The Obesity Epidemic: Its effects on the present and future Dutch health.

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July, 2009
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“Prediction is very difficult, especially about the future”

Niels Bohr (Lopez et al., 2006; 404)

Acknowledgements

This thesis in front of you would not have has its present shape without the help and support of a number of people. Firstly I would like to thank my supervisor Dr. Fanny Janssen for all her time, comments, assistance and critiques. These have all helped to further develop my thesis and myself. Further I would like to thank Prof. Dr. Inge Hutter for her comments on my research proposal during the classes of research process. Besides that I appreciate the comments of my fellow students during the same classes on my research very much. Lastly I would also like to thank my family for their support, time and assistance.

Abstract

In today’s world diseases that will not cause death directly but influence the health status of a population are increasing. Obesity is one of those diseases. This disease has grown fast in many countries and has become more and more a worldwide issue in recent years. Moreover in some cases it is already referred to as the obesity epidemic, thus it is a serious problem which needs attention. Mostly obesity is caused by a disparity between the input of energy (e.g. calories) and the output (e.g. physical activity). Another cause could be a disparity between our biology and our current environment. Over consumption is promoted in our society and physical activity is cut out of our daily routine. Thus our nutrition and our environment are important aspects, which are also point of consideration for the government. Many programs to counter the obesity epidemic are in place, though making people choose different foods and change their behaviour takes quite a lot of time. Therefore no real change in the increasing trend has been seen yet.

The focus in this research is on the Netherlands where the obesity prevalence has been increasing for quite some time. In 2008 11 per cent of the total adult population was obese, 9.9 per cent of the adult males and 12.1 per cent of the adult females were obese. Looking at different age groups provides large differences in prevalence in 2008, 3.6 percent of all the 25-34 year old males were obese which is the lowest percentage, the highest percentage is recorded in the 65-74 age group with 15.3. For the females the lowest percentage is 6.8 in the 18-24 age group, within the 65-74 age group the highest percentage of 19.3 is recorded.

With a quantitative research and with the use of secondary data, it is the aim to find out how the present Dutch Obesity Adjusted Life Expectancy (OALE) is influenced by this obesity epidemic and how this will develop in the future. It will thus also be an explorative study.

Using the self reported obesity prevalence data of the CBS the past and present situation is illustrated. This prevalence data is in turn used in the Sullivan method to look at the effect on the Obesity Adjusted Life Expectancy. For this data on the number of population and the number of deaths is needed too, which is derived from the CBS. The effects are looked into for seven age groups for both sexes.

For the prospective aspect of this research several scenarios are developed for the obesity prevalence. The five selected scenarios are power trend, linear trend, exponential trend, stable prevalence and decline of prevalence, of which the first three scenarios are trend projections and the latter are other possible future developments. The future development of the obesity prevalence will be made until 2015. Future obesity prevalence’s per age group and sex are used as input for the Sullivan method to look at the effects of all the scenarios on the Obesity Adjusted Life Expectancy. The future number of population and deaths which are needed are derived from prognosis of the CBS.

Of all the scenarios, the trend based scenarios generally indicate a continuation of the increase in prevalence up to 2015. The obesity prevalence proportionally increases the most within the younger age groups. When the influence on the health status is considered the females suffer the most, their OALE will decline by 2015. The OALE of the males increases despite the increase in prevalence. Only the stable and decline scenario show increases in the OALE for both sexes, though the males proportionally gain more than the females in both scenarios. Overall though the OALE of the females remains higher than that of the males.

This research thus indicates that an increase in prevalence does affect the health of the females negatively and that of the males not. For the OALE of the females to improve a stabilisation of the obesity prevalence or a decline in the prevalence is needed, though this is very hard to achieve. Despite the fact that today there are many policies and programs in place to counter the obesity trend, our present society makes it easy to avoid physical activity and to obtain unhealthy food. This contradiction is where we face a challenge.

Keywords: Obesity prevalence, Obesity Adjusted Life Expectancy, Projection, Scenarios,
The Netherlands

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1. Introduction

1.1 Introduction

The world population is getting older and older. For several generations now the life expectancy is growing. In Europe (EU-25) the average life expectancy for men in 2006 was 76.3 years and for women it was 82.4 years (Eurostat, 2009). The fact that we live longer is linked, among others, to the epidemiologic transition. Which is in general about the movement of countries through multiple stages from death due to pestilence and famine (stage 1) to death due to degenerative and man-made diseases (stage 4) (Omran, 1998). Within the stages of this transition the life expectancy grew from 20-30 years to where Western Europe is now, around 80 years. In the fourth stage, in which most of Western Europe is now, there is a decline in mortality of several diseases, such as cardiovascular diseases. This is mostly due to the medical breakthroughs (e.g. early diagnosis and treatments) and lifestyle changes (e.g. smoking and diets) (Omran, 1998).

Combining the two changes in the population, longer life and fewer deaths and diseases, should theoretically lead to a longer healthy life. However there are diseases that will not cause death, but will affect the health status. This can be measured by looking at the effect of the disease on the number of years a person can expect to live in good health, so life without suffering from a disease (van Baal et al., 2006).

A condition which is an example of a condition that will not cause death directly, but affects the health status and is becoming more and more of a problem is obesity. Furthermore, the number of years lived in good health will be affected by obesity. There can be a discussion on whether obesity is a disease or a risk factor, though since last year a new multidisciplinary guideline has come about in which many medical practitioners have decided that obesity is a chronic disease (Pronk, 2008). The fact remains though that more and more people become obese. Not only in the western societies, but all over the world the number of obese people is rising (Dagevos, 2007). According to WHO as cited by Dagevos (2007) there are 1.6 billion adults worldwide who are overweight, four hundred million of them are obese.

Looking at the United States’ obesity levels of 2005 in the age group 15 to 100, 36.5 per cent of the males and 41.8 per cent of the females were obese. Estimations for 2015 for both sexes indicate an increase to percentages exceeding 50 per cent (WHO, 2008). A slightly lower percentage is indicated by the OECD (2008) which indicates that on average 34.3 per cent of the whole United States population was obese in 2006. Either way, too many people suffer from obesity. Not just in the United States, also in Europe the number of people suffering from obesity is rising. In the Netherlands the percentages have grown from four per cent in 1981 to ten per cent in 2004 for Dutch males. For Dutch females the consecutive percentages are six and twelve (Veerman et al., 2007). The percentage of obese children has doubled or even tripled in this same period (Schokker et al., 2006). Within the older population the percentage is increasing as well (Arterburn et al., 2004). When recent figures of individual age groups are taken into account, even higher prevalence’s than the national average are recorded. Percentages as high as 15.7 (55-65 males in 2002) or even 19.5 (65-75 females in 2005) are recorded (CBS, 2009g). According to the WHO (2008) the Netherlands has a quite high percentage of obese people. Compared to other western European countries there are a few, like Germany and the United Kingdom, which have higher percentages.

Overweight and obesity have not become a problem overnight in the Netherlands, both have a longer history. The Heath Council of the Netherlands, already indicated a doubling in too heavy eight year olds in the late 1960s. Though at that point there was no talk of an obesity epidemic yet. More data on overweight and obesity, within children and adults, has only

become available since the 1980s. Since this decade the data indicates a worrying growth of overweight and obesity in the Netherlands (Gezondheidsraad, 2003).
The rising obesity prevalence is a growing concern. Not only for the society (e.g. medical costs and obesity prevention), but especially for the obese themselves. Being obese has many negative effects, not just physically but also mentally. Obese people often live a shorter life due to bad health and have a higher chance on developing various conditions and diseases. The overweight problem is an expensive problem too, annually €1.5 billion is spend on illnesses related to overweight problems. The expectation is these costs will only rise in the future (Ministry of VWS, 2009a).
Obesity has a huge influence on many terrains in the Netherlands especially on the health of the individuals themselves, but also on society. Having an indication of what the future might bring can be very helpful for the government to see whether they are on the right track with obesity prevention or whether more action needs to be taken. Besides that the effect on the general health of the people is an important aspect. Within this research projections for the percentage obese will be given which in turn will be used to look at the effect on the health status. Projections on the percentage obese have been made by multiple researchers, though projecting the effect of obesity on the health status is a new aspect which can indicate how big the effect of obesity is on the population now and in the future.

1.2 Objective and Research question

In this research it is the objective to find out how the present Dutch Obesity Adjusted Life Expectancy (OALE) is influenced by the obesity epidemic and how this will develop in the future. With this it is the aim to project the future obesity prevalence in order to find out the influence on the Dutch health.

These aims have led to the formulation of the following research question:

- To what extend does the obesity epidemic have an effect on the present and future Obesity Adjusted Life Expectancy in the Netherlands?

In order to answer the research question six sub questions have been formulated:

- Does the obesity epidemic have a different effect on the percentage obese per age and sex?
- Does the obesity epidemic have a different effect on the Obesity Adjusted Life Expectancy per age and sex?
- Which obesity projection methods can be applied to the Dutch obesity prevalence data to look at the future effect?
- What will be the most likely scenario to look at the effect on the future percentage obese per age and sex?
- What alternative scenarios exist to look at the effect on the future percentage obese per age and sex?
- What will be the effect of the obesity epidemic on the future Obesity Adjusted Life Expectancy per age, sex and scenario?

1.3 Structure

This paper will continue with a closer look at the theoretical framework in chapter 2. In this chapter all the theories that are related to this research are discussed, which is followed by a literature review. These two aspects come together in the conceptual model which is illustrated next. With this conceptual model the concepts used are also explained.
Chapter 3 continues with the data and methods of this research. The chapter will start with an illustration of what this research entails in the study design, which is followed by the operationalisation of this research. Further the data used for the present and future obesity prevalence trend is discussed, which is followed by an elaboration on methods which measure the effect on health. Next the secondary data used for the number of population and deaths is explained. Subsequently a series of existing projection methods of obesity and diseases is discussed. Lastly the selected projection scenarios are elaborated on.
The results of this research are discussed in chapter 4, in which the present and past situation of the obesity prevalence and the Obesity Adjusted Life Expectancy are illustrated first. This is followed by the future obesity prevalence of firstly the most likely scenario followed by the alternative scenarios. A comparison of all scenarios follows. Next the effects of these future prevalence’s on the Obesity Adjusted Life Expectancy are shown, first the most likely scenario followed by the alternatives. Again a comparison of all scenarios follows
Lastly is chapter 5 in which a discussion is provided, including a conclusion, a reflection on data and previous research and implications and further research.

2. Theoretical Framework

With the theories discussed in this chapter the framework surrounding this research will be explained. In section 2.1 the overall theories that apply to this research are discussed, which is followed by the literature review. This section provides some background information on the obesity epidemic; which factors play a part. Besides that an impression is given of which research has been conducted on this subject. The combination of the first two sections has led to a conceptual model which is elucidated in section 2.3. Lastly, in section 2.4, the main concepts used in the conceptual model and theory will be explained.

2.1 Theories

There are four main approaches that relate to this research. All theories are more or less interconnected with each other, they all include a sense of time and context. Besides that the first two approaches are concerned with the population and individual level, the latter two are more concerned with the population level though they are influenced by the individual level. This is also the case with the obesity epidemic which is measured at the population level with percentages, though behind this there are the individuals who make up the population.

2.2.1 Coleman’s model

The first model that relates to this research is Coleman’s model of 1990. This model indicates that a social outcome at the macro level can be explained through choices and behaviour of individuals at the micro level. Thus a social phenomenon not only takes place at the macro level, but is influenced by the acts of individuals on the micro level (Coleman, 1990). This applies for obesity as well. The number of people who suffer from obesity is measured at the macro level, which is the main concern of this research. Though how obesity comes about and the increasing number of obese people is also influenced by choices and behaviour of the people at the micro level. Hence the macro and micro level work together to produce an outcome at the macro level, called the social outcome. In the case of this research, the obesity prevalence and the Obesity Adjusted Life Expectancy are the social outcome.

2.2.2 Process-context approach

Another approach that nicely connects to this research is the process-context approach, which also relates to the population level and individual level (Hutter, 2008). In this approach the process is the act that is going on at the micro or individual level, so the behaviour of the people. Like fertility, health and migration, i.e. decision making. This relates to obesity, in the way that people can make choices to be more physically active or not and/or to eat more or less healthy food. The context relates to the place or country people live and the economic, social, cultural, political and historical circumstances in that area. This influences the choices and behaviour that people show. In this approach time is also taken into account, i.e. how it all changes over time. This nicely relates to the future aspect in this research.

2.2.3 Epidemiologic transition

Lastly the epidemiologic transition fits well into this research. This transition is about health and disease and their determinants and consequences in population groups. Involved, among others, are science, society, economics, demography, technology and environmental changes, because they relate to health outcomes (Omran, 1998). In relation to the other approaches

mentioned above, the involved aspects here are also at the macro level and a context in which this transition has taken place. Though the transition is visible at the macro level the micro level is involved in a way that the individuals act a specific way to make this transition happen.
In the epidemiologic transition there are multiple stages for different parts of the world. Most useful for this research are the five stages in the western transition model (Omran, 1998: 102):

“First stage	Age of pestilence and famine,
Second stage	Age of receding pandemics,
Third stage	Age of degenerative, stress, and man-made diseases,
Fourth stage	Age of declining cardiovascular mortality, aging, lifestyle modification, emergent and resurgent diseases,
Fifth stage (futuristic)	Age of aspired quality of life, with paradoxical longevity and persistent inequities.”

The stage which is of most importance in this research is the fourth stage; ‘Age of declining cardiovascular mortality, aging, lifestyle modification, emergent and resurgent diseases’. In this stage there is a decline in some causes of death (e.g. cardiovascular) and lifestyle (e.g. behaviour and choice) plays a role too.
Thus obesity is mostly looked at at the macro level, which is the level the epidemic is measured on. Though behind this there is a story at the micro level which is of influence and largely determines the macro level.

2.2.4 Nutrition transition

Related to the epidemiologic transition is the nutrition transition, these two work together on the field of health. Within the nutrition transition there are five broad patterns. Non of these patterns are restricted to a particular point in human history, though the order of the patterns does coincided with the major developments of human history. However this does not mean that the first stages do not occur anymore, they can still occur is certain areas or within certain sub-populations.
The patterns are the following (Popkin, 2000;93-94):

Pattern 1: Collecting food
Pattern 2: Famine
Pattern 3: Receding famine
Pattern 4: Nutrition related non communicable disease
Pattern 5: Behavioural change

Of these patterns the fourth one is the most important when obesity is concerned. This is also the stage in which most western countries reside. In the fourth stage the diet is mainly high in fat, cholesterol, sugar and other refined carbohydrates. On the contrary the diet is low in polyunsaturated fatty acids and fibre. This diet is then often also coincides with an increase in sedentary life. The diet of the fourth stage is distinctive for high income societies, though it is more and more increasing in low income societies. As a result of this diet the number of obese people increases which contributes to the degenerative diseases. This latter relates back to the epidemiologic transition of Omran (Popkin, 2002).

The next logical step would be to move to the next pattern of behavioural change. Though this is easier said than done, as indicated earlier behavioural change is hard to accomplish. Thus whether the western countries will move to pattern five is still uncertain as is the time when they will.

2.2 Literature review

To be able to research the growing problem of obesity, knowledge about what obesity is and knowledge about several causes is required. Besides that knowing the effects it has on health and which measures are taken to prevent further increase are useful. Further an idea about the future development of the obesity epidemic is helpful. Although the causes of obesity will not be researched in this research, just the effect on the Obesity Adjusted Life Expectancy, they could be used to indicate on which aspects policies should concentrate.

2.2.1 Causes of obesity

In most of the cases obesity is caused by a disparity between the input of energy (e.g. calories) and the output (e.g. physical activity). Another disparity could be between our biology, which is programmed for the creation of energy stores for less plentiful times and our current environment, in which there is plenty of food and avoiding physical activity is easy (Veerman et al., 2007). With every person consuming just a few (8-10) calories less a day and walking only for a few more minutes a day the obesity epidemic could be slowed down or even countered (Veerman et al., 2007).
Hill et al. (2003) state in their article that the environment is a major driving factor in the obesity epidemic, more than biology. Naturally, our biology defines our height and weight, but the weight development over the past decades is very much influenced by our environment. Overconsumption is promoted, in a way that food tastes good and is not expensive. Physical activity is cut out of our daily routine due to a decline in physical active jobs. Moreover many preferred activities, as watching television or surfing the internet, do not involve physical activity (Hill et al., 2003). Technology has played a part in this too, it has given us for example cars, so we do not have to walk, or elevators so we do not need to take the stairs (Hill et al., 2003).
The fact that people use the car or the elevator is a choice. It is a decision they make, whether or not they are aware of other options or the consequences. According to the theory of bounded rationality (Simon, 1986), our information processing capacity is limited and related to time and stress. So we may not always make the right or best decision. Mainly due to the fact that we have only a small part of all the knowledge, we do not chose the best option ever, but an option that is good enough for us (Simon, 1986).
Connected to making choices is behaviour related to making choices. Determining which behaviour you want to show, decisions have to be made based on positive and negative aspects of the eventual behaviour. This is based on the theory of Azjen, the theory of planned behaviour (Ajzen, 1991). Into account are taken the beliefs and attitudes a person has regarding a behaviour and the evaluation of the outcome. Besides that normative aspects are taken into account; what the person thinks others will think of a certain behaviour. This all leads to an intention of behaviour, which in turn leads to a decision to perform or not perform certain behaviour (Ajzen, 1991).
Thus obesity is a complex disease in which multiple factors play a part. In some cases the nutrition plays a bigger part than the environment or the genetic predisposition plays a larger part. Besides that there is the discussion whether obesity is a disease or a risk factor. Since

last year a new multidisciplinary guideline has come about in which many medical practitioners have decided that obesity is a chronic disease (Pronk, 2008).
Knowledge on the genes which might be involved in the sensitivity to developing obesity is still largely lacking. The same applies to the interaction of genes and lifestyle factors. Genetic factors are important though the environment and the psychological and social factors seem to be of more importance in the development of overweight. Not much research has been conducted in this area. Though there are strong indications that the ‘obesity environment’ (physical, economical and social-cultural factors) stimulates people to eat to much and not exercise enough (Gezondheidsraad, 2003). According to Stunkard et al. (1990), as cited by the Health Council of the Netherlands (2003), the genetic factors would for at least explain 70 per cent of the devolvement of obesity. Other research by Bouchard (1997) estimates this percentage between 25 and 40 per cent. Either way a persons genetics do play a part in the development of obesity.
However with or without the decision of obesity being a disease or whether or not our genes play a part, the fact remains that more and more people become obese. Being obese is not healthy and causes many health problems, besides that it is becoming a societal problem. More on this in the next sections.

2.2.2 Effect on health

Choices, behaviour and knowledge all play part in the causes of the obesity epidemic, on the other hand the epidemic itself has consequences. Being obese is not healthy. It will not cause death directly, though it affects your health severely. The obesity prevalence has been increasing for several years now, which means that more and more people suffer from obesity. In 2008 11 per cent of the Dutch adult population was obese, of the males 9.9 per cent was obese of the females 12.1 per cent.
To establish the general health situation of the population, one needs not just the life expectancy. The life expectancy does not take in to account the health situation of the population. Measures that do take in account the health situation of the population are mostly referred to as the HALE, Health Adjusted Life Expectancy (Wolfson, 1996). An example of estimating the HALE is by adding weights. Years lived in good health are appointed higher weights than years lived in ill health. This health utility index was used by Wolfson (1996) for his research in Canada. His research showed even at a young age, 15 years old, there is already a gap between life expectancy and the HALE. This gap is the burden of ill health, which is bigger for females than males. Moreover at 65 years and older the gap between females and males is even bigger (Wolfson, 1996). With this research it is indicated that having a disease or not living healthy has an effect of your life. Wolfson’s study included the overall health, though calculating the HALE only regarding obesity is also an option. Van Baal et al. (2006) use it in their research concerning obesity and smoking.
In their research van Baal et al. (2006) look into the effects on health for three cohorts, smokers of normal weight, obese non smokers and healthy people. All cohorts included people aged 20. To estimate the life expectancy and the Health Adjusted Life Expectancy use was made of the Chronic Disease Model, to look at different health stages. The results for the obese cohort indicated that the males lose 4.6 to the healthy cohort and the females 4.5. Hence both sexes are about equally affected by obesity (van Baal et al., 2006).
Another study by Peeters et al. (2003) is also concerned with obesity and smoking. From their article it becomes clear that when adults are overweight or obese there is an increased risk for death and disease. In their study they use data from the Framingham Heart Study and they show results for 40 year olds. Of the life of non smoking males 3.1 years are lost due to overweight, for females it is 3.3 years. When obesity is considered the number of years lost is

even higher, for non smoking males and females the consecutive years are 5.8 and 7.1. Combining obesity with smoking results in even more years lost.
In an article by Bonneux et al. (2005) it is indicated that, based on data from the Framingham Heart Study, people who are obese or overweight live shorter lives than people with a normal weight. People whom are overweight live 3.2 years shorter, people whom are obese live 7.0 years shorter. Even when all years lost due to cardiovascular diseases or cancer are added, overweight still causes a larger loss of years (Bonneux, 2005).
Overall being obese has many negative effects, not just physically but also mentally. Obese people often live a shorter life due to bad health and have a higher chance on developing various conditions and diseases. Besides that obese people are often stigmatised, which could result in mental problems. The amount of money annually spend on illnesses related to overweight problems is €1.5 billion, which indicates that overweight and obesity are an expensive problem. The expectation is these costs will only rise in the future (Ministry of VWS, 2009a).
The previous mentioned negative effects do not solely pertain to adults, the problem of obesity has also spread to children. Health conditions related to obesity only seen in adults are now also seen in children. Examples are high blood pressure and diabetes type 2. Taking childhood obesity into account in the long term, it might even affect the life expectancy in the future. Large parts of the present youth are less healthy and possibly live less long than their parents (Daniels, 2006). The National Institute for Public Health and the Environment (RIVM) state in their report that programs which prevent the youth of becoming obese, could potentially produce a health profit (van Baal et al., 2006b).
It has become clear that obesity has quite an influence on the health of an individual and thus indirectly on the overall health of a population. Obese people often life shorter lives, are at risk of many diseases and now even the youth is affected. From this it is clear that something needs to be done to prevent further growth of the obesity epidemic. This will be discussed in the next section.

