied by eleven independent variables creates 88 different coefficients that can lead to some being significant by chance. With a significant level of 5% the expectation would be to gain four to five of the coefficients being significant. The six significant findings in the placebo model can thus be explained by false positives and low sample size of the broken hip health shock. There is room for improvement with this method but based on the comparison to the other models it seems that the method used is valid.

Table 7: Panel data results for the placebo model whereby health shock is measured at time [t+2].

	(1) Smoking	(2) Alcohol	(3) Substances	(4) Physical Activity	(5) Sleep	(6) Vegetables	(7) Fruit	(8) Diet
Health shock [t+2] No Health shock								
Angina	0.068	-0.045	0.007	-0.064	-0.004	0.035	-0.024	-0.023
	(0.064)	(0.078)	(0.037)	(0.078)	(0.017)	(0.047)	(0.044)	(0.038)
Heart	0.019	-0.004	0.031	-0.017	-0.010	0.016	0.037	-0.036
	(0.042)	(0.064)	(0.038)	(0.065)	(0.056)	(0.054)	(0.043)	(0.037)
Stroke	-0.033***	0.184	-0.045	-0.115	0.017	0.003	-0.039	-0.042
	(0.005)	(0.126)	(0.036)	(0.077)	(0.101)	(0.071)	(0.080)	(0.062)
Diabetes	0.038	-0.034	-0.008	-0.032	0.043	0.003	-0.032	0.006
	(0.052)	(0.055)	(0.019)	(0.062)	(0.046)	(0.039)	(0.055)	(0.049)
Lung	-0.018	0.120*	-0.009	0.121	-0.022	-0.125**	0.051	0.011
	(0.040)	(0.071)	(0.052)	(0.078)	(0.057)	(0.058)	(0.060)	(0.055)
Cancer	-0.010	-0.066	-0.036	-0.022	0.015	0.005	-0.003	-0.050
	(0.037)	(0.049)	(0.027)	(0.057)	(0.033)	(0.039)	(0.033)	(0.036)
Broken hip	0.167	-0.028***	0.122	0.116	0.011*	-0.116	-0.003	-0.010**
	(0.333)	(0.007)	(0.115)	(0.212)	(0.006)	(0.116)	(0.006)	(0.004)
Fracture	0.060	-0.001	-0.015	-0.045	0.028	0.012	0.018	-0.028
	(0.039)	(0.041)	(0.028)	(0.059)	(0.036)	(0.032)	(0.047)	(0.034)
Tumor	0.006	0.061	-0.037	0.021	-0.054	-0.012	0.038	0.022
	(0.056)	(0.056)	(0.035)	(0.061)	(0.042)	(0.038)	(0.032)	(0.035)
Other	-0.006	0.017	0.008	-0.030	0.000	0.006	0.025	-0.021
	(0.021)	(0.022)	(0.011)	(0.024)	(0.017)	(0.016)	(0.017)	(0.014)
Health shock>1	0.043	-0.024	0.003	0.040	-0.016	0.002	-0.048	0.033
	(0.049)	(0.080)	(0.037)	(0.065)	(0.034)	(0.040)	(0.051)	(0.037)
Age category:								
Age 15-24								
Age 25-34	0.068**	0.047**	0.020**	-0.020	0.020*	-0.008	-0.001	0.006
	(0.029)	(0.021)	(0.010)	(0.017)	(0.011)	(0.012)	(0.016)	(0.010)
Age 35-44	0.014	0.048***	0.005	0.029*	0.004	-0.006	-0.007	0.006
	(0.025)	(0.018)	(0.009)	(0.015)	(0.011)	(0.011)	(0.014)	(0.009)
Age 45-54	0.012	0.055***	0.019**	-0.002	0.003	0.000	0.000	0.004
	(0.024)	(0.018)	(0.009)	(0.015)	(0.010)	(0.011)	(0.014)	(0.009)
Age 55-64	0.009	0.074***	0.012	0.018	0.015	-0.012	-0.006	0.013
	(0.024)	(0.017)	(0.009)	(0.014)	(0.010)	(0.010)	(0.013)	(0.008)
Age 65 or older	0.009	0.099***	0.015	0.010	0.013	-0.012	-0.001	0.011