2.2.3 Obesity prevention

Considering the increase of the obesity prevalence the government and other private parties step in to prevent further increase and find solutions to counter the trend. On the one hand you might argue that it is not the task of the national government to tell us what to eat and to exercise more. Though one of the basic responsibilities of a government is to “Aim to improve the quality of life and wellbeing of the population it represents” (Van de Kaa, 2006;194). Obesity can be considered a disease which decreases the quality of life and wellbeing of individuals, therefore the government should do something about it.
In an attempt to counter the epidemic governments try to influence the people and help them change their life styles around. So behaviour change plays a big role in turning the obesity epidemic around, but this is one of the hardest things to do (Veerman et al., 2007). Hill et al. (2003) indicate that first there needs to be a societal and economical change towards ‘healthy life style choices’. To change is the people’s choice, the government can only assist in that choice (ministry of VWS, 2008). The Dutch government has made agreements with the foods industry, restaurants, employers, health insurance companies and sport organisations to counter obesity. One of the agreements is to have one logo on products which indicates that it is healthy (ministry of VWS, 2008). In the United Kingdom the Health Secretary, Alan Johnson and Ed Balls, the Secretary of State for Children, Schools and Families have published a plan to counter obesity. This proposal is about bringing together different groups, as employers and communities, to promote healthy food and physical activity (Department of Health, 2008). The Irish government is taking it even further by developing a framework for

obesity prevention. This includes individual change (e.g. individual, at home) and environmental change (e.g. schools, media, legislation) (Treacy, 2005).
The Ministry of Public Health, Wellbeing and Sports admits that promotion of healthy living needs a strong commitment. Therefore in their policy ‘Choosing a Healthy Life’ they announce that € 4.6 million is available for prevention programs in 2007 (Ministry of VWS, 2006a). Government associated programs will be financed with this money. In the ministries previous policy, the total amount spend on prevention in 2004 was €210 million. About €2 million of this budget was specifically assigned to obesity prevention and research (Ministry of VWS, 2003). Hence over the years more money is spend on the obesity prevention.
Promoting a healthy lifestyle is the main topic of this prevention policy. The way to do this is by stimulating people to make healthy choices. Having more and more people living a life in good health will result in an increase in life expectancy, in healthy life expectancy and in fewer differences between social groups. Related to the prevention policy is a societal aim. People who live longer in good health are longer capable to participate in society without any help or care. Hence investing in a good system of prevention has a societal relevance too (Ministry of VWS, 2006a).
Research by the Health Council of the Netherlands indicates that the main points of the government policy, diet and exercise, could have an effect on the general health of the individuals. It has been shown that weight loss deceases the chance on diabetes type two and cardiovascular diseases in overweight and obese individuals. Reducing ones weight by 10 to 15 per cent, when the person has a BMI of 40 or less, and sustaining that weight for about two years decreases the chance on developing diabetes type two and cardiovascular diseases. Changes in lifestyle and nutrition could postpone or even prevent the development of diabetes type two (Gezondheidsraad, 2003). Hence the obesity prevention programs of the governments and public parties should theoretically work and have a positive effect on health. A positive effect on the obesity prevalence has not occurred yet. The development in the future it the topic of the next section.

2.2.4 Projections

Several researchers have taken a look at the future development of the obesity epidemic. With these projections an idea of what the future might hold can be given, which in turn can be anticipated on by governments and private parties. Obesity prevention in the future will remain important if the prevalence continues to increase, when a decline sets in it shows an effect of the government policies. In this section several results of previous research into the future development of the obesity epidemic are illustrated. A further elaboration on most research mentioned and additional research on projections can be found in section 3.6.
A Dutch obesity prevention organisation have published in their research that if present growth rates of obesity would pertain, the obese population will grow to about 15 to 20 per cent in 2015 (Overweight Agreement, 2005a).
The Health Council of the Netherlands reaches the same conclusion. In their projection a linear trend is used to predict the obesity prevalence in 2015. With, according to the researchers, no signals indicating a decline in the prevalence, the prevalence data of 2000 was used to predict the prevalence into the future. The Health Council of the Netherlands predicts that in 2015 between 15 and 20 per cent of the Dutch adult population will be obese (Gezondheidsraad, 2003).
Other research shows that an increase of obesity within the elderly populations is very likely. In the United States this increase in prevalence also means that the number of elderly who are obese will increase from 32.0 per cent in 2000 to 37.4 per cent in 2010 with the middle case scenario. Hence more than one in every three elderly will be obese (Arterburn et al., 2004).

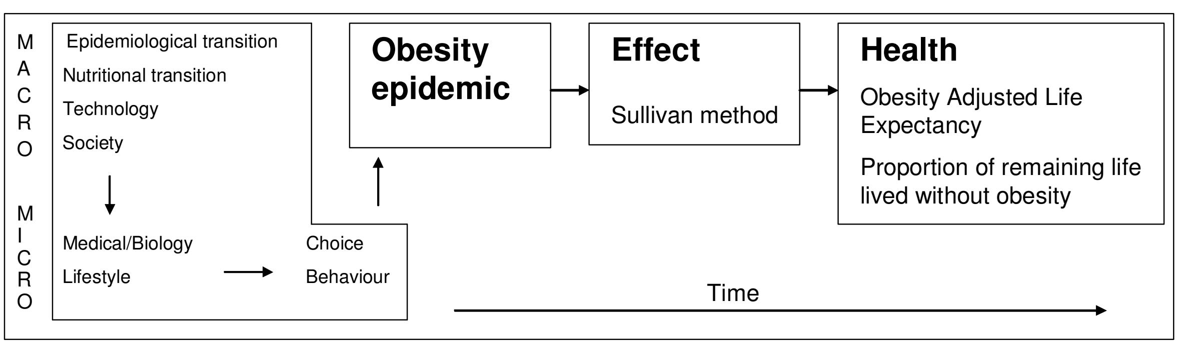
Kelly et al. (2008) predict the obesity prevalence for the whole world. With a continuation of the same prevalence an increase of 45 per cent in the number of obese worldwide to 573 million in 2030 is projected. When a further increase of prevalence occurs 1.12 billion obese worldwide are projected for 2030 (Kelly et al., 2008).
Zaninotto et al. (2009) use different scenarios to project the future prevalence for the United Kingdom in 2012. If a linear trend were true the prevalence's will be 32.1 per cent for males and 31.0 per cent for females. When a power trend would occur this will lead to a prevalence of 25.7 per cent for males, for females it will be 26.2 per cent. The exponential method indicates a prevalence of 37.9 per cent for males and 33.9 per cent for females (Zaninotto et al., 2009).

From the literature review it has become clear that many aspects are related to the obesity epidemic, e.g. nutrition, environment, genetics, behaviour. In previous research conducted by many researchers topics occur in relation to obesity. Other research indicates that being obese definitely has an effect on peoples health and also that many policies exist. These aspects also relate back to the theories discussed in 2.1. Together the theories and the aspects of the literature review are combined in the conceptual model which will be explained in the following section.

2.3 Conceptual Model

With the literature review and the theories as basis a conceptual model is constructed for this research (figure 2.1). The model is partly based on the micro and macro model of Coleman (1990). Within this model the emphasis is on the connection between events on the macro and micro level. Events which are more related to society as a whole are shown at the upper level; the macro level. At the lower part of the model aspects more related to the individual are shown; the micro level. In Coleman's model (1990) both levels are of great importance, though in this research the main focus is on macro level.
The left side of this conceptual model indicates that the obesity epidemic has not come about out of the blue, many processes at the macro and micro level have played a part in this as has been discussed in the theories and literature review.

Figure 2.1: Conceptual model



Source: Own creation

Of main importance is this research is the obesity epidemic and the effect is has on the health status of the population. The effect on health will be measured with the Sullivan method, which results in an effect on health expressed in the Obesity Adjusted Life Expectancy and the proportion of remaining life lived without obesity.

Further more the model also takes into account the process-context approach. In which the process relates to the decision making and the context to the social, cultural and political circumstances. In this model it is the obesity epidemic which is the process. This epidemic has come about within a specific context, like culture and politics. This latter relates back to the left side of the model in which the epidemiological transition and nutritional transition have taken place within and created a certain context.
Lastly a time aspect is also included in this model. This is because the research will entail projections for the future effect of obesity on the health status.

2.4 Concepts

In this chapter various concepts have been used which need some further elaboration in order to indicate how they are defined in this research. Some of these concepts occur in the conceptual model, others are explained for a better understanding of the remainder of this paper.
First up is the operationalisation of obesity and how obesity will be measured in this research. This is followed by an explanation of the concepts Life Expectancy and Health Adjusted Life Expectancy, both are needed to measure the effect of obesity on health. Accompanying the time aspect are projections and scenario, which are explained last.

Being obese *(obesity)* is considered having a BMI of 30 or more (see Body Mass Index) (Visscher et al., 2002).

The *Body Mass Index* (BMI) is calculated through the measurement of weight and height of a person. The weight in kilograms is divided by height in meters squared (Visscher et al., 2002).

Prevalence in the case of obesity, is the number of people who are obese or the percentage of the population who is obese. This could be at a specific time or for a period, like a year (RIVM, 2008).

The *life expectancy* (LE) is the “average number of additional years that a survivor to age x will live beyond that age” (Preston et al., 2000).

Health (Obesity) Adjusted Life Expectancy is “a summary measure of population health indicating the expectation or equivalent years lived in good health. Health Adjusted Life Expectancy, like Life Expectancy, is independent of the size and composition of the population and is therefore useful to make comparisons between populations over time” (van Baal et al., 2006). In the case of obesity ‘good health’ is defined as not being obese. For that reason the name of the measurement is changed into Obesity Adjusted Life Expectancy.

“Population *projections* are estimates of the total size and composition of populations in the future” (OECD, 2008). When looking at obesity, projections are related to the number or prevalence of the obese population in the future.

A *scenario*, as described by the UN, is: “A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technology change, prices) and relationships. Scenarios are neither predictions nor projections and sometimes may be based on a narrative storyline. Scenarios may be derived from projections but are often based on additional information from other sources” (UN, 2009).

3 Data and methods

To establish the effect of obesity on the Obesity Adjusted Life Expectancy over time in the Netherlands, several data sets and (projection) methods are needed. In this chapter insight is given into these data sets and (projection) methods. All data used will pertain to the whole of the Netherlands, of which the average obesity prevalence data per age group and sex is used. Of course differences can exist within the Netherlands, though these are not taken into account. Projections per age group will also pertain to that whole age group in the Netherlands.
To start of this data and methods chapter the design of this study will be elaborated on to provide a general idea of what this study entails. This is followed by the operationalisation on the research questions and concepts, including a short overview of the data sets and the method used.
After this a more extensive explanation of the used data and methods is provided, with first a look at the secondary data of obesity. This is followed by an illustration of methods which look at the effect of lifestyle on health and the reason for choosing the Sullivan method. Next two more data sets, population and deaths, are discussed, followed by an examination of several obesity projection methods that exist. Lastly the chosen projection scenarios are elaborated on, including an explanation on which data and methods are used for every scenario.

3.1 Study design

In this part on the study design it will become clear what the research will look like, what the study area is and which data sets are used. Furthermore information pertaining to different age groups and projections will be given.

3.1.1 Studying the effect on present and future health

This research will be a quantitative research with the use of secondary data. It will be explorative too, with this research a look into the future will be taken. Though it will also descriptive, by explaining what the present situation is. In this research the country of interest is the Netherlands. The study will concentrate on period 2000 up to 2008 for the description of the present situation, only for these years obesity prevalence data is available from one source, being the CBS. Obesity prevalence data is derived from surveys of POLS in which respondents mention their height and weight (CBS, 2008). Data concerning the Body Mass Index is available, among others, for a BMI of 30+. It includes the prevalence in total, for males, females and the several age groups. Of these age groups the following have been chosen to take into account, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74 and 75+. Data on younger age groups is present, though in this research adult obesity is considered.
For the calculation of the Obesity Adjusted Life Expectancy (OALE) the Sullivan method will be used (Bossuyt, 2001). The CBS uses the same method to calculate the OALE and the secondary data will be derived from the CBS. Data from the latter source is mostly quite reliable what makes it accurate enough to be used in this research.
Subsequent are the data sets which are used to calculate the OALE. Needed are the number of inhabitants and the number of deaths per age and sex. Both data sets are available on the website of the CBS. Data is available from age 1 up to 99, though the youngest age group is 18-24 hence data from 18 up to 99 is used. The data is available for many calendar years, however the research period is 2000 up to 2008.

Projections for the future obesity prevalence will be made with use of the past obesity prevalence trend. In turn these projected prevalence’s will be used to project the OALE for the coming years for both males and females and for all age groups. The projections of both the obesity prevalence and the OALE will be made up to 2015.

3.1.2 Ethical aspects

There are several aspects that should be kept in mind during this research. The reporting should be done as accurately as possible, including the errors, limitations and shortcomings of the research. Besides that the sources of the data used and the quality of this data should be noted down. Lastly it is of importance to show how the data is used, for example which methods or data massaging techniques have been used.

3.2 Operationalisation

Within the operationalisation it will become clear how the concepts that occur in the conceptual model will be measured in this research. Besides that it will be indicated which data and methods are needed to measure the effect on the present and future health, in order to answer the research questions. Both aspects, the data and methods, will be indicated shortly in this section of this chapter. A further elaboration on the exact data sources and the selection on the methods will follow in the remainder of this chapter.

3.2.1 Required data to measure the effect on present and future health

The first sub question of this research is concerned with the percentage obese in the Netherlands. In this research obesity is measured with the Body Mass Index (BMI), which in turn is a comparison of a person’s weight and height. Data on the BMI is collected with a survey called ‘Permanent Research on Living Situation’ (POLS; Permanent Onderzoek LeefSituatie), which collects data on the living situation of the Dutch inhabitants (CBS, 2008). The CBS provides information of different categories of BMI, though for this research only the data pertaining to a BMI of 30 and larger is taken into account. This data which pertains to obesity can be found of the CBS website under the title ‘Self reported medical consumption, health and lifestyle’. The data is also available for both sexes and multiple age groups, which is also a part of the first research question. On the website of the CBS the obesity data is provided in prevalence’s, which is the same as the percentage obese.
Sub question two is concerned with the effect of the obesity epidemic on the Obesity Adjusted Life Expectancy. This will be measured by using the Sullivan method from 1971. In this method age specific mortality and age specific prevalence of illnesses are used, in combination with the life table, to calculate the Obesity Adjusted Life Expectancy (Bossuyt, 2001). Additionally for this method the number of population per age is needed as well as the number of deaths. The CBS provides information on this too, under the following titles the data can be found ‘Population at January 1st, age, sex and martial status’ and ‘Deaths: age (last birthday), sex and martial status’.
All the data sources above pertain to the present situation (2000-2008), however in this research a look into the future is taken as well (sub questions three through six). In order to make these projections use will be made of several scenarios, which will be selected with the help of previous research on obesity. With in these scenarios different ‘futures’ of the obesity prevalence are calculated. These projected prevalence’s in turn form the basis for the future effect on the Obesity Adjusted Life Expectancy. The required data on the number of population and the number of deaths will be derived from the CBS. They provide prognosis

on these two subjects on their website under the following titles; 'Projected population on January 1st by age and sex, 2009-2050', and 'Projected life born, diseased and migration, 2008-2049'. All data is available for both sexes and all ages, moreover projections will be made for both sexes and several age groups.

3.2.2 Methodology; measuring the effect on present and future health

Sub question two and six are both concerned with the Obesity Adjusted Life Expectancy and as mentioned they will be answered by using the Sullivan method. In this section a short explanation of what this method entails will be given. The Sullivan method uses the life table to calculate the Health Adjusted Life Expectancy (HALE), which will be used to calculated the Obesity Adjusted Life Expectancy. Age specific mortality (m_x) is needed in the life table and can be calculated with the number of population (P_x) and the number of death (D_x), which are available on the CBS website. With the use of a hypothetical cohort in the life table, the life expectancy (e_x) for every age group is calculated. From the CBS the data on the obesity prevalence will be derived, which has records containing self reported obesity prevalence (BMI $\geq$ 30) for the past years. Self reported data will always be different from the real statistics, though it is the only available dataset on the website of the CBS. The self reported prevalence rates of obesity will be used in the Sullivan method as the specific illness (π_x) (Jagger et al., 2006).
In order to make predictions about the development of the obesity epidemic, a projection method is needed. For this research the projection method as used by Janssen and van Wissen (2007) was proposed to use. This is a combination of the deterministic approach and stochastic approach in which the mortality trend is split up in a constant linear trend and a non-linear trend. The method was applied to the smoking and non smoking mortality. However this method is not applicable to this research due to the fact that in this research the disease is central and not mortality. Obesity prevalence data is used and not obesity mortality data. Therefore different projection methods were needed, the search for these methods will be further explained in section 3.6. With the use of these projection methods various scenarios have been made.

3.3 Description of secondary obesity data

The obesity prevalence in this research is measured with the Body Mass Index (BMI). In this research the future obesity prevalence, and thus also the future OALE, are based on the past trend of the obesity prevalence. Hence considering the usefulness and the quality of this trend data is in order. Because the future prevalence is based on the past trend, the quality of this projection depends on the quality of the data used.
The data on the obesity prevalence has been derived from the CBS website. The CBS in turn has derived this information from the 'Permanent Research on Living Situation' (POLS; Permanent Onderzoek LeefSituatie). This POLS has a basic questionnaire and questionnaires for different aspects of the Dutch population. The goal is to collect high quality and consistent data on the living situation of the Dutch population. Every person in a private household from zero years onwards is in the target population. The research is conducted every year by taking a sample at random, which is spread out over all the months of the year. With the use of Computer Assisted Personal Interviewing (CAPI), the interviews are conducted at peoples homes (CBS, 2009a).
There is a special questionnaire for health; POLS – Health. This research has the goal to give an as complete as possible overview of the development of the health, medical consumption, living style and prevention behaviour within the Dutch population. The minimum age is here

zero years as well, though for some topics there is another minimum age. This research is also conducted annually. From 1997 onwards a sample at random of persons is used, which is also spread out over the months of the year. Since 1990 Computer Assisted Personal Interviewing (CAPI) is used, an additional questionnaire is given to people over the age of 12. Every year the sample is around 10.000 people, of which the annual non response is around 35-40 per cent. An annual weighing is applied to correct for the composition of the sample. Because the research uses a sample it is subjected to coincidence fluctuations. When in a specific group there are less than 50 people, no data is shown on the website. The confidence intervals can be calculated using the standard error (CBS, 2009b).
Information on the length and weight of a person, which are used to calculate the BMI, are derived from the POLS – Health survey. The questions on length and weight are asked to every person of 12 years and older. Thus the data is self reported, the interviewee is not measured and weighted by the interviewer. With this information of height and weight the BMI of every person is calculated and published on the CBS website in different age categories and by several other characteristics (CBS, 2009).
On the website of the CBS the Dutch obesity prevalence data can be found, under the title ‘Self reported medical consumption, health and lifestyle’. Further selections can be made regarding, age, sex, insurance, education, social economic status, household situation and urbanisation. For all combinations the prevalence and the standard error are available. All the data is obtainable from 2000 up to 2008 (CBS, 2009g).
Within this research the focus is on different age groups and both sexes, hence the selections age and sex are included in this research. This resulted in obesity prevalence data for the age groups 18-24, 25-34, 35-44, 45-54, 55-64, 65-74 and 75 and older, both for males and females separately.
As indicated the BMI data used here is self reported data. Studies on obesity often use self reported data on height and weight, though it has some consequences for the quality of the data. Making use of self reported data on obesity often leads to underestimation of the obesity prevalence rates. This is due to the fact that the interviewed people tend to underreport their body weight and over report their height. Some groups tend to do this more than other groups, besides that rounding of to values ending with 0 or 5 occurs quite often too. Though on the other hand there have been researchers who question the severity of this under or over reporting (Visscher et al., 2006). Nevertheless “self-report is acknowledged as being effective for monitoring purposes” (Dal Grande et al., 2005;346).
Moreover some researchers question if obesity should be indicated by the BMI. For some age groups (e.g. the elderly) measuring the waist-hip ratio or waist circumference might give a better indication. Though this information is hard to obtain in self reported surveys. Hence the BMI might not be the best indicator to measure obesity, it is adequate to show the change in obesity prevalence over the years (Dal Grande et al., 2005). Veerman et al. (2007) also use the BMI as an indicator for obesity. They argue that using the BMI for monitoring populations is useful because: “it is reported widely and because it is easier to measure and less error-prone than, for example, waist circumference; and it is more valid for following populations through time than for comparing individuals” (Veerman et al., 2007;2369).
In this research use is made of self reported data due to the lack of any other sources of data. Most of the research on obesity uses the BMI as an indicator, which they all recon as a sufficient indicator. The Dutch self reported data shows very volatile obesity prevalence pattern, which can be caused by the self reported data, though smoothing techniques will be used to reduce this.