	(0.025)	(0.021)	(0.010)	(0.019)	(0.012)	(0.014)	(0.015)	(0.011)
Lagged emotion state	0.001	0.003	-0.052***	0.012	-0.060***	-0.026	-0.051***	-0.006
	(0.025)	(0.027)	(0.014)	(0.026)	(0.018)	(0.018)	(0.020)	(0.016)
No job								
Job	-0.012	0.020**	0.008*	0.020**	-0.007	0.002	0.002	0.003
	(0.008)	(0.010)	(0.004)	(0.009)	(0.006)	(0.006)	(0.007)	(0.005)
No previous HS								
Previous HS	-0.005	0.001	0.002	-0.007	-0.008	-0.001	0.000	0.000
	(0.008)	(0.009)	(0.004)	(0.008)	(0.006)	(0.006)	(0.006)	(0.005)
No spouse								
Spouse	-0.005	-0.009	-0.006	0.002	0.003	-0.003	0.005	0.012***
	(0.008)	(0.008)	(0.004)	(0.007)	(0.006)	(0.005)	(0.006)	(0.004)
Expectation 75 year:								
No Change								
Mediocre change	-0.011	-0.031*	-0.005	0.006	0.002	-0.007	0.017	-0.015
	(0.013)	(0.016)	(0.009)	(0.016)	(0.010)	(0.013)	(0.013)	(0.009)
Above average	-0.021*	-0.015	-0.007	0.021	0.009	0.003	0.017	-0.022***
	(0.012)	(0.015)	(0.008)	(0.015)	(0.010)	(0.012)	(0.012)	(0.009)
Absolutely certain	-0.028**	-0.018	-0.003	0.025	0.007	-0.006	0.006	-0.019*
	(0.013)	(0.017)	(0.008)	(0.017)	(0.011)	(0.013)	(0.013)	(0.010)
Subjective Health:								
Bad								
Normal	0.013	-0.009	-0.010	-0.022*	0.002	-0.003	-0.004	0.007
	(0.011)	(0.014)	(0.006)	(0.012)	(0.009)	(0.009)	(0.010)	(0.008)
Good	0.010	-0.029*	-0.007	-0.055***	0.007	0.000	0.006	0.006
	(0.014)	(0.016)	(0.007)	(0.015)	(0.010)	(0.011)	(0.012)	(0.009)
Constant	0.048*	-0.029	0.041***	-0.023	0.015	0.028*	0.027	0.003
	(0.029)	(0.026)	(0.014)	(0.023)	(0.017)	(0.016)	(0.020)	(0.014)
Observations	10253	18738	18733	18714	18504	18699	18699	18699
R-squared	0.004	0.004	0.004	0.002	0.002	0.001	0.001	0.001

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1*

4.6.0 The aggregated health behaviour model

Table 8 depicts the results for the main hypothesis:

"*Does aggregated health behaviour change for individuals after experiencing a health shock?*".

These models combines all the health behaviours into an aggregated health behaviour. This means including all the previous discussed health behaviour into one dependent variable $(HB_{i,t+1} - HB_{i,t-1}), with\ HB = (Smoking + Alcohol + Substances + Physical + Sleep + Vegetables + Fruit + Diet)$.

The first aggregated model based on Table 3 shows significance that a broken hip, a benign tumour and other health shocks lead to behaviour change. What stands out is that a lot of power of the model is attributed towards the emotion, adverse health events in the past, *preHS*, and a subjective health status of good as predictors for health behaviours. Those are all negative and indicate that people who are emotional stable do worsen their health behaviour, as they probably already had stable health behaviour to begin with. For the individuals with a *preHS* people will change their health behaviour negatively as their health behaviour is adjusted to their previous experience. Good subjective health the year before the health shock is used as reference point for the wellbeing of individuals and show a negative effect as the status good to good subjective health would not change health behaviour but good to normal or good to bad subjective health will negatively influence health behaviour.

The second aggregated model based on Table 4 shows no significance for hospitalization of three days or longer compared to less than three days. Only hospitalization does not impact average behaviour change and remains the same.

The third aggregated model based on Table 5 shows significance for heart attack, stroke and other health shocks. The coping effect of hospital stay combined with health shocks indicates that the shocks that are received as more severe in experience. The combination of longer hospital stay and immediately impacted health shocks like heart attack and stroke positively impact health behaviour the most. When those requirements are met individuals tend to improve their health behaviour and those behaviour changes can be called wake-up calls.