3.4 Effect of lifestyle on health

There are multiple models available to work with when looking at the effect of lifestyles on health. In this section three of these models will de discussed, the Sullivan method, the Chronic Disease Model and the Multi State Life Table. All three are closely related, though require different data and provide different outcomes. However one of the methods is more suitable for this research, which will become clear.

3.4.1 Sullivan method

First up is the Sullivan method, which dates back to 1964. In this year Sander proposed to combine mortality and morbidity data in one health indicator. A report of the United States Department of Health Education and Welfare used this indicator in 1969. Calculations on estimates of the disability free life expectancy were conducted by a method of Daniel Sullivan. He was the one to make a life table technique including both mortality and morbidity to produce an index of disability free life expectancy. The observed prevalence of a disability at all ages in the present population at one point in time is taken into account. Up to 1985 many researchers used this method (Mamun, 2003).
With the Sullivan method use is made age specific mortality and age specific prevalence data. The result of the calculations is the life expectancy, which reflects the present health situation of the population, independent of the age structure. Hence it gives the healthy life expectancy of the present population (Bossuyt, 2001).
Use of the Sullivan method is very attractive for researchers interested in public health. It is a simple method and input data can easily be accessed. Limitations of this method exist though, it is unable to take into account sudden changes in the health status and re-entries into the life table population (Mamum, 2003). Despite these limitations, the Sullivan method is used in this research.
Input for the Sullivan method are data sets per age and sex, for obesity prevalence, number of inhabitants and number of deaths. These three are needed in order to calculate the effect of obesity on the Health Adjusted Life Expectancy (HALE). The output of the Sullivan method is the "the number of remaining years, at a particular age, which an individual can expect to live in a healthy state (however health may be defined)" (Jagger et al., 2006; 2). In this case health is defined as not being obese. Hence the OALE reflects health as being not obese and not overall health. The paper by Jagger et al. (2006) is used as guidance in this research for the production of the Dutch life tables with the OALE extension. (The Sullivan method measures the HALE, though because in this research only obesity is considered the name is changed into Obesity Adjusted Life Expectancy)
The Sullivan method is similar to a normal life table, only with an extension at the end. Normally life tables begin with zero and end between 100 and 110 years, though in this research the starting age is 18 and the last category is 75+. All age groups pertain to 10 years, only the first age group is seven years wide. This difference is due to the data collection of POLS, who have made this distinction in their data collection. The 18-24 category is included in this study though, because adult obesity is studied.
There are several steps needed to fill in a life table. First of all the population per age group (N_x) is entered and following the number of deaths per age group (D_x) in that year. With these two numbers an age group specific death rate (m_x) can be calculated by dividing the number of deaths by the population. After that the 'average person years lived between age group x and age group x+n for persons dying in the interval' (${}_na_x$) is determined, in this research half of the age interval is chosen.

Following the ‘probability of dying between age group x and x+n’ ($_nq_x$) and the ‘probability of surviving from age group x and x+n ($_np_x$) is calculated. For the last age group, 75+, the probability of dying is one; eventually everyone dies. As a result the probability of surviving for this group is zero.
Next a hypothetical cohort (l_x) is created, which will indicate the number of people left alive. With this column the eventual outcome will be produced. This hypothetical cohort starts with 100.000 at the age of 18 and will decrease with age, related to the survival chance. Form there on you can calculate the ‘number of people dying between age group x and x+n’ ($_nd_x$), the ‘person years lived between age group x and x+n’ ($_nL_x$) and the ‘person years lived above age group x’ (T_x). Finally the total life expectancy (e_x) per age group is calculated. This is the end of a normal life table.
The extension added by the Sullivan method includes entering the proportion of the age group with a disability, in this case obesity. So if the percentage is 3.2 per cent, the proportion entered in the life table is 0.032 (3.2/100). Next the total person years lived without the disability for every age group is calculated followed by ‘the total years lived without disability (i.e. obesity) for age group x onwards’. Lastly the disability free life expectancy (OALE) is computed and the proportion on life lived disability (i.e. obesity) free. Overall three important outputs are generated; the normal life expectancy, the life expectancy without the disability (i.e. obesity) and the proportion of life lived without obesity.

Over the years the Sullivan method has been used by multiple researchers. The Scientific Institution of Public Health in Belgium worked with the Sullivan method in 2001 to construct the life expectancy by sex and education level for several groups. Their argument to use the Sullivan method is that for the Multi State Life Table (MSLT) longitudinal data is required. Information on the changes in health stages is a long and intensive process and this data is not available for Belgium. Hence they have chosen the Sullivan method, for which the age specific prevalence’s are available. Further they argue that the results of the Sullivan method and the MSLT will be comparable, though only when no large changes occur in the number of deaths (Bossuyt, 2001).
Research by Romero et al. (2005), into the healthy life expectancy of Brazil, is conducted using the Sullivan method. They argue that due to the simplicity of the method that is has been used in multiple countries, especially in developed countries. Now the method has been applied to the Brazilian database on Health Wellbeing and Aging. With this study they introduce the Sullivan method and try to estimate the Brazilian HALE by using different ways of measuring the state of health (Romero et al., 2005).
Manuel and Schultz (2004) use the Sullivan method in their research on diabetes mellitus to calculate the HALE. When for all groups life tables were constructed the HALE was estimated by weighting the years of life lived to the mean of the Health Utility Index by age and sex (Manuel and Schultz, 2004).
In research by Peeters et al. (2004) use is made of many different methods of which the Sullivan method is one. With logistic regression the age specific disability prevalence was estimated, which was in turn combined with life tables. These life tables were derived from age specific mortality rates, according to the Sullivan method. In turn life tables for various groups were made. Eventually life expectancy with and without disability was calculated (Peeters et al., 2004).

In Andrade's research (2006) into the health burden of diabetes in Latin America and the Caribbean use is made of a combination of methods. The diabetes free life expectancy is calculated with the Sullivan method, to get an idea about the general burden of diabetes. To find out if people with diabetes life fewer years and a larger part of their life with disability the Multi State Life Table (MSLT) is used. With the use of panel data the MSLT will estimate the active disability free and the disabled life expectancy by sex and diabetes status (Andrade, 2006).

3.4.2 Chronic Disease Model

The second method argued is the Chronic Disease Model. Hoogenveen et al. (1998) have developed a Chronic Disease Model for the National Institute of Public Heath and the Environment (RIVM). "In short, the RIVM Chronic Disease Model (CDM) has been developed as a tool to describe the morbidity and mortality effects of autonomous changes of and interventions on chronic disease risk factors taking into account integrative aspects" (Hoogenveen, 2005;12).

Simulation models on chronic diseases can used to describe chronic diseases and their relation to public health risk factors. The model has a structure to indicate the relations between diseases and risk factors. This structure is a multi state model based on the life table method. Required for this model are risk factor prevalence rates, incidence and prevalence rates. Also disease remission, progression data and deaths due to the diseases are needed. Within this model, in which people can move from one state to another, transition in illnesses are illustrated (Hoogenveen et al., 1998).

This CDM could be applied to the Dutch obesity data, though a lot of information on the transitions and the number of deaths is required. The data obtained for this research is prevalence data, hence much information is lacking to work with the CDM. Besides that the focus of the CDM is transitions between health states, which requires many assumptions and does not relate to the main objective of this research.

The CDM has been used by the RIVM in their research into diabetes mellitus. In this research though they have adapted the CDM to consider other risk factors like heart complications (Hoogenveen, 2005).

3.4.3 Multi State Life Table

Lastly a method related to the CDM, the Multi State Life Table (MSLT), will be discussed. This method relates back to the 1970s, to the multiregional demography. The MSLT is an extended version of a life table, but it is able to take into account people who enter the MSLT, exit it and move back and forth between several stages. Besides that the MSLT has the advantage of being able to take into account both increment and decrement data of various health states of the population. Thus the MSLT takes into account the experience of getting a disease and recovering from it for every age, there are no assumptions on the hierarchy of the changes in status. Some only experience one transition others can have more. The MSLT can provide estimates of the expected number of transitions a person will make in life or in a time period, hence it is a more individual model (Mamum, 2003).

Though before these estimates can be produced an input is needed. The MSLT is based on the age specific transition rates between the various stages. These transition rates can come from various sources. In an article by Nusselder and Peeters (2006), these rates are derived from 1980s prospective data originally collected for the Netherlands. Another way of obtaining the transition rates is calculating them. Mamum et al. (2004) calculate the observed transition rate

for each single year of age by dividing the number of events by the corresponding risk period of exposure in each health state.
The MSLT gives better estimates than the Sullivan method due to the fact the method allows several exits. However the one is not better than the other, they both use the same data, though methodologically and theoretically the MSLT is preferred. The difference between the two is in the use of (prevalence and incidence) data, where the MSLT is much more data demanding. The MSLT is based on flow data, the Sullivan method on the other hand is based on status data and only uses prevalence data. Both methods though give more or less the same indication of health expectancy, though only if the actual transition rates have been stable for a very long time. If this is not the case the outcome of Sullivan method will lag behind with what is actually happening. It could then indicate compression or expansion while the opposite is happening (Mamum, 2003).
The MSLT is widely used by researchers. A research in which the MSLT is applied is the research of Reynolds et al. (2005). They look into the impact of obesity on the active life expectancy of elderly Americans. To estimate the total and active life expectancy they have used a MSLT which takes into account longitudinal data. Consequently the MSLT considers that the health of individuals can improve and deteriorate. Moreover different mortality rates can be applied to different stages of disability. In addition the Interpolation of Markov Chains Method was used to estimate the transitions and the life expectancy (Reynolds et al., 2005).
In an article by Lubitz et al. (2003) on health, life expectancy and health care spending among the elderly a MSLT is used for the calculations. The MSLT was used to estimate the total and active life expectancy. Health status was classified into five stages in this research and there were 25 possible transitions in the model. The MSLT was chosen because it allows these transitions from one state of health to another (Lubitz et al, 2003).

As mentioned at the beginning op this section, on of the discussed methods is more suitable to the available data used in this research. The method that is used is the Sullivan method, despite the restrictions of the method. Though due to data restrictions, the required data for the other two methods is not available, the Sullivan method is used. When only prevalence data is on hand, the Sullivan is the right method to use. Besides that the Sullivan method is not a very difficult method, relative accurate and the interpretation is not very complex.

3.5 Description of secondary population and mortality data

As mentioned, the Sullivan method requires the input of the number of inhabitants and the number of deaths per age and sex. The Dutch data set on the inhabitants, with the title ‘Population at January 1st, age, sex and martial status’, can be derived from the CBS website (CBS, 2009c). For this research the population from the age of 18 onwards was needed (the lowest age group), for both males and females. Hence data from individual ages 18 up to 99 and onwards was collected for the years 2000 up to 2008. Ages were added to end up with the total population per year for the previous indicated age groups. To obtain the data for 2009 the projected population was used. All this data though, pertains to the population at January 1st and mid year data is needed. Thus the population numbers of for example January 1st 2000 and January 1st 2001 were added and divided by two to get the mid year population for 2000. This was done for all years, up to 2008.
Further the data set concerned with the number of deaths per age and sex per calendar year is needed. This too is provided by the CBS (2009d) under the title ‘Deaths: age (last birthday), sex and martial status.’ Again the population from 18 up to 99 and older is taken into account, for both males and females. Data was collected for the years 2000 up to 2008. Ages were added to end up with the total population per year for the previous indicated age groups. No

further changes were made to these figures. Use is made of the deaths recorded by age at last birthday or exact age and not of the average age at January 1st. This is related to the Sullivan method, in which the age specific mortality needs to pertain to one age, which is the case with deaths recorded by age at last birthday. The other method, average age at January 1st, takes into account deaths in one calendar year (van der Meulen and Janssen, 2007).
Contradictory to the BMI data, the data concerning the number of inhabitants and the number of deaths are all observed data. The only exception is the number of inhabitants’ data for 2009, which is a projection. Though the expectation is that the CBS is not far of with this prediction. Overall the data is collected and processed by the CBS, of which the assumption can be made that the data is of good quality.

3.6 Existing projection methods

To be able to project the obesity prevalence into the future a projection method is required, though there is not just one projection method at hand for the Dutch obesity prevalence data. Therefore several previous studies regarding obesity and other diseases have been examined. Articles were taken into account when use was made of prevalence data, the periods/years the data pertained to was recent, use was made of scenarios and if different methods were taken into account.
The aim in this research is not to find a projection method which will precisely indicate what the levels of obesity will be in the future, though the aim is to indicate what might happen if past trends are considered. As Zaninotto et al. (2009;145) state in their article “it could be argued that it is an impossible task to provide an accurate forecast of future levels of obesity, given that levels can depend so much on short-term influences”. That is why for this research various projection methods are examined to find methods that considers the past trends and the possible influence of policies.

3.6.1 Existing projections of obesity

Health Council of the Netherlands
In a 2003 publication of the Health Council of the Netherlands, titled ‘Overweight and Obesity’, it is indicated that in scientific research often the BMI is used to measure obesity and overweight. According to the WHO definition adult obesity is considered a BMI of 30 or higher. Generally there are more men with a BMI of 30+ than females. Besides that the BMI increases with age for both sexes, though within the elderly the relation of BMI and health is less clear. However despite the age the risk on obesity related diseases increases considerably from a BMI of 30 onwards.
The obesity prevalence data of MORGEN (a project of the National Institute for Public Health and the Environment) indicates that about 10 per cent of the Dutch adult population obese. This number is lower than that of the CBS due to under- and overestimation of height and weight in the health surveys of the CBS. Both though do show an increasing trend in the number obese.
Morbid obesity (BMI >40) data is not available for the Netherlands, though based on the extrapolation of American data it is estimated that about 1.0 to 1.5 per cent of the Dutch adults is morbid obese.
Within this document a projection is also made, a linear trend is used to predict the obesity prevalence in 2015. With, according to the researchers, no signals indicating a decline in the prevalence, the prevalence data of 2000 was used to predict the prevalence into the future. The Health Council of the Netherlands predicts that in 2015 between 15 and 20 per cent of the Dutch adult population will be obese (gezondheidsraad, 2003).

These calculations are based on the obesity prevalence of 2000 (11 per cent for males and 12 per cent of females) and the obesity prevalence of the 1970s, 1980s and 1990s (of which no exact data are mentioned). In the three previous mentioned decades the rise in obesity prevalence was about 3 per cent in 15 years. For the period 1993-1997 the increase in male obesity prevalence was 0.5 per cent, for females the increase was 0.4 per cent. The assumption made by the Health Council of the Netherlands was that this past increase in obesity prevalence will continue in a linear way into the future. Simultaneously they assume the linear increase for males to be a little steeper than for females (Gezondheidsraad, 2003).
Own comment on the method:
The Health Council of the Netherlands is a renowned institute which does much research for the government, hence we can assume that the research is of good quality. Though this research does not take into account the possibility that the policies and programs, which are now in place, have any effect on the prevalence. On the other hand taking the past into account gives a strong indication of were the trend might be heading. However taking the same growth as in the past is an easy way out, leaving any change that could be possible out of the equation. With all the policies being implemented and all the programs, it would be likely to go down or at least stagnate. Overall this method could be useful in this research.

Arterburn et al.
In 2004 Arterburn et al. have published an article on the future obesity prevalence under elderly (60 years and older) Americans. Within this research they have worked with different birth cohorts. The projections are based on these birth cohorts and different scenarios. Of all combinations the outcome is published. They also refer to the health and economic implications of these future prevalence’s. Data is derived from national representative surveys executed between 1960 and 2000 (Arterburn et al., 2004).
The first birth cohort is 1911-1920. All age groups will move up one age group every survey, hence an obesity prevalence line could be plotted per birth cohort. Four groups are taken into account, all the way up to the 1950 cohort, they will be 60 in 2010 (Arterburn et al., 2004).
The first scenario is a best case scenario in which they assume that obesity would change to the lowest rate observed across the observation period (1960-2000). This was completed separately for every birth cohort. Secondly there is the middle case scenario. For this they assumed that the prevalence would change to the mean rate of the change across the births cohorts. Last is the worst case scenario where they assumed that the observed changes, i.e. increase, between the last two preformed American health studies will continue for another 10 years. All previous mentioned calculations were done for three population projections, given by the U.S. census bureau, low, middle and high (Arterburn et al., 2004).
Their results show that an increase within the elderly populations is very likely. Consequently this will challenge the healthcare and financing system. All scenarios indicate an increase in prevalence, even the best case scenario. In the United States this increase in prevalence also means that the number of elderly who are obese will increase from 32.0 per cent in 2000 to 37.4 per cent in 2010 with the middle case scenario. Hence more than one in every three elderly will be obese. They have also taken into account the normal weight elderly and projected this too. Logically this group will decline, from 30.6 per cent in 2000 to 26.7 per cent in 2010 with the middle case scenario. Related to all this is also the increase on the number of elderly in the coming decades due to the world wide aging (Arterburn et al., 2004).
Own comment on the method:
This method could very well be applied to the Dutch case. Only in this research no data is available on birth cohorts, just data per age group over the past eight years. Though of these age group prevalence’s a line could be plotted of which minimum increase and mean increase

could be calculated. In this method they take into account the future population growth, which is something that needs to be considered in the Dutch case too.
The researchers have worked with scenario's of which you never know if they are right, they acknowledge this in their article. Acknowledged too, is that birth cohorts could be misclassified due to the lack of individual data. Besides that the data used is cross sectional and not follow up data. This is the reason no incidence rates could be calculated.

Zaninotto et al.
Zaninotto et al. have produced an article for the English Ministry of Public Health in 2006. In this article they project the English obesity. After indicating the prevalence data for both sexes and several regions in 2003, they use the 1993 up to 2003 data for the projection. Moreover they make use of the prevalence's by sex and age group. All the age groups are plotted and a non linear curve is fitted using a curve estimation procedure in SPSS. The prevalence rates are then projected up to 2010 based on the prevalence rates of 1993 up to 2003 (Zaninotto et al., 2004).
Use was made of power and exponential as the best fitting non linear options. Per age group the choice between the two was made based which one fitted the best. They have chosen to use power and exponential, because they both allow acceleration or slowing down to show in the projection (Zaninotto et al., 2004).
Assumption within this projection of the English obesity is that trends are not linear, all other assumptions are possible. A linear trend could be fitted to more recent data. Providing all options in the report gives a range of plausible values of future prevalence (Zaninotto et al., 2004).
Expected is that the number of English male who are obese will increase from 4.3 to 6.6 million. For females they expect an increase of about 1.2 million. Further they have produced projections by socio-demographic factors, jobs, alcohol use and different regions (Zaninotto et al., 2004).
Own comment on the method:
This too is a method that can well be applied to the Dutch case. In this article they use prevalence's by age group and sex, as in this research. Making use of SPSS is definitely something to keep in mind for the Dutch case, especially the options power and exponential.

Kelly et al.
In this article by Kelly et al. an obesity projection is made for the whole world until 2030. For this projection they make use of age and sex specific prevalence's. Within all parts of the world the women are the majority of the obese. Within overweight there is variation (Kelly et al., 2008)
Kelly et al. use two methods for projecting. In the first method they assume that the prevalence stays the same. The projection is than based on "present prevalence rates, population growth, demographic changes including age composition of the population and urbanization for regions that provided data for both urban and rural areas" (Kelly et al., 2008; 1433). In the second option they assume a secular trend obesity increase will continue. The projections are then "based on the most recent regional secular trends in prevalence of overweight or obesity estimated from available data, population growth and demographic shifts (age distribution and urbanization)" (Kelly et al., 2008; 1433). For both methods use is made of age standardised data.
The first method projects and increase of 45 per cent in the number of obese worldwide to 573 million in 2030. The second method projects 1.12 billion obese worldwide in 2030, which is 20 per cent on the adult population in the world. Most increase is expected in the fast developing regions in the world (Kelly et al., 2008).

The projection for the whole world might be influenced though by the fact that for several countries the prevalence data on obesity was not there. For these countries an estimate was produced by giving it the prevalence of a geographically similar country of comparing the GNI. Besides that the counties of which the data was lacking make up only a small percentage of the world population. Overall though the projection results are quite similar to other research (Kelly et al., 2008).
Own comment on the method:
Aspects of this article that can be useful are the two ways of projection. In the one they keep the prevalence the same and in the other they take the trend into account. They could be taken into account in the Dutch case. All data here is age standardised, I am not sure whether this should be done in the Dutch case.

Dal Grande et al.
In this article Dal Grande et al. (2005) look into obesity in South Australia. Data is derived from face to face interviews with adults executed from 1991 up to 1998 and 2001 and 2003. Information gathered on BMI is self reported data. Of all South Australian adults 8.7 per cent is obese in 1991, in 2003 this has risen to 14.1 per cent (Dal Grande et al., 2005).
The BMI data is standardised in this research to control for the change in age and sex profile over time. Though the researchers have individual data. "Significant changes in the prevalence of obesity over time were examined using the X^2 for trend test and the Durbin-Watson test was used to test for autocorrelation over time" (Dal Grande et al., 2005;344). Both were preformed using SPSS. Projections were made with linear regression, using the current proportions. Further the researchers have made use of birth cohorts to find out which cohort had the largest increase over time. Four birth cohorts were determined; pre 1925, 1925 up to 1945, 1946 up to 1964 and 1965 up to 1980 (Dal Grande et al., 2005).
Projected for 2013 is a total of 27.8 per cent of the South Australian adults to be obese, for males the percentage is 26.4 and for females 29.3. Further there is an indication that the prevalence does grow fastest within the younger adult age groups (Dal Grande et al., 2005).
In this research data has been used from large scale samples, which have been constant over the years. Also self reported data was used, which could have an influence on the prevalence data. Though using the method of self reporting is acknowledged as being effective for monitoring purposes (Dal Grande et al., 2005).
Own comment on the method:
In this research they use individual data, which is self reported. It is good to see that other research is also conducted with self reported data. They use age groups and cohorts, though the SPSS calculations are a little vague. For the projections they use linear regression, which is something to keep in mind for the Dutch case. Again here the data is standardised, I am not sure whether this should be done in the Dutch case.

Veerman et al.
Veerman et al. (2007) project obesity until 2015 in their article. They have constructed a model in which they describe the population in terms of BMI. The researchers assume that: "Underlying the prevalence of overweight and obesity is the population distribution of BMI, of which the mean predicts the number of deviant individuals. It, therefore, makes sense to relate changes in the prevalence of obesity and overweight to the mean BMI of a population" (Veerman et al, 2007; 2366).
With a mathematical construction they describe the population by its BMI, which is the base line population. After that future populations can be derived form the base line population. These future populations can be made by manipulating the mean BMI of the base population, this will influence the variance (Veerman et al, 2007).

Following one projection with intervention and one without (same mean BMI) intervention are made until 2015. In the projection without intervention the trend in BMI remains the same. Expected with this method is that male prevalence increases from 25 per cent in 2000 to 39 per cent in 2015. For females the consecutive percentages are 32.2 and 44.5. The projection with the interventions takes into account an intervention policy, which increases the daily activity. With this projection it is expected that males move from 25 per cent in 2000 to 26.3 per cent in 2015. For females they expect an increase from 32.2 per cent in 2000 to 37.1 per cent in 2015 (Veerman et al, 2007).
For the model in this article assumptions are made of log normality of the BMI distribution and the population level energy balance. This of course has an influence of the outcome of this research. Both have an influence on the obesity prevalence, either under- or over estimating it. This is reflected in the predictions made in this article which are a little higher than predicted in other articles using data on the whole of the United States (Veerman et al, 2007).
Own comment on the method:
Within this article they take into account the whole population and the BMI distribution to produce a base line population. In this research not the whole population is taken into account, hence the method is not very useful. Though the two projection ways, one without and the other with influence of intervention, could be applicable to the Dutch case.

Wang and Beydoun
Wang and Beydoun (2007) look into the obesity epidemic in the United States. For gender, age, socioeconomic situation, ethnicity and geographical characteristics trends are indicated. Data for these trends is derived from national representative surveys.
The projections are made with use of linear regression models. With this model they have estimated the annual increase for every group between 1980 and 2004. For some groups the pace was faster than in others. The increase was faster for adult females that for adult males for example. For all groups these estimates were calculated and the projection was based on that (Wang and Beydoun, 2007).
Expected is that the adult obesity prevalence will be 40.8 per cent in 2015. For non-Hispanic Black women the percentage will even be 62.5 per cent (Wang and Beydoun, 2007).
Own comment on the method:
In this research use is made of linear regression too. For the Dutch case it needs to be investigated if this method can be used. Taking into account the annual increase for every group is something that can be applied in this research.

Zaninotto et al.
This article by Zaninotto et al. (2009) relates to the previous mentioned article on the projection of English obesity for the English Ministry of Public Health also by Zaninotto et al. (2004). In this article the researchers aim to project the English obesity too, now until 2012. For this they use the prevalence data from 1993 up to 2004. In this period the prevalence’s have grown fast, from 13.6 per cent to 24.0 per cent for males and from 16.9 per cent to 24.4 per cent for females. The researchers use three scenarios to project the English obesity until 2012. All data is standardised by age and a 95 per cent interval is calculated (Zaninotto et al., 2009).
The first projection model is based on extrapolation of the linear trend from 1993 up to 2004. If this were true the prevalence’s will be 32.1 per cent for males and 31.0 per cent for females. Projections made with the second projection method are based on the best fitting curve, which can either be power or exponential. This to allow for change, acceleration or slowing down, in the prevalence rates of obesity. For males the power method leads to a prevalence of 25.7 per

cent in 2012 for females it is 26.2 per cent. The exponential method indicates a prevalence of 37.9 per cent for males and 33.9 per cent for females (Zaninotto et al., 2009).
For the third method, extrapolation of the linear trend, prevalence date from the six most recent years, 1999 up to 2004, is used (Zaninotto et al., 2009).
All projection methods indicate an increase, though they differ on how large the increase will be. The one method suggests one in every four English adults will be obese in 2012, the other indicates one in every three (Zaninotto et al., 2009).
Results of this research could be biased though by the decline in response rate in the surveys conducted from 1993 up to 2004. Respondent's bias could occur when non response people are more obese people or low educated, then they are left out of the survey. This in turn can lead to underestimation of the obesity prevalence. Besides that the prevalence might be affected, because people over 130 kg were excluded (Zaninotto et al., 2009).
Own comment on the method:
As the previous discussed article by Zaninotto et al. (2006), this too is a method that can well be applied to the Dutch case. The use of three different projection methods will give a broad view on what the future might hold. Besides that the use of past trends to base the projections on is a thing to keep in mind.

McCusker et al.
This projection made by and for the state of Texas includes the assumption that the past rapid increase in prevalence will not sustain into the future. That increase will not be sustainable over time. Hence they assume a decrease will take place in the obesity prevalence or at least the prevalence change over time will slow down. In their projection until 2010 they take ¼ of the prevalence growth of 1999 up to 2002. For the next three decades they take ½ of the prevalence change until 2010 (McCusker et al., 2008).
The data used for making the estimations is derived from secondary sources, hence the reliability depends on the collection of this data and the recording of the mortality and morbidity data. Though use of secondary data is quite normal in research. Besides that use is made of self reported BMI data. When in Texas obtained prevalence's are compared to the nation wide collected prevalence data a discrepancy is shown. The used prevalence's in this research are lower then that of the nation wide study, hence underestimation of the BMI has taken place by the self reporting (McCusker et al., 2008).
Own comment on the method:
An aspect of this research which can be useful is the fact that they assume stagnation or a decline in the prevalence. They way they make an assumption on this, by taking a percentage of the previous trend can definitely be used in the Dutch case.

3.6.2 Existing projections of diseases

Brookmeijer et al.
In this research Brookmeijer et al. (1998) look into Alzheimer's disease. With this research they want to project the future prevalence and incidence of Alzheimer's disease in the United States. They take into account the present number of ill people and the new diagnosed persons. This to find out how many new cases can be expected in the coming 50 years. For this they use age specific incidence rates and mortality rates. The expectation is that in the coming year a large increase in the number of new cases will be the case (Brookmeijer et al., 1998).
Own comment on the method:
In this research they take into account incidence rates, which will be difficult to calculate in the Dutch case of obesity. There number of people in an age group in a particular year is

known (i.e. the group at risk), though the number of new cases is hard to judge. The increase or decrease in the number of cases per year in an age group could be looked at, though it is not known if in every year different people were interviewed, or if double counting is possible. Moreover the prevalence rate of obesity is very volatile, which will cause a negative number of new cases. In a formula used in the research they move on to use mortality rates, which are there for obesity (ICD E66), though very low. I am not sure if this will be of use. Maybe use of this technique is possible for the overall obesity prevalence or a few age groups. In this research some other aspects were mentioned that could be useful for the Dutch case. They enter all the data into SPSS, to produce an average curve. The researchers use a minimum and a maximum to establish a plausible range and multiple scenarios. Another thing to keep in mind is the growth of the population groups in the future. If the groups grow, more people can be obese in these groups. This could have an effect on the prevalence in the future. Within this growth there can be differences for males and females.

Miyasaka et al.
In this research, by Miyasaka et al. (2006), on Atrial Fibrillation, use is made of age-, sex- and calendar year specific incidence rates. Limited data exist on this disease and they looked into one area being Olmsted County, Minnesota, United States. In the research the use age adjusted Atrial Fibrillation incidence data. Although this might be an underestimation due to the fact that not all patients were seen in the hospital were the research was conducted. With the Poisson model the overall rates were calculated. Further they use linear regression and Poisson regression for the projections. The projection shows and increase in Atrial Fibrillation incidence. This prevalence projection for the whole of the United States is derived from three local studies, hence it is uncertain if this projection is really valid for the whole country. Besides that most of the research participants were white, this also might influence the study and the projections for the whole country (Miyasaka et al., 2006).
Own comment on the method:
Again in this research incidence rates are used, which are difficult to calculate with the Dutch data on obesity. Use of the Poisson model in the Dutch case should be looked into.

Looking back on the discussed articles, they almost all use prevalence data and might also indicate the total number of obese. Most articles report on the total population, though some take into account birth cohorts of different (age) groups. Articles about other illnesses than obesity, also take into account incidence data. Furthermore most articles use recent prevalence data. The biggest difference between the articles is in the methods and scenarios. Different projection methods that are used are linear growth, non linear growth, extrapolation of annual, lowest or mean growth or a decrease with respect to the present trend. Some researchers take into account different birth cohorts, others look at the influence of interventions. Overall all articles have aspects that can be very useful for the projections in this research.
One or multiple of these projection methods just discussed will be used to project the Dutch obesity prevalence. This will result in prevalence's for the years 2009 up to 2015 for all different age groups. In turn these new prevalence's will be re-entered into the Sullivan method life table to produce the future OALEs. With this the change in number of inhabitants and number of deaths is taken into account.
In this research prevalence per age group is the starting point, from there on projections will be made and the future OALE will also pertain to these age groups. The final outcomes will be given in prevalence's and the OALE in years. The decision to make projections for the different age groups is related to policies, which can be targeted better if data is available for the different age groups. Though another method is to work with the total prevalence as starting point to project this total prevalence and later redistribute the future prevalence over

the different age groups. Also the final outcome could be in the total number of obese instead of prevalence’s. When projecting the individual age groups causes problems this latter method might be an alternative.

3.7 Selected projection scenarios

From part 3.6 it has become clear that many projection methods exist. In every research different methods are used depending on the data available in that study. Many of the indicated projection methods can be applied to the Dutch obesity prevalence data in some sort of way. It has been decided to use a variety of projection methods to create a wide view on the future prevalence and the OALE. Nobody knows what the future might hold; hence having an indication of several possible futures can be an advantage. The combination of the five scenarios should provide a plausible indication for the future. Government policies and programs to counter obesity trend can be tuned to these possible futures. Considering that obesity prevalence data is only available for nine years (2000-2008), the projection will be made up to 2015.
The following scenarios are chosen to give a projection for the future obesity prevalence:

1. Linear trend. In this scenario further linear growth of the present obesity prevalence trend is assumed. Even though further growth of the obesity trend in a linear way is very unlikely, this scenario has been taken into account as the Health Council of the Netherlands (2003) made a projection making use of the linear trend. Due to the fact that linear growth is unlikely in the case of obesity this scenario is also considered to be a sort of worst case scenario.
2. Power trend. One of the reasons this scenario has been considered is due to the fact that Zaninotto et al. (2004) have used this form of non linear growth in their projection of the British obesity prevalence. Further the development of the obesity prevalence with a power trend is more likely to occur than the opposing linear trend.
3. Exponential trend. One of the reasons this scenario has been considered is due to the fact that Zaninotto et al. (2004) have used the exponential trend too in their projection of the British obesity prevalence. This type of non linear trend is also expected to be more likely than a linear trend. Both the power and the exponential trend are able to take acceleration or slowing down of the trend into consideration, which is useful in the very volatile Dutch obesity prevalence.

   Scenario one, two and three all anticipate on the failure of the government and the different organisations concerning the obesity prevalence. All their effort does not lead to a decline in the obesity prevalence by 2015. Besides that these three scenarios are trend based scenarios.
4. Stable prevalence. In this scenario for all age groups the obesity prevalence will remain on the 2008 level up to 2015. This projection method has been used by Kelly et al. (2008) in their research on the obesity prevalence. Within this scenario the effect of government policy and the numerous programs on obesity prevention has been taken into account, from 2008 onwards the trend stagnates. The stagnation of the obesity trend is a goal of the government too. This scenario also gives the change to see if the OALE is influenced by the stagnation of the obesity prevalence or not.
5. Decline of prevalence. This scenario is a step further than scenario four, a decline of the obesity prevalence will occur in every age group. Within this scenario it is assumed that governmental prevention programs and the programs of many organisations show result by 2015, in the form of prevalence decline. This scenario might not be very relevant right now a decline is not visible in the overall trend. Though with this scenario the influence of a decline on the prevalence and on the

OALE could be seen. Especially the influence on the OALE is of interest; will this be a large influence or not.

For all projection scenarios the past obesity prevalence trend is needed as input. Though as mentioned in part 3.3 (Description of secondary obesity data), the Dutch obesity prevalence is very volatile and smoothing would be applied. The smoothing has been executed by using a three year moving average. Hence the obesity prevalence rate of for example 2000, 2001 and 2002 have been added and divided by three, to obtain the new smoothed prevalence for 2001. This has been done for all age groups from 2000 up to 2008. As a result for all age groups the trend line is much smoother and does much more indicate a decline or an increase.
This smoothed obesity prevalence for the years 2000 up to 2008 has also been used in the calculations of the OALE for these years. Instead of the observed obesity prevalence for this period the smoothed prevalence has been used in order to create a better comparable OALEs. Now they are all calculated with the same set of obesity prevalence data (smoothed), which will rule out difference due to the use of different data sets.

For every projection scenario use is made of Excel, for calculations, graphs and trend lines. First of all for every scenario the obesity prevalence is entered and the smoothed obesity prevalence from 2000 up to 2008 was calculated, which is the same basis for every scenario. This is followed by making graphs per age group and fitting trend lines to all of them. The following methods have been used in the projection scenarios:

1. Linear trend. In this scenario use has been made of LINEST, which calculates the linear trend line that fits to the smoothed obesity prevalence trend data. This method produces the formula per age group, which has in turn been used to calculate the obesity prevalence from 2009 up to 2015. Consecutively these projected prevalence’s per age group, per sex and year have been entered into the new life tables to calculate the OALE.
2. Power trend. To obtain the projection result of the power trend, trend lines have been added to xy graphs with the smoothed obesity trend. Excel does not provide a similar method as with the linear trend for the power trend, hence the xy graphs method is used. This may cause the projection of the obesity prevalence to be a little less precise than the other trend line projections. Due to more manual calculations the possibility on errors is larger.
3. Exponential trend. To obtain the projection results of the exponential trend, use is made of the Growth method in Excel. This method provides the prevalence’s for 2009 up to 2015 directly, whereas the LOGEST method gives the formula first which can be used to calculate the future prevalence’s. Even though the LOGEST method is a regression analysis method and Growth is not, the Growth method has been used. This is because they give the same results for the projected prevalence’s and with the Growth method the results are shown directly and thus avoids mistakes.
4. Stable prevalence. Obtaining the future obesity prevalence’s is the easiest in this scenario. The smoothed prevalence of 2008 remains the same for every age group up to 2015 only the population and number of deaths changes in the life tables.
5. Decline of prevalence. Deciding on the amount of the decline is quite hard because the general trend is the obesity prevalence is not a decreasing one. Hence this scenario is not based on the overall past trend. The dilemma is how much the prevalence will decline if the enacted programs go to show some result i.e. a decline in obesity prevalence. Several obesity prevention programs are in place now for several years

and no real decline has been seen yet, so if a decline would occur it will be a slight decrease.

Thus to determine a decline for the coming years, there is no real guide, hence several possible ways have been explored. Another look has been taken at the literature, though they either consider a stabilisation or a slowing down of the growth or a further increase. None of them consider a decline, mostly because it is not really realistic yet.

Some statistical measures that have been tested did not work out. Taking the average of the prevalence of the past nine years for all age groups, was not useful for many age groups. Often the average was higher than the prevalence of 2008, hence then there would be an increase instead of a decline.

A decline to the lowest prevalence recorded in the past 9 years gives a lower prevalence than in 2008 for all age groups. Though for some age groups this will mean a huge decline in just a few years, which will not be realistic.

Taking the median of the trend is not applicable to all age groups. Again the median will be higher than the prevalence in 2008, which will cause an increase of the prevalence and not a decline. Also the highest prevalence recorded is no option, nor is subtracting the lowest prevalence from the highest. This does not provide realistic prevalence’s for the year 2015, there would be many unrealistic declines in prevalence.

It has been decided to base the decline on the slight declines which have been seen in the obesity prevalence trend of a few age groups. The male age groups 25-34 and 45-54 and the female age groups 45-54 and 75+ show small declines within the normal obesity prevalence. When the smoothed prevalence is concerned the male 25-34 age group and the female 75+ age group show a decline which is even smaller. In the normal prevalence the decline is on average 20 per cent, with in the smoothed prevalence the decline is on average three per cent. Hence the normal prevalence gives a quite large decline and the smoothed prevalence hardly any decline. Though it has been decided to use the average decline of the smoothed prevalence. In all other calculations the smoothed prevalence has been used, hence it is the most logical to use it here as well. This results in 3.2 per cent decline for every age group by 2015. In the years in between the prevalence decline will be evenly spread. With this decline every age group will decline with the same percentage, which will cause the higher prevalence’s to decline faster than the lower prevalence’s. With this method all the age groups experience the same proportional decline and good comparisons will be possible, also for the OALE.

For all the scenarios separately and for the comparison of the scenario use has been made of tables in this research. The tables in the results chapter often contain a column which indicates the proportional change (%) that has occurred in a certain period of time. These proportional changes have been calculated with the following formula: (N-O)/O. Firstly the old data is subtracted from the new data and than divided by the old data.

Another point that needs to be clarified once more is that in this research is that the Health Adjusted Life Expectancy is renamed the Obesity Adjusted Life Expectancy (OALE). This is because only obesity is considered in the Sullivan method and no other diseases, hence only the effect of obesity is measured. Besides the OALE the proportion of remaining life lived without obesity is also looked at to see the effect of obesity at the general health.

A last thing that has been taken into account with all projection scenarios is the change in the number of population and the number of deaths. In the life tables for the projection period (2009-2015) new data on the number of inhabitants and the number of deaths needs to be entered, in order to calculate the future OALEs. The data used in this research is derived from the CBS, who provides projections on these two aspects on their website until 2050. Data on the future population has been derived from ‘Projected population on January 1st by age and sex, 2009-2050’, (CBS, 2009e) for the future number of deaths the data has been derived from ‘Projected life born, diseased and migration, 2008-2049’ (CBS, 2009f). For both data per age and sex has been collected, which has been added to obtain the data per age group for every year. Both projections are part of the population projections of the CBS.