The fourth aggregated model based on Table 6 shows significance for the health shocks heart attack and chronic lung disease. This is the group that had a hospitalization of less than three days. The effects compared to the other group are negative. Experiencing a heart attack affects the health behaviour negatively and can be due to the fact that they had a shorter hospital stay. The decrease in health behaviour for chronic lung diseases can be caused by the long term effects and the impairments that are associated with the disease.

The last aggregated model based on Table 7 shows no significance for health shocks. This is to be expected as it is the aggregated placebo model. It proofs that the method used to test the hypothesis is supported by empirical evidence.

The hypothesis is true for the positive behaviour changes where the health shock impacts the individual immediately and experiences health shocks more severe. The negative behaviour changes is caused by the limitations that the type of health shock entails and a shorter duration of hospitalization.

Table 8: Panel data results for aggregated health behaviour based on the previously constructed tables and health shocks. Whereby (1) measures the aggregated health behaviour change, (2) the hospitalization, (3) the group of hospitalization at least three days, (4) the group of hospitalization less than three days and (5) the placebo model.

	(1) Aggregated health behaviour	(2) Aggregated health behaivour	(3) Aggregated health behaviour: Hospital stay at least 3 days	(4) Aggregated health behaviour: Hospital stay less than 3 days	(5) Aggregated placebo health behaviour HS [t+2]
No Health shock					
Angina	-0.226		-0.013	0.134	-0.068
	(0.162)		(0.463)	(0.387)	(0.182)
Heart	0.046		0.597**	-0.646***	0.076
	(0.167)		(0.284)	(0.212)	(0.170)
Stroke	0.121		0.993*	0.096	-0.073
	(0.343)		(0.590)	(0.453)	(0.235)
Diabetes	-0.058		0.214	0.052	0.060
	(0.132)		(0.432)	(0.246)	(0.141)
Lung	-0.175		0.551	-0.555**	0.217
	(0.157)		(0.522)	(0.252)	(0.151)
Cancer	0.037		-0.155	-0.128	0.017
	(0.136)		(0.182)	(0.287)	(0.139)
Broken hip	0.949**		0.940		0.217
	(0.464)		(0.662)		(0.405)
Fracture	-0.097		-0.094	-0.274	0.099
	(0.107)		(0.243)	(0.255)	(0.144)
Tumor	-0.265**		-0.597	-0.340	0.078
	(0.130)		(0.412)	(0.428)	(0.144)

Other	-0.101**		-0.397**	-0.120	-0.004
	(0.048)		(0.199)	(0.153)	(0.063)
Health shock>1	0.108		0.008	0.303	0.013
	(0.142)		(0.304)	(0.291)	(0.147)
Age category:					
Age 15-24					
Age 25-34	0.038	0.243	0.256	0.129	0.021
	(0.073)	(0.238)	(0.478)	(0.289)	(0.082)
Age 35-44	-0.008	0.156	0.280	0.017	0.038
	(0.065)	(0.231)	(0.450)	(0.280)	(0.073)
Age 45-54	0.007	0.220	0.344	0.149	0.014
	(0.062)	(0.222)	(0.443)	(0.262)	(0.070)
Age 55-64	0.045	0.296	0.327	0.208	0.044
	(0.060)	(0.218)	(0.423)	(0.259)	(0.069)
Age 65 or older	0.047	0.180	0.339	0.070	0.041
	(0.066)	(0.229)	(0.437)	(0.272)	(0.075)
Lagged emotion state	-0.283***	-0.334	-0.871**	-0.002	-0.239***
	(0.071)	(0.245)	(0.394)	(0.309)	(0.077)
No job					
Job	0.001	-0.048	-0.038	-0.079	0.017
	(0.024)	(0.080)	(0.141)	(0.104)	(0.026)
No previous HS					
Previous HS	-0.059***	-0.117	-0.095	-0.088	-0.053**
	(0.022)	(0.073)	(0.132)	(0.097)	(0.024)
No spouse					
Spouse	-0.007	-0.062	0.029	-0.075	-0.021
	(0.021)	(0.076)	(0.134)	(0.100)	(0.023)
Expectation 75 year:					
No change					
Mediocre change	-0.029	0.020	0.009	-0.069	-0.064
	(0.041)	(0.110)	(0.199)	(0.130)	(0.043)
Above average	-0.004	0.059	0.077	-0.022	-0.018
	(0.038)	(0.107)	(0.191)	(0.135)	(0.041)
Absolutely certain	-0.045	0.037	0.002	-0.057	-0.054
	(0.042)	(0.124)	(0.225)	(0.157)	(0.046)
Subjective Health:					
Bad					
Normal	-0.040	-0.103	-0.050	-0.080	-0.056
	(0.032)	(0.088)	(0.159)	(0.118)	(0.034)
Good	-0.081**	-0.262**	-0.060	-0.286	-0.100**
	(0.039)	(0.130)	(0.229)	(0.176)	(0.043)
Hospital stay less than 3 days					
Hospital stay at least 3 days		0.105			
		(0.068)			
Constant	0.328***	0.260	0.509	0.237	0.303***
	(0.078)	(0.250)	(0.469)	(0.290)	(0.086)
Observations	12084	1268	476	734	10091
R-squared	0.005	0.014	0.059	0.025	0.004