4 The effect of the obesity epidemic on the Dutch health

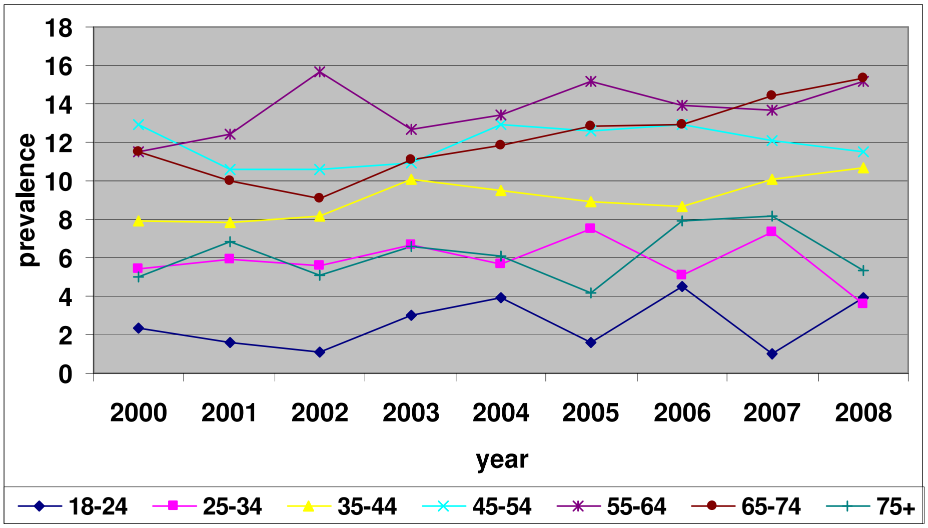
Central in this research are the projections of the obesity prevalence and the OALE. In this chapter the present and past trend of the obesity prevalence will be illustrated firstly, which will be followed by the present and past trend of the OALE based on the obesity trend. Based on the past obesity trend five projection scenarios have been made. The results of the projected obesity prevalence are shown per scenario, starting with the most likely scenario followed by the alternative scenarios and lastly a comparison. With the projection of the OALE the same order is used, the results of the scenarios are given separately and are compared at the end. Overall this chapter will provide more insight into the present and past obesity prevalence and OALE trends and what the future might hold considering these past trends.

4.1 Obesity prevalence trend

In 2008 11 per cent of the Dutch adult population suffered from obesity, for the male population the prevalence was 9.9, for females 12.1. As well as for the total population as for the males and females an increase of the obesity prevalence has occurred in the past years (see appendix A).
An increase in obesity prevalence can also be seen for the individual age groups of which the past trend is shown in figures 4.1 and 4.2. For both males and females all age groups show a quite volatile pattern. They all show many ups and downs, besides that there is quite a lot of difference between the age groups. Age group 18-24 of the males shows prevalence’s between one and four and a half, for the male age group of 55-64 prevalence’s between nine and 15 are recorded (figure 4.1). Overall the prevalence increases as the age group increases; the prevalence is higher in age group 25-34 than in age group 18-24. Only exception on this is the 75+ age group, this age group shows prevalence’s similar to the 25-34 age group. The three highest age groups show the most volatility, they have the largest difference between the lowest and the highest recorded prevalence. Generally a slight increase of the obesity prevalence is seen for most male age groups.
The story of the trend in obesity prevalence of the males largely applies to that of the females. All the female age groups show a volatile pattern too, as well as large differences between the different age groups. Age group 18-24 shows the lowest prevalence’s recorded; between two and a half and seven (figure 4.2). The largest prevalence’s are recorded within the 65-74 age group; 14 up to 19.5. In general the prevalence increases as the age group increases, only the 75+ age group is an exception again. For the females this age group is more in line with the 55-64 age group. As with the male age groups, the largest three age groups of the females show the largest difference between the lowest and the highest recorded prevalence. In accordance to the male prevalence, the female obesity prevalence does show an increasing trend too.

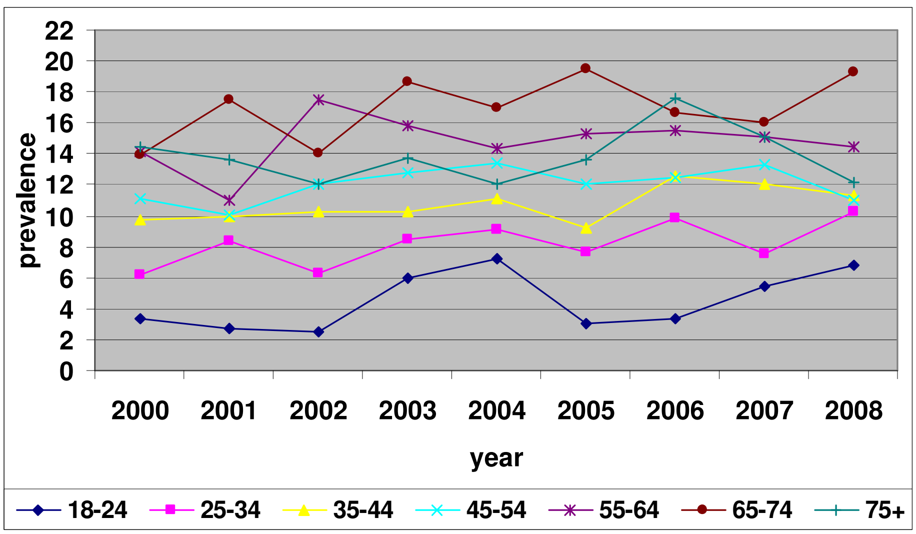
Overall the past obesity prevalence trend of the males and females are quite similar. They both show volatile patterns, though for both an increase in prevalence is visible. The only difference is that the female prevalence is higher in all age groups for all years, except in a few cases in the 45-54 and 55-64 age groups.

Figure 4.1: Male obesity prevalence trend, per age



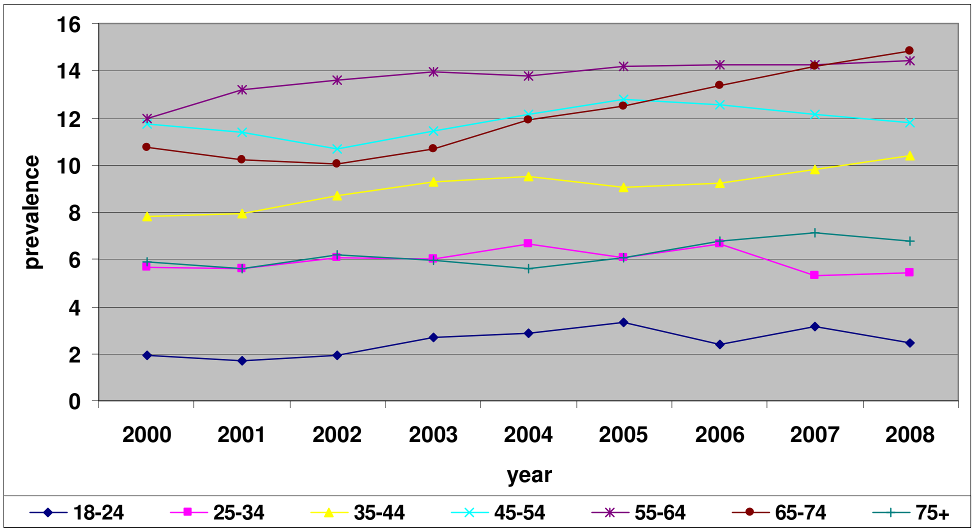
Source: CBS, 2009a

Figure 4.2: Female obesity prevalence trend, per age



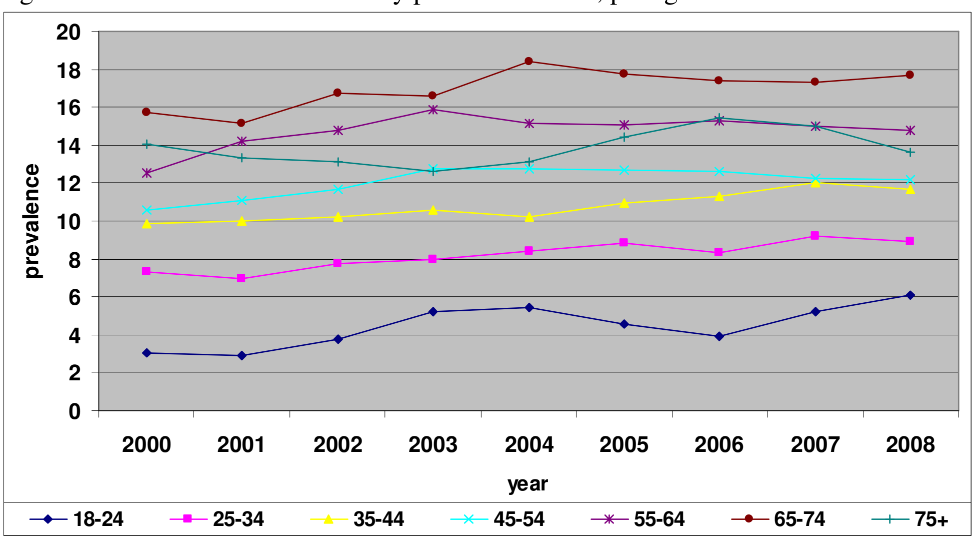
Source: CBS, 2009a

Figure 4.3: Male smoothed obesity prevalence trend, per age



Source: CBS, 2009a, adapted.

Figure 4.4: Female smoothed obesity prevalence trend, per age



Source: CBS, 2009a, adapted.

From the figures 4.1 and 4.2 it can be concluded that the obesity prevalence data from 2000 up to 2008 is not really a good basis to make a projection on. Due to the volatility the projection for the future will not be very reliable. There are several aspects that play part in this volatility of the obesity prevalence data. With a survey (Permanent Research on Living Situation) the Central Statistics of the Netherlands (CBS) has obtained the data on the obesity prevalence. In the survey the interviewee reports his or her weight and height. Both surveys and self reported data can compromise the quality of the data (a further elaboration on this can be found in the 'Data and methods' chapter).

Another aspect that can contribute to the volatility in all age groups is the selected sample. The annual obesity prevalence is based on the results of the questionnaires of that year. Due to the fact that it is a random sample, one year more obese people could be in the sample than in another year. This could cause the trend to be as volatile as it is. Thus basing the future trend on this past trend would not result in a realistic projection. Therefore a three year moving average (a smoothing technique) has been applied to all prevalence data of all age

groups. This results is much smoother lines as can be seen in figures 4.3 and 4.4. When these figures are compared to figures 4.1 and 4.2 it is clear that the smoothed lines indicate a trend much better. For that reason the choice has been made to use the smoothed obesity prevalence data as the trend data on which the projection is based. All further references and calculation in this chapter to or with the obesity prevalence data refers to the smoothed obesity prevalence data.
A further reason to use the smoothed prevalence data and not the normal prevalence data is that the trend lines do fit (R^2) the smoothed data better. As indicated in table 4.1 the trend lines fitted to the normal prevalence data fit less good than the trend lines fitted to the smoothed prevalence. For example the R^2 of the ‘power smoothed’ is larger than the ‘power’ in the male 18-24 age group. Only exception is the male 25-34 age group, in the linear and exponential case the use of the normal obesity prevalence data results in a better fit (R^2) of the trend lines. However overall the fit of the smoothed prevalence data is better, which indicates that the use of the smoothed prevalence is better to base the future trend on. For these reasons the smoothed obesity prevalence data from 2000 up to 2008 is used in this research. The bold figures in the table indicate which trend line has the best fit on the smoothed prevalence data per age group, which is in most cases the smoothed power trend.

Table 4.1: R^2 (goodness of fit) of the applied trend lines to the normal and smoothed prevalence data

R^2 males	Linear	**Linear smoothed**	Power	**Power smoothed**	Exponential	**Exponential smoothed**
18-24	0,1189	0,4091	0,0424	**0,5063**	0,0452	0,4473
25-34	0,0149	0,0020	0,0060	**0,0138**	0,0478	0,0043
35-44	0,6027	0,8471	0,5983	**0,8527**	0,6132	0,8441
45-54	0,0559	0,2948	0,0221	0,2389	0,0643	**0,2951**
55-64	0,3980	0,7581	0,4494	**0,9265**	0,3490	0,7361
65-74	0,7515	**0,8909**	0,4687	0,6601	0,7187	0,8878
75+	0,0831	**0,6143**	0,0704	0,4323	0,0617	0,6100

R^2 females	Linear	**Linear smoothed**	Power	**Power smoothed**	Exponential	**Exponential smoothed**
18-24	0,2542	0,5921	0,2449	**0,6551**	0,2754	0,6061
25-34	0,4059	**0,8355**	0,4287	0,8011	0,4015	0,8302
35-44	0,4314	0,8842	0,3686	0,7515	0,4201	**0,8914**
45-54	0,1447	0,4475	0,2568	**0,6988**	0,1473	0,4601
55-64	0,0606	0,3221	0,1258	**0,6096**	0,0813	0,3320
65-74	0,2633	0,5528	0,3448	**0,6484**	0,2732	0,5612
75+	0,0269	**0,2226**	0,0043	0,1111	0,0199	0,2189

Source: own calculations

4.2 Obesity Adjusted Life Expectancy trend

For the Obesity Adjusted Life Expectancy large differences exist between the age groups, this is due to the difference in life expectancy. Hence it is hard to give one figure for the whole population in 2008. For the individual age groups though this is possible. In 2008 the males OALEs varied between 55.1 for the 18-24 age group to 10.7 for the 75+ age group. For the females the consecutive numbers were 57.6 and 11.9 (see table 4.2). Hence the OALE is larger for the females than the males.

The past trend of the Obesity Adjusted Life Expectancy (OALE) is related to the obesity prevalence of section 4.1. Entering this obesity prevalence into the Sullivan method results in an outcome which is called the disability free life expectancy. This latter is the equivalent of the Health Adjusted Life Expectancy (HALE), the health adjusted aspect is the disability aspect. Hence in the case of obesity in the Sullivan method the HALE is called the ‘Obesity free life expectancy’. To avoid confusion with the HALE, which is a measurement which includes more than just obesity, measuring the effect of obesity will be called the Obesity Adjusted Life Expectancy (OALE) in this research.

Table 4.2 gives an overview of the outcomes of the Sullivan method for the obesity prevalence trend from 2000 up to 2008. In this research the starting age group is 18-24, hence the life expectancy outcome refers to the remaining life expectancy at the first age of the age group. As these life expectancies are calculated for this research they differ slightly from the numbers which the CBS provides, though not large enough to make changes in it. Another outcome, as mentioned, of the Sullivan method is the Obesity Adjusted Life Expectancy (OALE), which is the number of years remaining lived without obesity. Lastly from the previous two outcomes, life expectancy and OALE, a new one is generated, the proportion of life lived without obesity.

Taking a further look at table 4.2 shows that for males and females in all age groups the remaining life expectancy has increased from 2000 up to 2008. Although the increase is almost twice as large for males as for females. A similar pattern is visible for the OALE. All age groups show an increase, only all the male age groups have grown almost twice as much. For both the remaining life expectancy and the OALE there is an increase in proportional growth towards the higher age groups. A growth of the OALE is remarkable considering the increase of the obesity prevalence. Figure 4.5 visualises the increase of the OALE for two age groups of both males and females. These two age groups have shown the largest increase over the past year and this increase is clearly visible, as is the difference in growth between males and females.

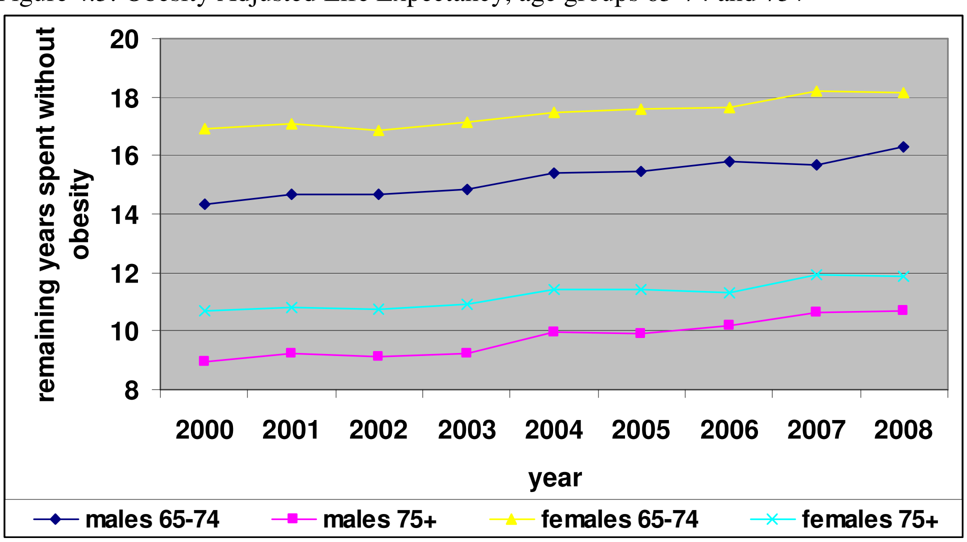
For all age groups the proportion of life lived without obesity has declined, except for the female 75+ age group (table 4.2). Within all age groups, except the latter, the proportional growth in the OALE has been smaller than the proportional growth in the remaining life expectancy, resulting in a decline in the proportion of life lived without obesity. Contrary to the other outcomes, the proportional decline of the males and females is about the same. Although the declines are very small, they do exist. This means that more or less all age groups lived more of their remaining life with obesity. For three age groups, which show the largest decline for the males, this decline is visualised in figure 4.6, which evidently shows the decline for both males and females. Both sexes show a stabilisation of the decline in the last three years and for females there is even a slight increase visible.

Table 4.2: Remaining life expectancy, Obesity Adjusted Life Expectancy and proportion of life lived without obesity, per age

	males			females		
Remaining Life Expectancy	**2000**	**2008**	**%00-08**	**2000**	**2008**	**%00-08**
18	58,48	61,66	5,44	63,70	65,62	3,02
25	51,75	54,84	5,97	56,81	58,70	3,33
35	42,07	45,11	7,23	47,02	48,87	3,93
45	32,60	35,57	9,11	37,46	39,22	4,68
55	23,66	26,49	11,95	28,37	30,04	5,89
65	15,70	18,29	16,50	19,84	21,48	8,27
75	9,54	11,49	20,44	12,43	13,74	10,48
Obesity Adjusted Life Expectancy (OALE)						
18-24	53,68	55,73	3,82	56,94	57,55	1,07
25-34	47,07	49,07	4,25	50,26	51,05	1,58
35-44	37,93	39,86	5,09	41,17	42,09	2,23
45-54	29,18	31,30	7,25	32,54	33,56	3,12
55-64	21,31	23,29	9,27	24,39	25,47	4,46
65-74	14,35	16,33	13,73	16,90	18,17	7,53
75+	8,97	10,71	19,35	10,69	11,86	11,00
Proportion of life lived without obesity						
18-24	91,80	90,39	-1,54	89,39	87,71	-1,89
25-34	90,95	89,47	-1,63	88,46	86,97	-1,69
35-44	90,14	88,34	-1,99	87,56	86,12	-1,64
45-54	89,52	87,99	-1,71	86,86	85,56	-1,50
55-64	90,07	87,91	-2,40	85,96	84,79	-1,35
65-74	91,42	89,25	-2,37	85,18	84,60	-0,68
75+	94,10	93,25	-0,90	85,95	86,35	0,47

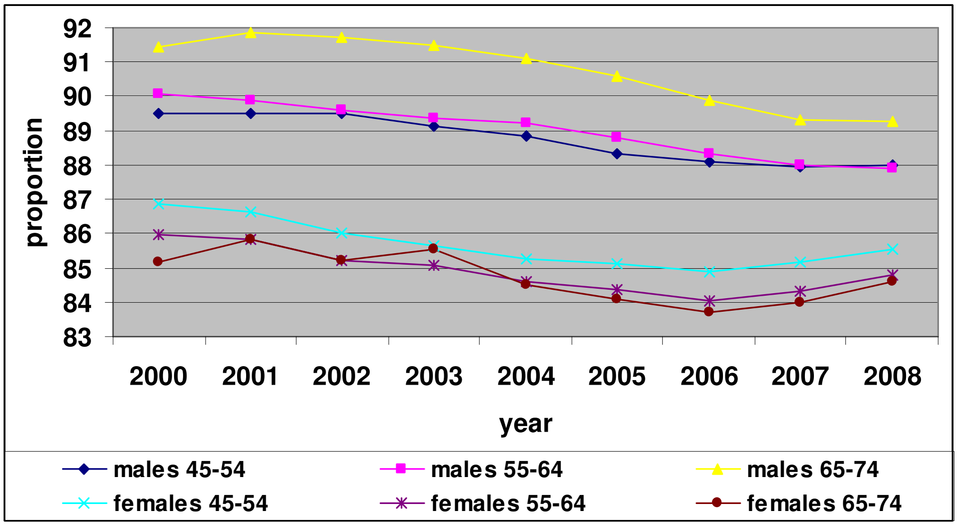
Source: own calculation

Figure 4.5: Obesity Adjusted Life Expectancy, age groups 65-74 and 75+



Source: own calculation

Figure 4.6: Proportion of remaining life lived without obesity, age groups 45-54, 55-64 and 65-74



Source: own calculation

4.3 Most likely future obesity prevalence

Nobody knows what the future will bring; hence making projections for the future is risky. That is why in this research the choice has been made to look into several possible 'futures'. With the projections for the future a wide view will be given of what can happen to the obesity prevalence. It is not the objective to exactly indicate what will happen; instead a broad spectrum of possibilities is given.

The scenario that has come forward as the most likely scenario will be discussed here, which is the power scenario. From table 4.1 it has become clear that in half of all the age groups the power trend line has the best fit, that is why this scenario has come forward as the most likely. Besides that the power scenario is often the middle one in the outcomes of all scenarios, thus it functions as a sort of middle case scenario or baseline scenario.

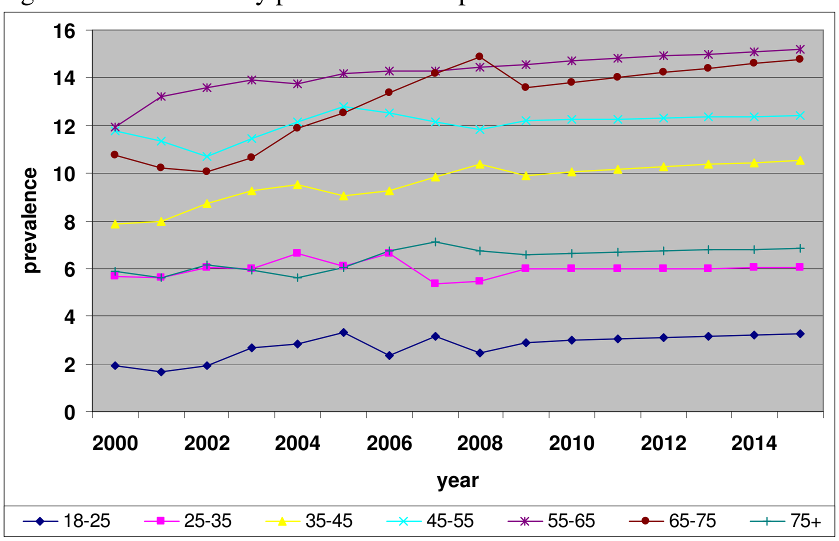
Moreover future development of the obesity prevalence in a non linear way is more likely than in a linear way. There are multiple forms of non linear growth, though power is on of them which allows acceleration or slowing down to show in the projection (Zaninotto et al., 2004). Non linear growth has also been applied to obesity prevalence research by Zaninotto et al. (2004, 2009).

Applying a power trend to the past obesity trend leads to an increase of the obesity prevalence for all age groups (figure 4.7 and 4.8). Both figures clearly show that some age groups have a larger increase in prevalence than others. For some age groups, for example the male 65-74 age group, an sudden decline in visible between 2008 and 2009. This is due to the fitted trend line, which has considered the lower prevalence in 2000 too. With regard to 2000 the male age groups 25-34 and 45-55 show only a minor increase in 2015, the other age groups especially 18-25 increase with a larger proportion (table 4.3). A deviation occurs in the 65-74 age group with regard to 2008, that age group shows a minute decline. All other age groups still show an increase. Not all age groups show the same proportional growth when only the projected prevalence is concerned (2009-2015). The 18-24 age group for example grows with more than 12 per cent, while the 25-34 not even grows with one per cent.

Looking at the female age groups, it is the 18-24 age group too whom shows the most increase for the period 2000 up to 2015. The 75+ age group shows here the smallest increase, while all other age groups grow with around 15 to 30 per cent. With regard to 2008 the

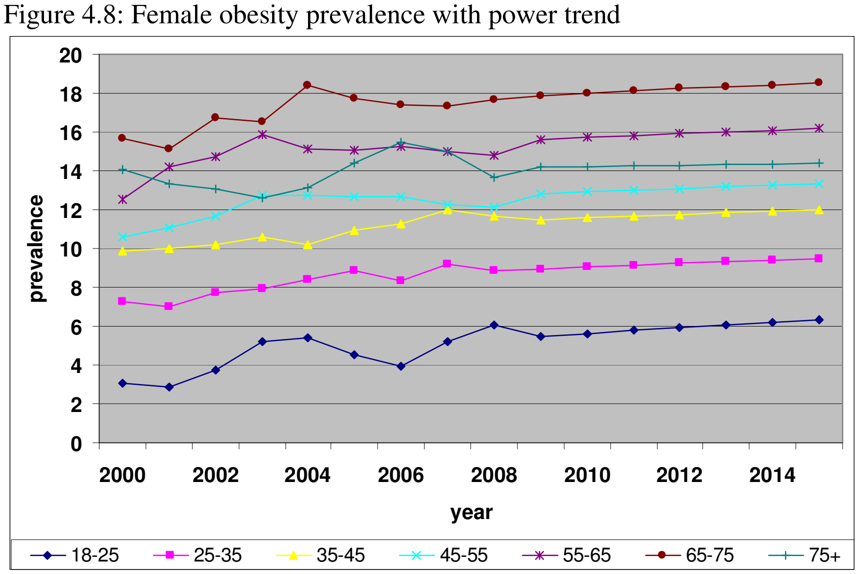
proportional growth is much smaller for all age groups, percentages are now between three and 10 per cent. Taking into account only the projected prevalence's (2009-2015), than all age groups still show an increase, though being it small. Only the 18-24 age group stands out again, with a growth of over 16 per cent.
For the males there is no clear trend in which the change in prevalence increases or decreases with increase or decrease of the age group. Though for the females a descending trend is visible for the projected period (2009-2015), the proportional growth declines with the increase of the age group. For all other periods this is not the case. The 18-24 age group shows the largest increase for both sexes in the periods 2000 up to 2015 and 2009 up to 2015. However in the 2008 up to 2015 period the former applies to the males, but not to the females. In that period the 18-24 age group shows the second lowest increase, the 45-54 and 55-64 age groups increase the most. Besides that it is not the case that the male or female age groups increase with larger amounts than the other, this is different for every age group. Generally the power projection causes quite some differences between males and females, as well as between the different age groups.

Figure 4.7: Male obesity prevalence with power trend



Source: own calculation

Figure 4.8: Female obesity prevalence with power trend



Source: own calculation

Table 4.3: Obesity prevalence with power trend, per age and sex

males								females						
	2000	**2008**	**2009**	**2015**	**08-15%**	**09-15%**	**00-15%**	**2000**	**2008**	**2009**	**2015**	**08-15%**	**09-15%**	**00-15%**
18-24	1,95	2,45	2,90	3,27	33,37	12,71	67,56	3,05	6,10	5,44	6,34	3,86	16,45	107,7
25-34	5,65	5,45	5,99	6,03	10,59	0,66	6,67	7,30	8,90	8,93	9,49	6,58	6,18	29,94
35-44	7,85	10,40	9,92	10,54	1,31	6,21	34,22	9,85	11,70	11,47	11,99	2,44	4,50	21,68
45-54	11,75	11,80	12,19	12,42	5,25	1,91	5,69	10,60	12,15	12,80	13,32	9,59	4,06	25,62
55-64	11,95	14,45	14,58	15,17	5,01	4,10	26,97	12,55	14,80	15,58	16,17	9,27	3,79	28,86
65-74	10,75	14,85	13,57	14,76	-0,63	8,78	37,27	15,70	17,65	17,87	18,52	4,93	3,62	17,96
75+	5,90	6,75	6,58	6,85	1,50	4,05	16,13	14,05	13,65	14,17	14,40	5,46	1,60	2,46

Source: own calculation

4.4 Alternative obesity prevalence's

Besides the power scenario four more alternative scenarios have been looked into. The first alternative scenario discussed will be the linear trend, which shows slightly higher results than the power scenario. Secondly the results of the exponential scenario will be shown, this too is a scenario which has often higher results than the power scenario. After these two higher alternatives the two lower alternatives come up for consideration. Both scenarios are less likely to occur than the other three. The stable scenario is up first followed by the decline scenario. This latter is an unusual scenario, because it is based on a what if situation.

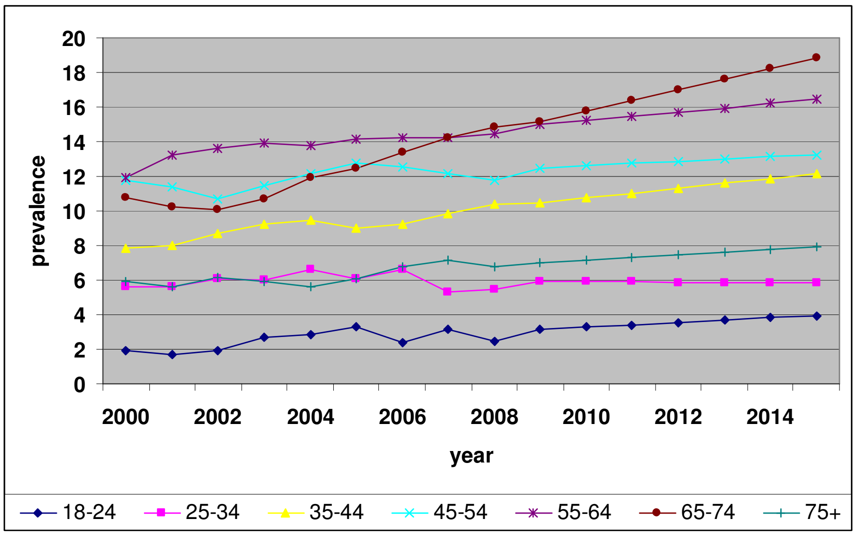
4.4.1 Future obesity prevalence with a linear trend

In this second scenario the continuation of the obesity prevalence trend in a linear way has been assumed. This scenario has been taken into account even though it is expected to be the most unlikely future development. Though in previous obesity prevalence research (Gezondheidsraad, 2003; Zaninotto et al., 2009) the linear development of the obesity trend is considered. Moreover non linear growth is chosen as a scenario too, therefore linear growth is also considered as a comparison to the non linear growth. What if a linear trend will be the case in the future, how high will the prevalence be?

The results of when a linear trend is applied to the past obesity prevalence trend are shown in figures 4.9 and 4.10. Figure 4.9 indicates the future prevalence's for the male age groups. All age groups show an increase of the prevalence in 2015 with respect to 2000 (table 4.4). Some age groups increase more than others. The prevalence of the 18-24 age group has more than doubled in 2015, while the 25-34 age group only shows a minute increase of three per cent. All other age groups show proportional increases in between these two extremes.
When the difference with regard to 2008 is considered every age group shows an increase again, though the proportional growth is smaller now. The difference with regard to 2009 shows a deviation, the 25-34 age group shows a very minor decline. For all the other age groups an increase is visible again. Thus overall for every age group an increase in prevalence is projected. Every age group has its own pace in this growth, depending on the past growth, some have larger increases in prevalence than others.
For the females the projection of future prevalence is visualised in figure 4.10, for all age groups the prevalence will increase with respect to 2000. As with the male age groups, some will increase more than others. In table 4.4 the differences in proportional growth are indicated.
The female age group 18-24 shows a massive growth with respect to 2000, as does this male age group. Every other age group shows an increase between the 10 and 50 per cent. As with the males, the proportional growth for the female age groups with respect to 2008 decreases,

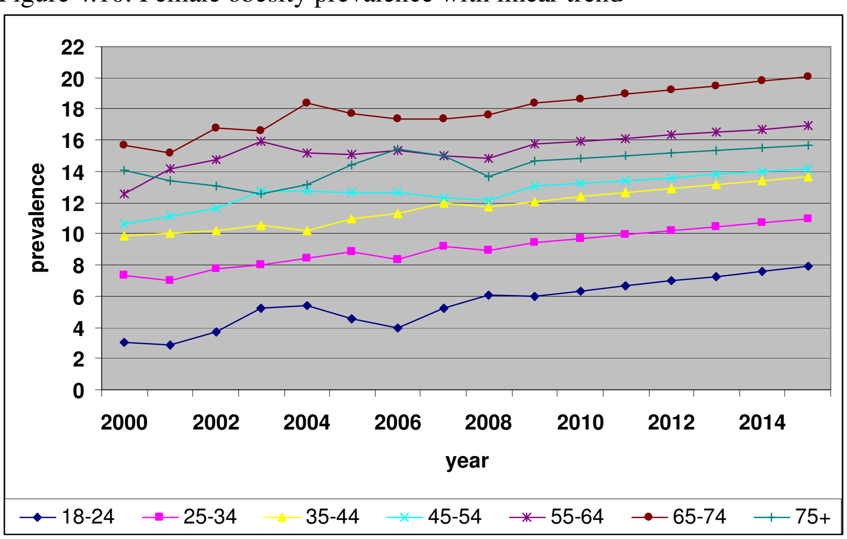
though growth remains. When growth with regard to 2009 is considered, the growth pertains, though in most age groups it slows down. There are no age groups which show a decline. Generally for all age groups the projection is an increase, though some age groups show more increase than others, depending on the past trend of that age group.
For both sexes there is no clear trend in which the change in prevalence increases or decreases with increase or decrease of the age group. The 18-24 age group of both sexes has the largest proportional increase for all periods considered. The ranking of all other age groups is different for males and females. Besides that it is not the case that the male or female age groups increase with larger amounts than the other, this is different for every age group. Nor does the one increase more than the other, for one age group the males increase more for the other age group it is the females. Hence the linear projection causes large difference between males and females, as well as between the different age groups.

Figure 4.9: Male obesity prevalence with linear trend



Source: own calculation

Figure 4.10: Female obesity prevalence with linear trend



Source: own calculation

Table 4.4: Obesity prevalence with linear trend, per age and sex

males								females						
	2000	2008	2009	2015	08-15%	09-15%	00-15%	2000	2008	2009	2015	08-15%	09-15%	00-15%
18-24	1,95	2,45	3,14	3,94	61,00	25,44	102,28	3,05	6,10	6,03	7,92	29,75	31,37	159,5
25-34	5,65	5,45	5,91	5,86	7,50	-0,79	3,70	7,30	8,90	9,46	10,98	23,32	16,08	50,35
35-44	7,85	10,40	10,47	12,14	16,70	15,88	54,60	9,85	11,70	12,09	13,69	16,98	13,24	38,95
45-54	11,75	11,80	12,49	13,25	12,29	6,08	12,77	10,60	12,15	13,03	14,18	16,73	8,85	33,80
55-64	11,95	14,45	14,96	16,44	13,78	9,87	37,58	12,55	14,80	15,73	16,90	14,22	7,46	34,70
65-74	10,75	14,85	15,13	18,81	26,66	24,35	74,96	15,70	17,65	18,37	20,06	13,65	9,20	27,77
75+	5,90	6,75	6,99	7,91	17,23	13,21	34,12	14,05	13,65	14,67	15,64	14,56	6,61	11,30

Source: own calculation

4.4.2 Future obesity prevalence with an exponential trend

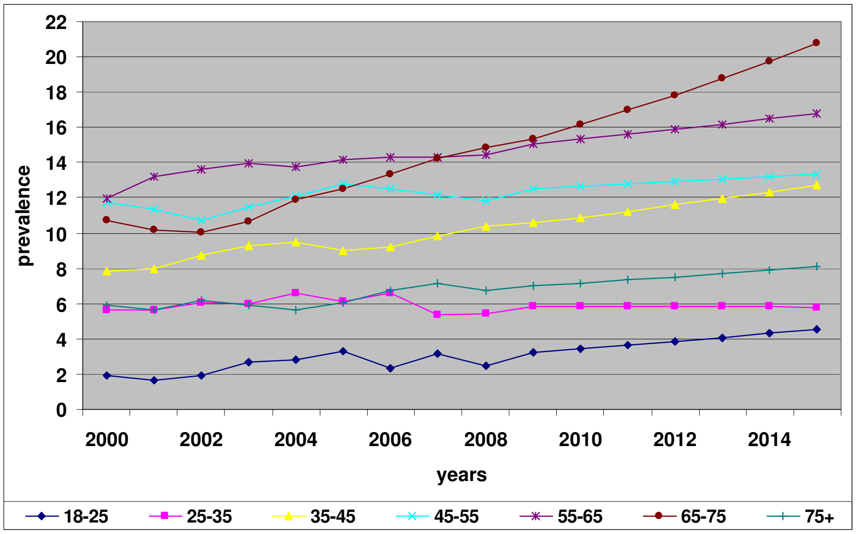
Another form of non linear growth, being the exponential, has been used in this scenario. As mentioned this has also been used in research by Zaninotto et al. (2004). What happens to the obesity prevalence with an future exponential trend is shown in figures 4.11 and 4.12. It becomes clear that some age groups have their obesity prevalence increase faster than others, this is listed in table 4.5.

Of all male age groups the 18-24 group shows the most increase from 2000 up to 2015, the prevalence more than doubles, the 65-74 group shows almost a doubling of the prevalence. Age group 25-34 shows the smallest increase, whereas the other age groups show a wide variety of increases in between. With regard to 2008 the 18-24 age group still shows the largest increase, though smaller than before, as do all age groups. A deviation is shown by the 25-34 age group with regard to the projected prevalence (2009-2015), this age groups shows a decline of just over one per cent. All other age groups show an increase.

When looking at the female age groups the 18-24 age groups stands out, here is more than triples its prevalence from 2000 up to 2015. All other age groups show an increase in that time period varying from 11 to almost 60 per cent. Except for the 75+ age group, for all age groups the proportional growth is lower considering the period 2008 up to 2015. With regard to only the projected prevalence (2009-2015) the growth is lower than in 2008 up to 2015, though all age groups still show increases varying from seven to almost 60.

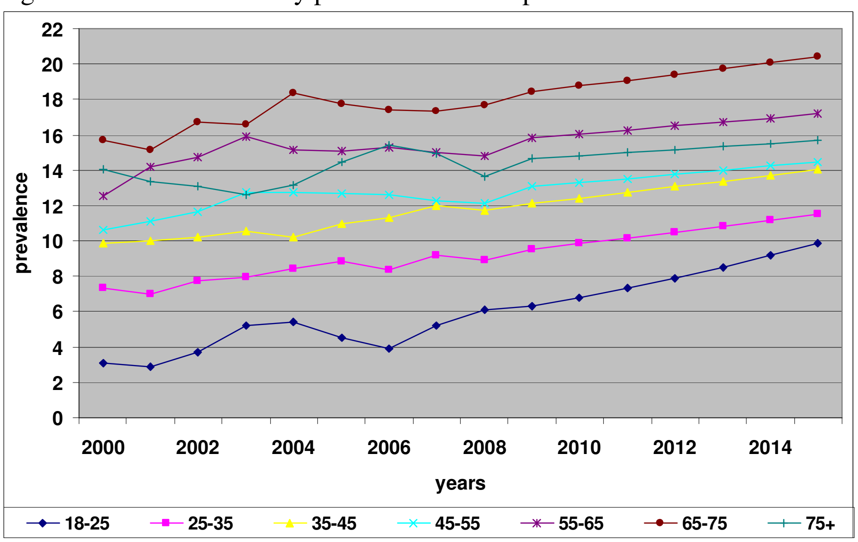
So for both males and the females the 18-24 age group shows the largest increase for all periods considered. For the males there is no clear trend in which the change in prevalence increases or decreases with increase or decrease of the age group. Though for the females a descending trend is generally visible for all periods, the proportional growth declines with the increase of the age group. Only the 65-74 age group stands out in the 2000 up to 2015 period and the 55-64 age group stands out in the 2000 up to 2015 period. Another aspect is that that the male or female age groups do not increase with larger amounts than the other, this is different for every age group. Generally the exponential projection causes some differences between males and females, as well as between the different age groups.