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

5.0.0. Discussion:

The method used to construct the models to answer the main hypothesis; "*Does aggregated health behaviour change for individuals after experiencing a health shock?*", is to take the difference $(HB_{t+1} - HB_{t-1})$ with a reference point (HB_{t-1}) to look at behaviour change. There are certainly other methods that could be used like the ordered logistic model for ordinal variable and the logistic model for dichotomous variables. These could give insight about the magnitude of the increase or decrease in percentage points towards changing health behaviour. For this method is not chosen as the main goal of this study is to construct an aggregated model for health behaviour that gives insight to how people react after a health shock. It is also noted that some of the standard errors are rather large. This is one of the consequences of the inclusion of multiple ordinal control variables. This is a disadvantage as it makes the evaluation of the magnitude for the coefficients rather difficult. Another reason why the magnitude is difficult to evaluate is because of the transformation done towards the ordinal behaviour variables. They are transformed to (-1), (0) or (1), but in reality some of them can be less than (-1) or more than (1). The aggregation of all the stand-alone behaviours need to weighted equally per behaviour and thus the change for the ordinal variables are constructed in this manner. The model evaluates if the behaviour change is overall positive and negative. This study is done to give an overview for causality of health shocks towards health behaviour change instead of exploring the percentage points increase or decrease towards a behaviour. Therefor the difference model is chosen over the logistic regressions methods.

Follow-up studies could use these findings to further test these effects. One method is to evaluate the behaviour via Cronbach's Alpha that focus on all the underlying variables of a given behaviour in more detail. For example by the construction of the variable alcohol consumption there is only one question out of the questionnaire used in the model, but with the use of Cronbach's Alpha a more accurate representation of alcohol consumption could be constructed. For this questionnaire all the questions about alcohol would be examined and tested for how useful they are to represent alcohol behaviour.

Emotional variable uses the equal space method to create an interval [0,1] for underlying emotional determining variables. For skewed ordinal variables the lognormal distribution would be preferred and this could be beneficial to reduce bias (Chen & Wang, 2014).

The health shock broken hip or thigh bone is short of observation which results in inaccurate prediction as seen in the placebo model. Same could be argued for the health shock of experiencing a stroke. How further in the future the model extrapolates how more observations are lost. The placebo model test health shocks at time HS_{t+2} with the dependent variable still being $(HB_{t+1} - HB_{t-1})$, this means that the time period of the model increases from a three year period to a four year period. This is problematic as it reduces the amount of observations, because not all participating individuals filled in the questionnaire for all available years. Thus there are more people that follow-up in filling in the questionnaire for three years after each other than for four years, etc. This lead to biased results as low observations do not sketch a clear image for the actual population and give high standard errors, which is certainly the case for the health shock a broken hip. However the aggregated placebo behaviour model shows that none of the health shocks are significant and supports the method used to construct these models.