Figure 4.11: Male obesity prevalence with exponential trend



Source: own calculation

Figure 4.12: Female obesity prevalence with exponential trend



Source: own calculation

Table 4.5: Obesity prevalence with exponential trend, per age and sex

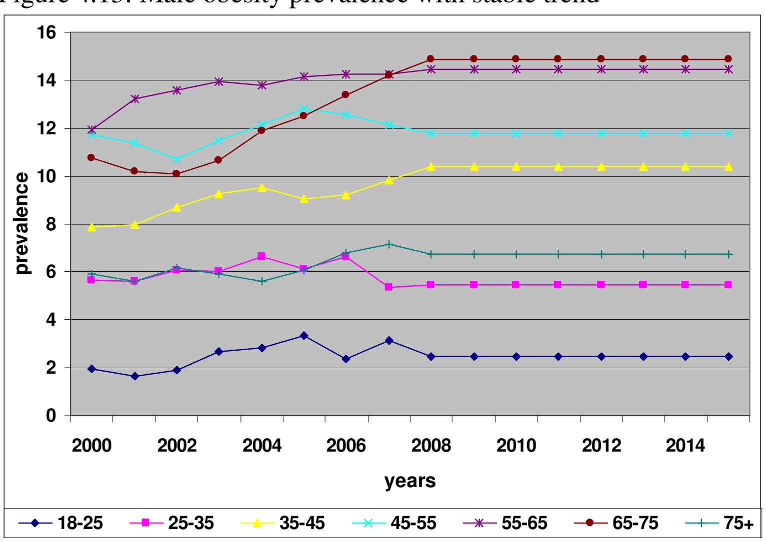
males								females						
	2000	2008	2009	2015	08-15%	09-15%	00-15%	2000	2008	2009	2015	08-15%	09-15%	00-15%
18-24	1,95	2,45	3,23	4,57	86,43	41,47	134,2	3,05	6,10	6,29	9,89	62,11	57,14	224,2
25-34	5,65	5,45	5,87	5,81	6,53	-1,13	2,76	7,30	8,90	9,54	11,52	29,45	20,72	57,82
35-44	7,85	10,40	10,56	12,71	22,20	20,32	61,90	9,85	11,70	12,13	14,07	20,23	15,92	42,81
45-54	11,75	11,80	12,50	13,33	13,00	6,69	13,48	10,6	12,15	13,09	14,46	19,02	10,48	36,42
55-64	11,95	14,45	15,04	16,79	16,22	11,69	40,53	12,55	14,80	15,80	17,20	16,23	8,85	37,06
65-74	10,75	14,85	15,35	20,74	39,65	35,13	92,91	15,70	17,65	18,44	20,42	15,70	10,76	30,07
75+	5,90	6,75	7,00	8,09	19,93	15,66	37,20	14,05	13,65	14,65	15,69	14,94	7,12	11,66

Source: own calculation

4.4.3 Future obesity prevalence with a stable trend

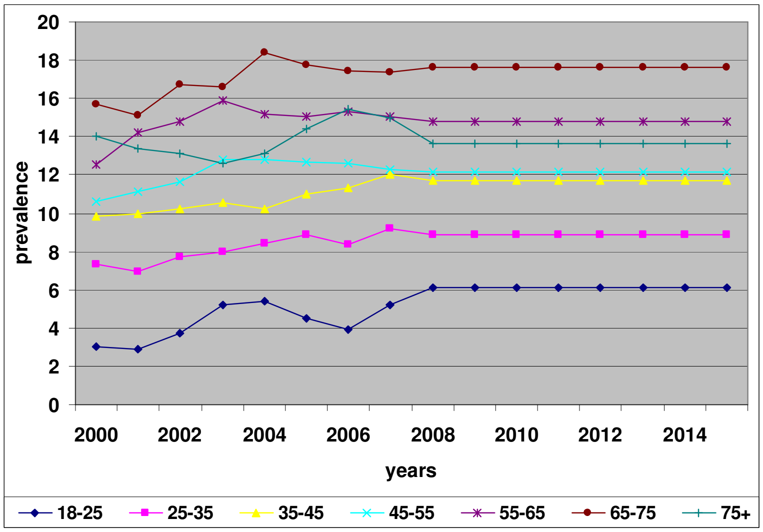
In this scenario the wish of the government to stabilise the obesity prevalence within the adult population is taken into account. The Dutch government anticipates on a stabilisation in 2010, in this scenario this stabilisation already starts in 2008 and extends up to 2015. The prevalence of 2008 has been kept stable for every age group, while the number of deaths and the number of inhabitants has changed according to the CBS projection (2009e,f). The use of a scenario in which the obesity prevalence stabilizes has been used in previous obesity prevalence research by Kelly et al. (2008).
Due to the fact that only the number of population and the number of deaths change in this projection, not much can be said about the change in prevalence. Figures 4.13 and 4.14 visualise the stable prevalence, table 4.6 shows the proportional change. The prevalence of 2008 has been continued up to 2015, hence no proportional change has been indicated for 2008 up to 2015 and 2009 up to 2015, which will be zero per cent. With regard to 2000 the proportional change is listed, which shows that the male age group 25-34 shows a decline, all other age groups show an increase.
Within the female age groups the 75+ age groups is the one who shows a decline with regard to 2000. The 18-24 age group indicates a doubling of the prevalence, every other age group shows an increase varying from 12 to just over 20 per cent.
So both males and females have one age group which indicates a decline of about the same amount. For the females the 18-24 age group has the largest increase, for the males it is the 65-74 age group. For the males there is no clear trend in which the change in prevalence increases or decreases with increase or decrease of the age group. Though for the females a descending trend is generally visible for 2000 up to 2015, the proportional growth declines with the increase of the age group. Another aspect is that that the male or female age groups do not increase with larger amounts than the other, this is different for every age group. Generally the projection with stable prevalence causes quite some differences between males and females, as well as between the different age groups.

Figure 4.13: Male obesity prevalence with stable trend



Source: own calculation

Figure 4.14: Female obesity prevalence with stable trend



Source: own calculation

Table 4.6: Obesity prevalence with stable trend, per age and sex

	males				females			
	2000	2008	2015	00-15%	2000	2008	2015	00-15%
18-24	1,95	2,45	2,45	25,64	3,05	6,10	6,10	100,0
25-34	5,65	5,45	5,45	-3,54	7,30	8,90	8,90	21,92
35-44	7,85	10,40	10,40	32,48	9,85	11,70	11,70	18,78
45-54	11,75	11,80	11,80	0,43	10,60	12,15	12,15	14,62
55-64	11,95	14,45	14,45	20,92	12,55	14,80	14,80	17,93
65-74	10,75	14,85	14,85	38,14	15,70	17,65	17,65	12,42
75+	5,90	6,75	6,75	14,41	14,05	13,65	13,65	-2,85

Source: own calculation

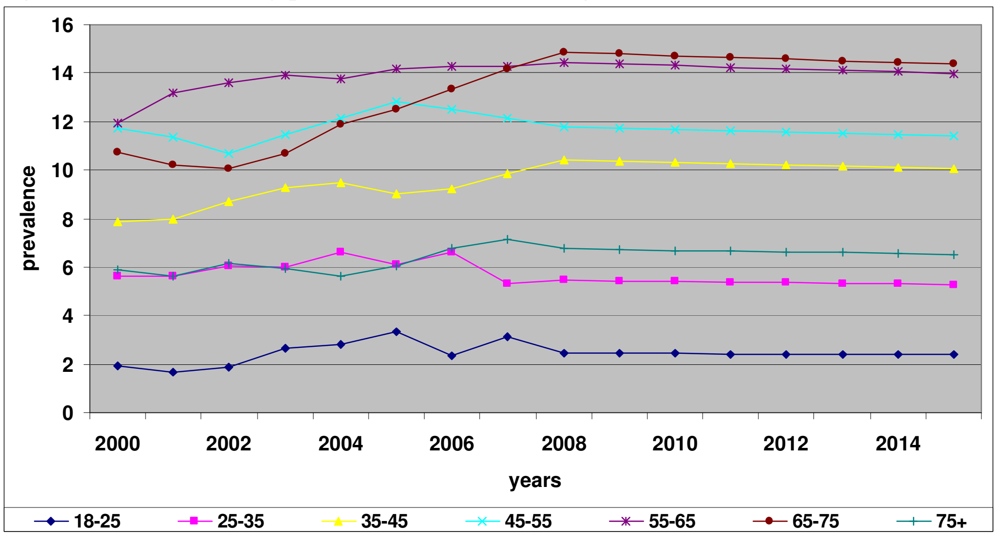
4.4.4 Future obesity prevalence with a declining trend

As a fifth scenario a decline in the obesity prevalence has been taken into account. This is not a very likely future, because the general trend is an increasing one. Thus this decline cannot be based on the overall obesity prevalence trend. This projection is more or less based on a what if case. What if the future develops in a different way than expected, which is a decline of the obesity prevalence, what will be the influence on the general health of a decline in prevalence. Thus this projection of a decline of the prevalence is needed as input to calculate the effect on health. Besides that many programs are in place to counter the present increasing trend of the obesity prevalence, so what if these programs show some result by 2015? This is also something which is considered in this scenario.

Only a small decline has been considered, because a large decline in a short period of time is very unlikely. Behavioural change takes time to show some effect, hence a small decline is more logical. Based on past declines in some age groups the decline has been set on 3.2 per cent for every age group. Figures 4.15 and 4.16 show this decline, visible is that all age groups decline in a parallel way, they all decline with the same percentage.
Due to the decline the male age groups 25-34 and 45-54 show overall (2000-2015) declines of consecutively almost 7 and almost 3 per cent (table 4.7). Every other age group shows an increase of which the 65-74 age group shows the largest increase. From 2008 onwards the decline sets in for every age group with the same percentage, hence they all show a decline of

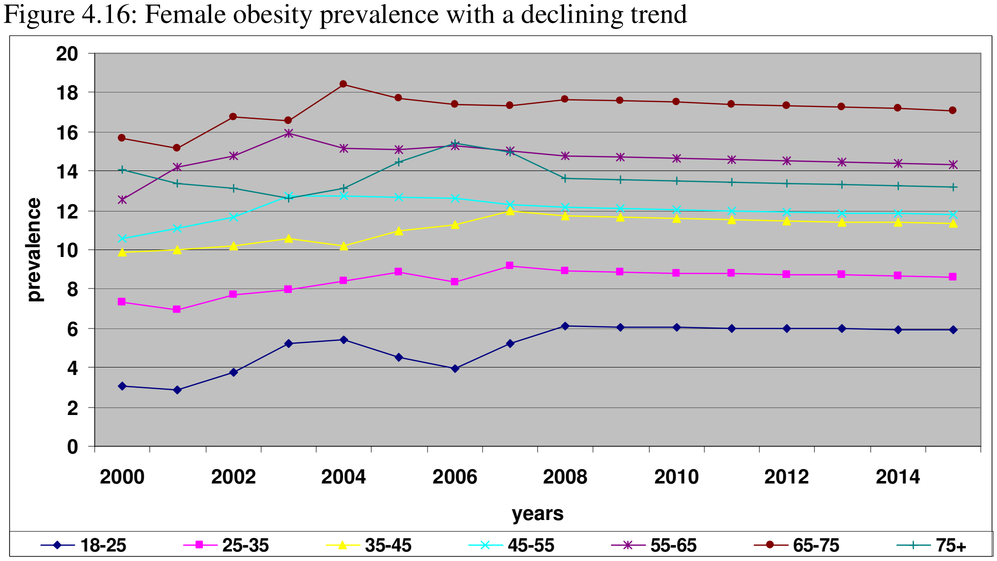
3.2 per cent. The same accounts for the period 2009 up to 2015, the decline is evenly spread out over the intermediate years, hence they all decline with the same percentage again.
Of the female age groups there is only one age group which shows a decline, the 75+ age group shows a decline of almost 7 per cent. All other groups show increases of which the 18-24 shows the largest increase. For the years 2008 up to 2015 and 2009 up to 2015 the same applies to the females as it does to the males. From 2008 onwards the decline sets in with the same percentage and the decline is evenly spread out over the intermediate years.
So both males and females have age groups which indicate a decline for the period 2000 up to 2015. In this scenario for both males and females no clear upward or downward trend with the increase or decrease of the age group is visible. Another aspect is that nor the male nor female age groups do increase with larger amounts than the other, this is different for every age group. Generally the decline projection causes a few differences between males and females, as well as between the different age groups.

Figure 4.15: Male obesity prevalence with a declining trend



Source: own calculation

Figure 4.16: Female obesity prevalence with a declining trend



Source: own calculation

Table 4.7: Obesity prevalence with a declining trend, per age and sex

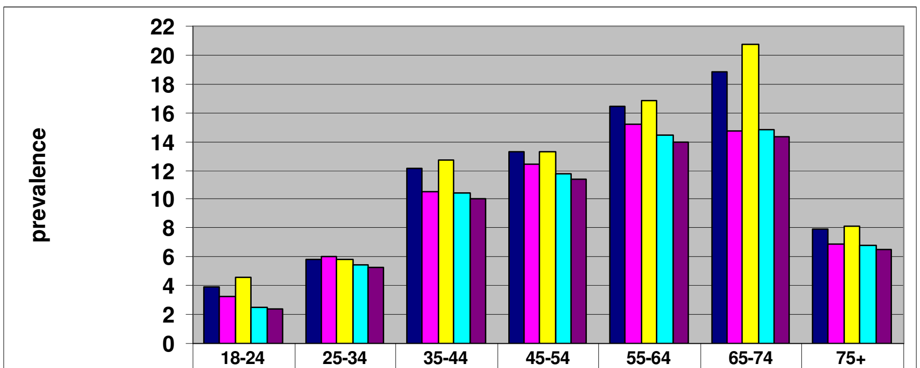
	males							females						
	2000	**2008**	**2009**	**2015**	**08-15%**	**09-15%**	**00-15%**	**2000**	**2008**	**2009**	**2015**	**08-15%**	**09-15%**	**00-15%**
18-24	1,95	2,45	2,44	2,37	-3,20	-2,76	21,62	3,05	6,10	6,07	5,90	-3,20	-2,76	93,60
25-34	5,65	5,45	5,43	5,28	-3,20	-2,76	-6,63	7,30	8,90	8,86	8,62	-3,20	-2,76	18,02
35-44	7,85	10,40	10,35	10,07	-3,20	-2,76	28,24	9,85	11,70	11,65	11,33	-3,20	-2,76	14,98
45-54	11,75	11,80	11,75	11,42	-3,20	-2,76	-2,79	10,60	12,15	12,09	11,76	-3,20	-2,76	10,95
55-64	11,95	14,45	14,38	13,99	-3,20	-2,76	17,05	12,55	14,80	14,73	14,33	-3,20	-2,76	14,15
65-74	10,75	14,85	14,78	14,37	-3,20	-2,76	33,72	15,70	17,65	17,57	17,09	-3,20	-2,76	8,82
75+	5,90	6,75	6,72	6,53	-3,20	-2,76	10,75	14,05	13,65	13,59	13,21	-3,20	-2,76	-5,96

Source: own calculation

4.5 Comparison of all projected prevalence’s

Of the five scenarios discussed in the previous sections, the projected prevalence’s for all age groups and both sexes in 2015 are shown in figures 4.17 and 4.18. For an indication of the total adult obesity prevalence trend until 2015 for the adult population for all scenarios see appendix A.

Figure 4.17: Male obesity prevalence per age and scenario, 2015



	18-24	25-34	35-44	45-54	55-64	65-74	75+
linear	3,94	5,86	12,14	13,25	16,44	18,81	7,91
power	3,27	6,03	10,54	12,42	15,17	14,76	6,85
exponential	4,57	5,81	12,71	13,33	16,79	20,74	8,09
stable	2,45	5,45	10,40	11,80	14,45	14,85	6,75
decline	2,37	5,28	10,07	11,42	13,99	14,37	6,53

Source: own calculation

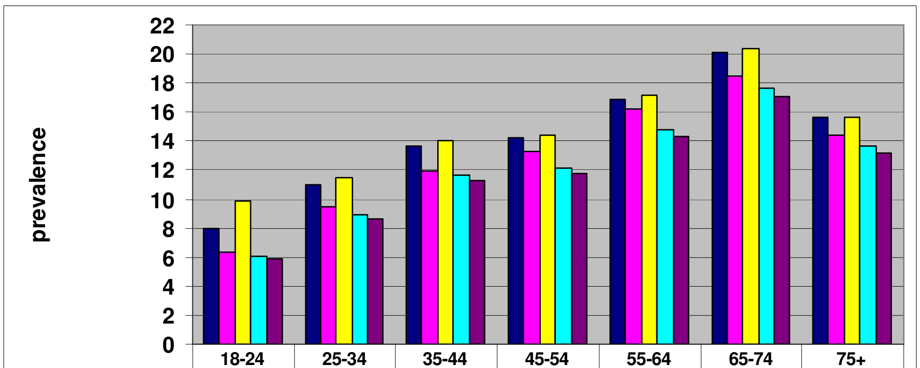
Figure 4.17 indicates the results for the males, which shows that for all age groups the projected prevalence of the decline scenario projects the lowest obesity prevalence for 2015. The maximum projected prevalence and the difference between the highest and the lowest projected prevalence is different for every age group.

For the male age group 18-24 the highest prevalence is 4,57 (exponential) and the difference is 2.20. For the male age group 25-34 the highest prevalence is 6.03 (power) and the difference is 0.75. For the male age group 35-44 the highest prevalence is 12.71 (exponential) and the difference is 2.64. For the male age group 45-54 the highest prevalence is 13.33 (exponential) and the difference is 1.91. For the male age group 55-64 the highest prevalence is 16.79 (exponential) and the difference is 2.80. For the male age group 65-74 the highest prevalence is 20.74 (exponential) and the difference is 6.37. For the male age group 75+ the highest prevalence is 8.09 (exponential) and the difference is 1.56.

Thus except for one age group (25-34) the exponential scenario predicts the highest prevalence. Of all age groups the 65-74 age group shows largest difference between the calculated future prevalence's, the 25-34 age group shows the smallest difference. Overall there is quite some dissimilarity between the differences recorded for the male age groups.

In figure 4.18 the results for the females are indicated. As with the males, the decline scenario predicts the lowest prevalence for the females. Every age group has as highest predicted prevalence the exponential scenario, though the differences between the highest and lowest recorded prevalence differ.
For the age group 18-24 the difference is 3.99. For the age group 25-34 the difference is 2.90. For the age group 35-44 the difference is 2.74. For the age group 45-54 the difference is 2.70. For the age group 55-64 the difference is 2.87. For the age group 65-74 the difference is 3.33. For the age group 75+ the difference is 2.48.
The 18-24 age group indicates the largest difference between the highest and lowest projected prevalence's, the smallest difference is within the 75+ age group. Overall the differences are close together, unlike the ones of the males.

Figure 4.18: Female obesity prevalence per age and scenario, 2015



	18-24	25-34	35-44	45-54	55-64	65-74	75+
linear	7,92	10,98	13,69	14,18	16,90	20,06	15,64
power	6,34	9,49	11,99	13,32	16,17	18,52	14,40
exponential	9,89	11,52	14,07	14,46	17,20	20,42	15,69
stable	6,10	8,90	11,70	12,15	14,80	17,65	13,65
decline	5,90	8,62	11,33	11,76	14,33	17,09	13,21

Source: own calculation

For a further comparison between the different scenarios, table 4.8 and 4.9 indicate the proportional change the projections caused for two periods. The changes of the projection period (2009-2015) and the overall period (2000-2015) are compared.
From figure 4.17 it has become clear that generally the exponential scenario causes the highest prevalence, followed by the linear scenario and than the power scenario. This is also resembled in the proportional change in table 4.8. The stable scenario logically has no change in the projection period and the decline scenario shows the same decline for all age groups. The age group 25-34 stands out with a minor decline in the scenarios linear and exponential. On the other hand the 18-24 age group has the highest proportional growth in the linear, power and exponential scenario, followed by the 65-74 and 35-44 age groups.
Considering the overall period the exponential shows the highest increases again, followed by the linear and power scenarios. Except for the 25-34 age group for which power is the highest, followed by the linear and exponential scenarios. Declines in prevalence are only visible for the 25-34 (stable and decline) and 45-54 (decline) age groups. On the other hand the 18-24 age group has the largest proportional increases followed by 65-74 and 35-44 age groups.

Table 4.8: Change in male obesity prevalence per scenario, age and period

males	linear	power	exponential	stable	decline	linear	power	exponential	stable	decline
	09-15 %	**09-15 %**	**09-15 %**	**09-15 %**	**09-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**
18-24	25,44	12,71	41,47	0,00	-2,76	102,28	67,56	134,2	25,64	21,62
25-34	-0,79	0,66	-1,13	0,00	-2,76	3,70	6,67	2,76	-3,54	-6,63
35-44	15,88	6,21	20,32	0,00	-2,76	54,60	34,22	61,90	32,48	28,24
45-54	6,08	1,91	6,69	0,00	-2,76	12,77	5,69	13,48	0,43	-2,79
55-64	9,87	4,10	11,69	0,00	-2,76	37,58	26,97	40,53	20,92	17,05
65-74	24,35	8,78	35,13	0,00	-2,76	74,96	37,27	92,91	38,14	33,72
75+	13,21	4,05	15,66	0,00	-2,76	34,12	16,13	37,20	14,41	10,75

Source: own calculation

From figure 4.18 it has become clear that for the females the exponential scenario causes the highest prevalence, followed by the linear scenario and than the power scenario. This is also visible in the proportional change in table 4.9. The stable scenario logically has no change in the projection period and the decline scenario shows the same decline for all age groups.
For the projection period (2009-2015) the female age groups only show increases, except for the decline scenario. In this period the youngest three age groups show the largest proportional increases. The eldest age group shows the lowest proportional increases. Generally a downward trend is present, in which the proportional change decreases when the age group increases, the 65-74 age group disrupt this trend in two of the scenarios.
Regarding the overall period of 2000 up to 2015 the exponential scenario presents the highest proportional growth again, followed by the linear and power scenarios. The largest proportional increases are recorded for the two youngest age groups, the smallest for the eldest age group. In the linear, power, exponential and stable scenario a downward trend is present, in which the proportional change decreases when the age group increases. For the age group 75+ a proportional decline in prevalence is recorded twice, within the stable and decline scenario.