Biases about the variables are already discussed in Chapter 3 and can be beneficial for the construction of new questionnaires and follow-up studies regarding health behaviour. Another impairment is that the questions asked in the questionnaire can be differently interpreted and be confusing to some of the participants. This can result in measurement bias, although inaccurate answers like having a weight of 1000 or larger kilograms are removed. For continuous variables it was easier to fish out the outliers but for ordinal variables it remains the question how accurately every participant answered the question. A solution to improve questions is to use the method of Item Response Theory with the support of computer adaptive tests. A computer adaptive test is that the questions asked about topics are individualised by evaluating past given answers towards a particular topic to gain the most accurate answers. The item response theory uses the questions to elicit values of the underlying topic, which in this study would be to better define health behaviour (Reeve & Fayers, 2005).

6.0.0. Conclusion:

The models give a clear overview for causality between the health shocks and the health behaviours. The model that haves the most explanatory power based on results and the underlying theoretical literature are the models whereby the individuals are split in two groups, the first group that have a hospitalization of under three days and the second group where the hospitalization is at least three days. The answer on the research question is that there are causalities between health shocks and their health behaviour related components. The combination of severity and type of health shock predicts the most change in health behaviour, which is related to the type of health shock received. Another finding is that the impact of health shocks can influence health behaviour not positively but also negatively. The acquiring of a health shock can limit the individual's health behaviour especially if the consequences of the shock are long lasting. This is certainly more the case for the behaviours sleep and physical behaviour. The health shock chronic lung disease shows an overall negative impact on the health behaviour for individuals.

The behaviour substances abuse results in different findings than the other behaviours as age category, emotional state and the longitude of hospital stay influences this behaviour. An explanation for this behaviour change can be that younger people are more risk seeking and can lead to more substance abuse for that age category (Decker & Schmitz, 2016). The hospitalization can be seen as the wake-up call that leads to improvement of the behaviour substance abuse. For smoking the severity of the health shock and the type of health shock heavenly influences the behaviour. The transparency of the consequences for smoking are well known under the population and the more severe the health shock is the more incentives it gives people to change their smoking behaviour (Smith, Taylor Jr, Sloan, Johnson, & Desvousges, 2001), (Falba, 2005), (Clark & Etilé, 2006). This coincide with the perceived beliefs of individuals that smoking deteriorate health and could lead to chronic lung diseases, strokes and heart attacks (Conner, 2015). The same can be said for the risks of substance abuse and this validates the concepts of the Health Belief Model (Janz & Becker, 1984).

The aggregated health behaviour model shows that the severity for heart attack and stroke influence the health behaviour of the individual. People that stayed at least three days in the hospital and received a stroke or heart attack change their behaviour positively while for the other group it decreases. For the group that have a shorter hospital stay the health behaviour change is negative and the lagged emotional state does not influence the aggregated behaviour change. People with a better emotional state decreases the health behaviour as a good emotional state correlates with good health behaviour. When the variable emotional change is included the results supports this, discussed in Appendix A. The aggregated model of emotional change validate that there is a link between emotion and health behaviour. These findings are corresponding with earlier literature that give empirical evidence of the relation between the mental health or emotional state that influence health behaviour (Ferrer & Mendes, 2018).

The conclusion is that the short term changes of health behaviour are influenced by severity, emotional state, emotional change and the type of health shock. Policy makers should focus on giving transparency and insight to the public of how poor health behaviour could result in specific dismal health states to improve their perceived values about health behaviour. When a health shock would occur health institutions should provide long term support to monitor the health behaviour of individuals afterwards. The policy recommendation is in line with other findings as the immediate effect after a health shock incentives people to change their behaviour but on the long term they return back to their initial behaviour pattern (Boudreaux, Bock, & O'Hea, 2012). The recommendation could result in individuals putting in more effort in their health behaviour and on average eventually lead to an improvement of human capital and a reduction of chronic diseases.

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Appendix A: Emotional change

To evaluate the change in emotion on health behaviour the formula $HB_{i,t+1} - HB_{i,t-1} = \beta_1(Emotional_{i,t+1} - Emotional_{i,t-1}) + \beta_2 AgeCategory_{i,t} + \beta_3 Job_{i,t-1} + \beta_4 PreHS_{i,t-1} + \beta_5 Spouse_i + \beta_6 SurviveAge75_{i,t-1} + \beta_7 SubjectiveHealth_{i,t-1} + Constant.$

This model is constructed to answer the hypothesis about mental health:

"What is the effect of a change in emotional state on health behaviour?".

The interpretation of the coefficient of change in emotion, Table 9, is that when the emotional state at $Emotional_{i,t+1}$ is worse than the previous emotional state at $Emotional_{i,t-1}$ then the change in emotional state is negative. This value $(Emotional_{i,t+1} - Emotional_{i,t-1})$ multiplied by the coefficient β_1 of change in emotional state results in a decrease of health behaviour when the coefficient is positive. If the emotional state increases over time then the individual improves its health behaviour for the variables: substances use, physical activity, sleep, vegetables and fruit. These are all significant on the 1% significant level. These results support the hypothesis and there is an effect on the health behaviour by the change in emotional state. There is the possibility of reverse causality as a change in health behaviour can lead to a change in emotional state.

Emotional change model given the experience of a health shock

To test whether people change their health behaviour due to a change in emotional state while also having experienced a health shock. The people that experienced a health shock gets separated from the people that did not.

"Do people change their health behaviour when they have experienced a health shock and change their emotional state?".

The formula used to answer the hypothesis is $HB_{i,t+1} - HB_{i,t-1} = \beta_1(Emotional_{i,t+1} - Emotional_{i,t-1}) + \beta_2 AgeCategory_{i,t} + \beta_3 Job_{i,t-1} + \beta_4 PreHS_{i,t-1} + \beta_5 Spouse_i + \beta_6 SurviveAge75_{i,t-1} + \beta_7 SubjectiveHealth_{i,t-1} + Constant, if\ HS > 1.$

This hypothesis solves the problem of reverse causality too, because the change in emotional state can now be linked to the experience of a health shock. The result of Table 10 is that people who experienced a health shock and positively change their emotional state significantly improve their health behaviour of substance use and sleep. Compared to Table 9 there are now less behaviour changes caused by a change in emotion. The variables physical activity, vegetables and fruit consumption are not significant anymore. There is definitely a correlation between emotion and health behaviour, but when people experienced a health shock the change in certain health behaviour due to a change in emotional state is less prevalent.

Aggregated health behaviour model based on emotional change

The aggregated behaviour change due to a change in emotional state is present for the three models. The group that experienced no health shock is included in Table 11 to compare them with the group that did. For all three models emotional change causes aggregated behaviour change. For the whole questionnaire population and the group that experienced no health shock the control variables good subjective health and previous health shock are of significance compared to the group that did experienced a health shock. The significance of emotional change on people that have had a health shock at time *t* supports that emotional change still impacts the overall health behaviour. A better emotional state improves the health behaviour after the health shock and the reverse is true that a worsened mental health results in a negative behaviour change. It also supports the theory that change of emotional can lead to health behaviour improvements or deteriorations (Pandey & Choubey, 2010), (Ferrer & Mendes, 2018).

Table 9: Panel data results for the relationship between the change in health behaviour and change in emotional state.

	(1) Smoking	(2) Alcohol	(3) Substances	(4) Physical Activity	(5) Sleep	(6) Vegetables	(7) Fruit	(8) Diet
Emotional change	-0.026	-0.007	0.122***	0.086***	0.311***	0.053***	0.077***	-0.020
	(0.024)	(0.026)	(0.016)	(0.029)	(0.019)	(0.020)	(0.021)	(0.017)
Age category:								
Age 15-24								
Age 25-34	0.060**	0.060***	0.012	-0.010	0.025***	-0.009	-0.006	0.011
	(0.026)	(0.017)	(0.009)	(0.014)	(0.010)	(0.010)	(0.013)	(0.008)
Age 35-44	0.010	0.055***	0.001	0.029**	-0.000	-0.007	-0.015	0.009
	(0.022)	(0.015)	(0.008)	(0.013)	(0.009)	(0.009)	(0.012)	(0.008)
Age 45-54	0.009	0.065***	0.011	0.010	-0.005	-0.002	-0.008	0.005
	(0.021)	(0.015)	(0.008)	(0.013)	(0.009)	(0.009)	(0.011)	(0.007)
Age 55-64	0.010	0.087***	0.005	0.026**	0.008	-0.011	-0.012	0.013*
	(0.021)	(0.014)	(0.007)	(0.012)	(0.008)	(0.009)	(0.011)	(0.007)
Age 65 or older	0.005	0.109***	0.009	0.011	0.011	-0.020*	-0.008	0.017*
	(0.022)	(0.018)	(0.008)	(0.016)	(0.010)	(0.012)	(0.013)	(0.010)
No job								
Job	-0.013*	0.018**	0.005	0.015*	-0.007	-0.002	0.001	0.008
	(0.007)	(0.009)	(0.004)	(0.008)	(0.005)	(0.005)	(0.006)	(0.005)
No previous HS								
Previous HS	-0.004	-0.002	-0.005	-0.013*	-0.005	-0.003	-0.001	0.006
	(0.007)	(0.008)	(0.003)	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)
No spouse								
Spouse	-0.012*	-0.014*	-0.006*	0.003	0.001	-0.003	-0.002	0.006
	(0.007)	(0.007)	(0.003)	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)
Expectation 75 year:								
No change								
Mediocre change	-0.009	-0.020	-0.013*	0.006	0.006	-0.018	0.016	-0.014*
	(0.012)	(0.015)	(0.008)	(0.015)	(0.009)	(0.011)	(0.011)	(0.008)
Above average	-0.021*	-0.018	-0.016**	0.015	0.009	-0.006	0.009	-0.021***
	(0.011)	(0.014)	(0.007)	(0.014)	(0.009)	(0.010)	(0.011)	(0.007)
Absolutely certain	-0.026**	-0.020	-0.014*	0.021	0.008	-0.019*	-0.001	-0.016*
	(0.012)	(0.015)	(0.008)	(0.015)	(0.009)	(0.011)	(0.012)	(0.008)
Subjective Health:								
Bad								

Normal	0.020**	-0.012	-0.015***	-0.017	0.004	-0.006	-0.004	0.011
	(0.009)	(0.011)	(0.006)	(0.010)	(0.008)	(0.008)	(0.009)	(0.007)
Good	0.016	-0.024*	-0.017***	-0.043***	0.013	-0.006	-0.001	0.012
	(0.011)	(0.013)	(0.006)	(0.012)	(0.008)	(0.009)	(0.010)	(0.008)
Constant	0.052**	-0.029	0.024**	-0.021	-0.029**	0.029**	0.008	-0.011
	(0.023)	(0.019)	(0.011)	(0.017)	(0.012)	(0.013)	(0.015)	(0.010)
Observations	13030	24320	24314	24276	24018	24253	24253	24253
R-squared	0.003	0.004	0.008	0.002	0.023	0.001	0.001	0.001

Standard errors are in parenthesis

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

Table 10: Panel data results for the relationship between the change in health behaviour and change in emotional state for the group that experienced a health shock.

	(1) Smoking	(2) Alcohol	(3) Substances	(4) Physical Activity	(5) Sleep	(6) Vegetables	(7) Fruit	(8) Diet
Emotional change	-0.040	-0.011	0.131***	0.112	0.321***	0.071	-0.020	0.002
	(0.053)	(0.063)	(0.042)	(0.070)	(0.056)	(0.048)	(0.050)	(0.040)
Age category:								
Age 15-24								
Age 25-34	-0.112	0.104*	0.065**	0.013	0.035	-0.081**	0.017	0.045
	(0.081)	(0.060)	(0.029)	(0.052)	(0.040)	(0.036)	(0.044)	(0.032)
Age 35-44	-0.087	0.073	0.050**	-0.005	-0.012	-0.050	0.008	0.040
	(0.075)	(0.051)	(0.025)	(0.046)	(0.036)	(0.035)	(0.039)	(0.029)
Age 45-54	-0.071	0.081*	0.062**	0.024	-0.028	-0.049	0.018	0.027
	(0.073)	(0.049)	(0.025)	(0.044)	(0.035)	(0.034)	(0.038)	(0.028)
Age 55-64	-0.067	0.132***	0.036	0.014	-0.018	-0.066**	0.005	0.023
	(0.071)	(0.047)	(0.023)	(0.040)	(0.033)	(0.032)	(0.036)	(0.027)
Age 65 or older	-0.043	0.153***	0.045*	0.038	0.001	-0.068*	0.043	0.004
	(0.073)	(0.056)	(0.025)	(0.049)	(0.038)	(0.039)	(0.040)	(0.030)
No job								
Job	0.047**	0.015	-0.017	0.011	-0.012	0.013	0.010	-0.018
	(0.022)	(0.027)	(0.012)	(0.028)	(0.020)	(0.018)	(0.019)	(0.016)
No previous HS								
Previous HS	-0.034**	0.018	-0.002	0.006	-0.004	-0.001	-0.000	0.009
	(0.016)	(0.024)	(0.011)	(0.023)	(0.017)	(0.015)	(0.017)	(0.014)
No spouse								
Spouse	-0.013	-0.022	-0.018	-0.013	-0.017	0.001	0.029	-0.002
	(0.019)	(0.026)	(0.012)	(0.023)	(0.018)	(0.015)	(0.019)	(0.014)
Expectation 75 year:								
No change								
Mediocre change	-0.063*	-0.040	-0.004	-0.027	0.014	-0.057*	0.017	-0.057**
	(0.035)	(0.045)	(0.028)	(0.042)	(0.032)	(0.030)	(0.033)	(0.026)
Above average	-0.067*	-0.046	-0.014	-0.023	0.030	-0.038	-0.006	-0.060**
	(0.034)	(0.046)	(0.027)	(0.041)	(0.031)	(0.028)	(0.032)	(0.025)
Absolutely certain	-0.069*	-0.012	-0.013	-0.008	0.015	-0.057*	0.008	-0.052*
	(0.039)	(0.051)	(0.028)	(0.046)	(0.034)	(0.032)	(0.035)	(0.029)
Subjective Health:								

Bad								
Normal	0.007	0.042	-0.038**	0.032	0.007	0.015	-0.040*	0.031*
	(0.024)	(0.034)	(0.017)	(0.030)	(0.023)	(0.021)	(0.024)	(0.018)
Good	-0.014	0.041	-0.019	-0.022	-0.000	0.010	-0.055*	0.048**
	(0.031)	(0.040)	(0.018)	(0.037)	(0.027)	(0.026)	(0.029)	(0.022)
Constant	0.155**	-0.082	0.021	-0.030	-0.023	0.072*	-0.024	0.018
	(0.077)	(0.062)	(0.038)	(0.053)	(0.042)	(0.041)	(0.045)	(0.035)
Observations	1836	3046	3045	3040	2917	3034	3034	3034
R-squared	0.010	0.007	0.015	0.003	0.020	0.005	0.004	0.004

Standard errors are in parenthesis

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

Table 11: Panel data results for the relationship between the change in health behaviour and change in emotional state for the whole questionnaire population, the group that experienced a health shock and the group that experienced no health shock.

	(1) Aggregated behaviour	(2) Aggregated behaviour: Health shock	(3) Aggregated behaviour: No health shock
Emotional change	0.772***	0.563***	0.806***
	(0.079)	(0.175)	(0.085)
Age category:			
Age 15-24			
Age 25-34	0.034	0.031	0.032
	(0.071)	(0.228)	(0.075)
Age 35-44	-0.022	-0.042	-0.020
	(0.063)	(0.203)	(0.067)
Age 45-54	-0.022	0.017	-0.029
	(0.060)	(0.196)	(0.064)
Age 55-64	0.009	-0.007	0.015
	(0.059)	(0.190)	(0.063)
Age 65 or older	0.010	0.110	-0.003
	(0.064)	(0.197)	(0.068)
No job			
Job	0.006	0.033	0.005
	(0.023)	(0.070)	(0.025)
No previous HS			
Previous HS	-0.054***	-0.014	-0.064***
	(0.021)	(0.059)	(0.022)
No spouse			
Spouse	-0.017	-0.075	-0.009
	(0.021)	(0.065)	(0.022)
Expectation 75 year:			
No change			
Mediocre change	-0.066*	-0.184*	-0.040
	(0.039)	(0.111)	(0.042)
Above average	-0.056	-0.189*	-0.031
	(0.037)	(0.111)	(0.039)
Absolutely certain	-0.091**	-0.147	-0.077*
	(0.041)	(0.124)	(0.044)
Subjective Health:			
Bad			
Normal	-0.045	-0.058	-0.051
	(0.030)	(0.077)	(0.033)
Good	-0.103***	-0.150	-0.106***
	(0.036)	(0.097)	(0.039)
Constant	0.178***	0.236	0.170**
	(0.068)	(0.210)	(0.072)
Observations	12817	1755	10993
R-squared	0.014	0.013	0.015

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1*