Table 4.9: Change in female obesity prevalence per scenario, age and period

females	linear	power	exponential	stable	decline	linear	power	exponential	stable	decline
	09-15 %	**09-15 %**	**09-15 %**	**09-15 %**	**09-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**
18-24	31,37	16,45	57,14	0,00	-2,76	159,5	107,7	224,2	100,0	93,60
25-34	16,08	6,18	20,72	0,00	-2,76	50,35	29,94	57,82	21,92	18,02
35-44	13,24	4,50	15,92	0,00	-2,76	38,95	21,68	42,81	18,78	14,98
45-54	8,85	4,06	10,48	0,00	-2,76	33,80	25,62	36,42	14,62	10,95
55-64	7,46	3,79	8,85	0,00	-2,76	34,70	28,86	37,06	17,93	14,15
65-74	9,20	3,62	10,76	0,00	-2,76	27,77	17,96	30,07	12,42	8,82
75+	6,61	1,60	7,12	0,00	-2,76	11,30	2,46	11,66	-2,85	-5,96

Source: own calculation

4.6 Life expectancy trend and projection

The remaining life expectancy is calculated in the Sullivan method the same way as in a normal life table, hence only with the use of the number of population and the number of deaths. No obesity prevalence is used in the calculation of the life expectancy, thus the outcome of the life expectancy is the same for every scenario. Table 4.10 and 4.11 show the development of the remaining life expectancy for males and females per age group.

For all male ages there is a proportional increase in remaining life expectancy over all indicated periods, where the older age groups gain proportionally the most. The increases from 2000 up to 2008 compared to the projected increase in 2009 up to 2015 are much larger, even though the number of years is almost the same. Overall the increases from 2000 up to 2015 are within the seven and 22 per cent. The projected gain in remaining life expectancy is between the one and a half and four and a quarter per cent.
Within the female age groups the proportional gain, for all periods, is much smaller than that of the males, for all age groups it is about half of the proportional growth. Between 2009 and 2015 the female age groups gain between a third of a percent and a half per cent, the 75+ age group even shows a decline in the remaining life expectancy. Though the females will still have a higher remaining life expectancy than the males in 2015, the difference for every age group is around the 2 or 3 years.

Table 4.10: Remaining male life expectancy, per age

	2000	**2008**	**2009**	**2015**	**00-08%**	**09-15%**	**00-15%**
18	58,48	61,66	61,83	62,85	5,44	1,65	7,47
25	51,75	54,84	54,99	56,00	5,97	1,83	8,20
35	42,07	45,11	45,24	46,24	7,23	2,20	9,90
45	32,60	35,57	35,63	36,61	9,11	2,74	12,31
55	23,66	26,49	26,46	27,39	11,95	3,51	15,75
65	15,70	18,29	18,13	18,90	16,50	4,25	20,39
75	9,54	11,49	11,22	11,70	20,44	4,25	22,69

Source: own calculation

Table 4.11: Remaining female life expectancy, per age

	2000	**2008**	**2009**	**2015**	**00-08%**	**09-15%**	**00-15%**
18	63,70	65,62	65,78	66,02	3,02	0,36	3,65
25	56,81	58,70	58,86	59,09	3,33	0,39	4,01
35	47,02	48,87	49,02	49,24	3,93	0,44	4,72
45	37,46	39,22	39,34	39,54	4,68	0,50	5,54
55	28,37	30,04	30,13	30,28	5,89	0,52	6,75
65	19,84	21,48	21,49	21,58	8,27	0,45	8,81
75	12,43	13,74	13,71	13,69	10,48	-0,14	10,08

Source: own calculation

Table 4.12: Proportional change in the number of deaths and population per age and sex

	males		**females**	
	Deaths 09-15 %	**Population 09-15 %**	**Deaths 09-15**	**Population 09-15**
18-24	-7,50	3,24	-7,32	3,20
25-34	-5,12	1,44	-5,08	1,84
35-44	-21,24	-15,40	-19,26	-13,62
45-54	-4,79	4,42	-1,32	4,59
55-64	-10,45	2,60	-1,35	3,76
65-74	12,79	29,92	18,69	25,54
75+	15,48	20,40	8,38	8,23

Source: CBS, 2009e and CBS, 2009f

The decrease in life expectancy of the female 75+ age group is due to the difference in the proportional growth of the total 75+ population and the number of deaths in that same population. For the period 2009 up to 2015 the projected proportional growth in the number

of deaths is larger than the projected proportional increase in the number of population (table 4.12). For all the other age groups the proportional increase of the projected population is larger than that of the deaths (e.g. 75+ males), or the proportional decline is smaller (e.g. 35-44 males).
The proportional change in the number of deaths shows a similar picture for the two youngest age groups, they both decline with about the same amount. Within the 35-44, 45-54 and 55-64 age groups the proportional decline of the males is much larger, especially in the 55-64 age group. A proportional increase is visible for the eldest two age groups, within the 65-74 age groups proportional more females will die, of the 75+ age group more males.
Regarding the change in population the youngest two age groups age about the same again, they both show a proportional increase. For the 35-44 age group both the males and the females indicate a proportional decline, in which the males decline more. The female 45-54 and 55-64 show a larger proportional decline than the males, for the 65-74 and 75+ age group it is the opposite.

4.7 Most likely effect on the Obesity Adjusted Life Expectancy

Of all scenarios the power scenario indicated the most likely continuation of the obesity prevalence trend. Therefore it will also indicate the most likely effect the obesity epidemic will have on the OALE in the future. In this section the effect of a future power trend of the obesity epidemic on the OALE and the proportion of remaining life lived without obesity will be illustrated.

For the projection period 2009 up to 2015 the power trend predicts an increase in the prevalence for all age groups and both sexes. These projected prevalence’s have been used to calculate the OALE and the proportion of remaining life lived without obesity. The results of both measures are listed in tables 4.13 and 4.14.

Table 4.13: Effect on the Obesity Adjusted Life Expectancy with power trend, per age and sex

	males							**females**						
	2000	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**	**2000**	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**
18-24	53,68	55,73	55,90	56,54	3,82	1,15	5,33	56,94	57,55	57,55	57,39	1,07	-0,27	0,79
25-34	47,07	49,07	49,25	49,90	4,25	1,33	6,02	50,26	51,05	50,99	50,89	1,58	-0,20	1,26
35-44	37,93	39,86	40,08	40,72	5,09	1,61	7,38	41,17	42,09	42,03	41,97	2,23	-0,13	1,94
45-54	29,18	31,30	31,41	32,10	7,25	2,20	10,01	32,54	33,56	33,45	33,42	3,12	-0,07	2,71
55-64	21,31	23,29	23,36	24,03	9,27	2,85	12,75	24,39	25,47	25,39	25,38	4,46	-0,04	4,08
65-74	14,35	16,33	16,31	16,88	13,73	3,54	17,62	16,90	18,17	18,09	18,09	7,53	-0,04	7,04
75+	8,97	10,71	10,48	10,90	19,35	3,96	21,45	10,69	11,86	11,76	11,72	11,00	-0,41	9,64

Source: own calculation

In table 4.13 the OALE is noted down, for both males and females. At the left side of the table the result for the males are shown. For all age groups proportional increases are shown for all periods. Though the proportional growth slows down in the projected period (2009-2015) compared to the observed period (2000-2008). Nevertheless overall there is a proportional growth visible for all age groups, with larger increases in the older age groups. On the whole the increase in prevalence caused by the power trend has no negative effect on the OALE, on the contrary.
On the right side of the table the female age groups show a different story. They do also show increases for the periods 2000 up to 2008 and 2000 up to 2015, though for the projected

period decreases are the case. However these decreases are very small, some of them are smaller than a tenth of a per cent. Overall there is not much influence of the increase of the obesity prevalence with the power trend, the OALE remains about the same for females in the projected period.

Was the outcome of the OALE still positive for all male age groups, the proportion of life lived without obesity shows a different outcome. Table 4.14 shows that for all periods there is a decline in the proportion of remaining life lived without obesity. This means that people will live more of their remaining life suffering from obesity. The proportional growth from 2000 up to 2015 is the largest in the older age groups, though the 75+ age group is an exception. For the projected period (2009-2015) the proportional declines are smaller, they are all smaller than one per cent. Again the older ages have larger proportional decline and yet again the 75+ age group stands out with a smaller proportional decline. Overall there is not much effect on the proportion of remaining life lived without obesity for the projected period.
The proportional decline of the OALE of the female age groups in the projected period (2009-2015) coincide with the decline in the proportion of remaining life lived without obesity. For all age groups a very small decline is shown, all groups decline with about a half per cent and once more the 75+ age group stands out. This latter group also stands out in the period 2000 up to 2008. Considering the proportional decline overall (2000-2015), the largest declines are within the youngest age groups. Generally there is only a very minor effect of the increase in prevalence on the proportion of remaining life lived without obesity for the projected period.

Table 4.14: Effect on the Proportion of life lived without obesity with power trend, per age and sex

	males							**females**						
	2000	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**	**2000**	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**
18-24	91,80	90,39	90,42	89,97	-1,54	-0,50	-1,99	89,39	87,71	87,48	86,93	-1,89	-0,63	-2,76
25-34	90,95	89,47	89,57	89,12	-1,63	-0,49	-2,01	88,46	86,97	86,63	86,13	-1,69	-0,59	-2,64
35-44	90,14	88,34	88,58	88,07	-1,99	-0,58	-2,29	87,56	86,12	85,73	85,23	-1,64	-0,58	-2,65
45-54	89,52	87,99	88,16	87,69	-1,71	-0,53	-2,04	86,86	85,56	85,01	84,53	-1,50	-0,57	-2,69
55-64	90,07	87,91	88,29	87,73	-2,40	-0,64	-2,59	85,96	84,79	84,28	83,81	-1,35	-0,56	-2,50
65-74	91,42	89,25	89,93	89,32	-2,37	-0,68	-2,30	85,18	84,60	84,21	83,80	-0,68	-0,49	-1,62
75+	94,10	93,25	93,42	93,15	-0,90	-0,29	-1,01	85,95	86,35	85,83	85,60	0,47	-0,26	-0,40

Source: own calculation

4.8 Alternative effects on the Obesity Adjusted Life Expectancy

As for the future obesity prevalence, for the future effect on the Obesity Adjusted Life Expectancy the same scenarios have been looked into. Firstly the linear trend and exponential trend will be illustrated, these scenarios predict more negative effects than the power trend. After this the more optimistic scenarios are discussed, though they are also less likely. Lastly the effects of all scenarios are compared.

4.8.1 Effect on the Obesity Adjusted Life Expectancy with a linear trend

For the period 2000 up to 2015 all age groups have shown an increase in obesity prevalence with the linear trend projection. The same accounts for the projected prevalence (2009-2015), only the male 25-34 age group shows a minor decline in the projection. The effect of these projected prevalence’s with this scenario on the OALE are shown in table 4.15 and 4.16.

Table 4.15: Effect on the Obesity Adjusted Life Expectancy with linear trend, per age and sex

	males							**females**						
	2000	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**	**2000**	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**
18-24	53,68	55,73	55,62	55,73	3,82	0,21	3,81	56,94	57,55	57,26	56,53	1,07	-1,26	-0,71
25-34	47,07	49,07	48,98	49,14	4,25	0,32	4,39	50,26	51,05	50,75	50,15	1,58	-1,18	-0,22
35-44	37,93	39,86	39,80	39,93	5,09	0,34	5,29	41,17	42,09	41,83	41,37	2,23	-1,09	0,49
45-54	29,18	31,30	31,18	31,47	7,25	0,90	7,83	32,54	33,56	33,31	32,99	3,12	-0,95	1,38
55-64	21,31	23,29	23,16	23,46	9,27	1,30	10,08	24,39	25,47	25,27	25,03	4,46	-0,97	2,63
65-74	14,35	16,33	16,13	16,41	13,73	1,74	14,32	16,90	18,17	17,99	17,79	7,53	-1,09	5,29
75+	8,97	10,71	10,44	10,77	19,35	3,22	20,06	10,69	11,86	11,70	11,55	11,00	-1,28	8,05

Source: own calculation

For the male age groups the OALE indicates a proportional growth from 2000 up to 2008, there is still proportional growth for all groups from 2009 up to 2015, though the growth has slowed down. The overall increase of the OALE is positive for all male age groups. A trend is visible in which the proportional growth increases when the age group increases.
The female age groups show a different picture. For the period 2000 up to 2008 the OALE has increased, though for the projected period all age groups show a decline of the OALE. Hence more of the remaining life is lived with obesity. When the whole period is considered (2000-2015) only the two youngest age groups show a decline in the OALE, all others still show a proportional increase. For the period 2000 up to 2008 and 2000 up to 2015 a trend is visible in which the proportional growth increases when the age group increases. The projected period does not show this trend, the largest declines are recorded for the youngest and eldest age group and the smallest decline is for the 45-54 age group.

Another important outcome of the Sullivan method is the proportion of the remaining life lived without obesity (table 4.16). If the remaining life expectancy grows proportionally faster than the OALE, a decrease in the proportion will be registered. This is the case for all male age groups and for all periods. A general trend of an increasing proportional decline towards the higher age groups is visible, the 75+ age group is the one who stands out though.
For the female age groups there is in all cases a decline of the proportion of remaining life lived without obesity, except for the 75+ age group in period from 2000 up to 2008. Generally the proportion of decline shows a downward trend where the youngest age groups show the largest proportions and the highest age groups the smallest proportional decline. This is the opposite of the trend within the male age groups.

Table 4.16: Effect on the proportion of life lived without obesity with linear trend, per age and sex

	males							**females**						
	2000	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**	**2000**	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**
18-24	91,80	90,39	89,95	88,67	-1,54	-1,42	-3,40	89,39	87,71	87,04	85,63	-1,89	-1,62	-4,21
25-34	90,95	89,47	89,07	87,75	-1,63	-1,49	-3,52	88,46	86,97	86,21	84,87	-1,69	-1,56	-4,07
35-44	90,14	88,34	87,96	86,36	-1,99	-1,82	-4,19	87,56	86,12	85,33	84,02	-1,64	-1,53	-4,04
45-54	89,52	87,99	87,52	85,95	-1,71	-1,79	-3,98	86,86	85,56	84,67	83,44	-1,50	-1,45	-3,94
55-64	90,07	87,91	87,52	85,66	-2,40	-2,13	-4,89	85,96	84,79	83,89	82,64	-1,35	-1,49	-3,85
65-74	91,42	89,25	88,95	86,81	-2,37	-2,41	-5,05	85,18	84,60	83,71	82,43	-0,68	-1,53	-3,23
75+	94,10	93,25	93,01	92,09	-0,90	-0,99	-2,14	85,95	86,35	85,33	84,36	0,47	-1,14	-1,85

Source: own calculation

4.8.2 Effect on the Obesity Adjusted Life Expectancy with an exponential trend

A continuation of the obesity prevalence with an exponential trend line results in an overall (2000-2015) increase in the obesity prevalence for all age groups. For the projected period all groups showed an increase, only the male 25-34 age groups showed a minor decline. The effects of these increases and minor decline on the OALE and the proportion of remaining life lived without obesity are shown in table 4.17 and 4.18.

Table 4.17: Obesity Adjusted Life Expectancy with exponential trend, per age and sex

	males							females						
	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %
18-24	53,68	55,73	55,58	55,42	3,82	-0,29	3,23	56,94	57,55	57,21	56,21	1,07	-1,74	-1,28
25-34	47,07	49,07	48,95	48,87	4,25	-0,16	3,82	50,26	51,05	50,72	49,96	1,58	-1,49	-0,59
35-44	37,93	39,86	39,76	39,66	5,09	-0,26	4,57	41,17	42,09	41,81	41,24	2,23	-1,36	0,17
45-54	29,18	31,30	31,16	31,25	7,25	0,28	7,08	32,54	33,56	33,29	32,90	3,12	-1,19	1,09
55-64	21,31	23,29	23,13	23,24	9,27	0,48	9,07	24,39	25,47	25,26	24,96	4,46	-1,20	2,36
65-74	14,35	16,33	16,11	16,22	13,73	0,66	12,96	16,90	18,17	17,98	17,75	7,53	-1,29	5,05
75+	8,97	10,71	10,44	10,75	19,35	3,03	19,83	10,69	11,86	11,70	11,54	11,00	-1,36	7,98

Source: own calculation

Overall the OALE for males increases (table 4.17), with the largest proportional increases in the older age groups. When the projected period (2009-2015) is considered there are declines visible. The age groups 18-24, 25-34 and 35-44 show a decrease of around a fifth or a quarter of a percent, hence very small. Though the increase in obesity prevalence does have a negative effect here on the OALE.

For the female age groups there are even proportional declines in the overall period. Age groups 18-24 and 25-34 show declines of respectively just over one per cent and just over a half per cent. The remaining age groups still show increases, with an increase of the proportions towards the older age groups. For all age groups a decline is registered in the projection period, with the largest proportional declines in the youngest and eldest age groups. The effect of the increase in prevalence is larger for females than for males, all female age groups show a decline of the OALE for the projected period.

Table 4.18: Effect on the proportion of life lived without obesity with exponential trend, per age and sex

	males							females						
	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %
18-24	91,80	90,39	89,89	88,18	-1,54	-1,91	-3,94	89,39	87,71	86,96	85,14	-1,89	-2,09	-4,76
25-34	90,95	89,47	89,02	87,27	-1,63	-1,96	-4,05	88,46	86,97	86,16	84,55	-1,69	-1,87	-4,42
35-44	90,14	88,34	87,88	85,77	-1,99	-2,41	-4,85	87,56	86,12	85,28	83,75	-1,64	-1,79	-4,34
45-54	89,52	87,99	87,45	85,35	-1,71	-2,39	-4,65	86,86	85,56	84,62	83,20	-1,50	-1,68	-4,22
55-64	90,07	87,91	87,43	84,87	-2,40	-2,92	-5,77	85,96	84,79	83,86	82,42	-1,35	-1,71	-4,11
65-74	91,42	89,25	88,84	85,78	-2,37	-3,44	-6,17	85,18	84,60	83,69	82,24	-0,68	-1,73	-3,45
75+	94,10	93,25	93,00	91,91	-0,90	-1,18	-2,33	85,95	86,35	85,35	84,31	0,47	-1,22	-1,91

Source: own calculation

A decline in the proportion of remaining life left lived without obesity for all age groups of both males and females is shown in table 4.18. In the overall period an upward trend is visible, the higher the age group the higher the proportional decline, only the 75+ age group is

the exception with the lowest proportional decline. For the projection period declines are registered too, which are even larger decline compared to the 2000 up to 2008 period.
Within the female age groups the declines are also visible. Though the visible trend for the period 2000 up to 2015 and 2009 up to 2015 is opposite of that of the males. The largest proportional declines are within the youngest age groups and they get smaller when the age group increases. For the females the declines are larger in the 2009 up to 2015 period compared to the 2000 up to 2008 period. Except for the youngest and eldest age group the proportional decline in the projected period is larger for males than for females.

4.8.3 Effect on the Obesity Adjusted Life Expectancy with a stable trend

In this scenario the obesity prevalence has remained the same as it was in 2008, only the number of population and the number of deaths have changed in every age group. The effect this has on the OALE and the proportion of remaining life lived without obesity is shown in tables 4.19 and 4.20.
The OALE for the projected period shows a proportional increase for all male age groups. For both the period 2009 up to 2015 and 2000 up to 2015 the general trend is an increasing proportional growth with an increase of the age group.
For the female age groups increases of the OALE are visible too, though they are quite small, all around a half per cent. The 75+ age group is the exception, this age groups shows a minor decline of the OALE for the projected period. For the overall period the trend is visible, in which the proportional growth increases towards the older age groups. Even though for both males and females there is an increase of the OALE for (almost) all age group, the stable prevalence has a much bigger effect on the males than on the females.

Table 4.19: Obesity Adjusted Life Expectancy with stable trend, per age and sex

	males							**females**						
	2000	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**	**2000**	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**
18-24	53,68	55,73	55,87	56,80	3,82	1,66	5,80	56,94	57,55	57,69	57,89	1,07	0,35	1,68
25-34	47,07	49,07	49,19	50,10	4,25	1,86	6,45	50,26	51,05	51,19	51,38	1,58	0,38	2,24
35-44	37,93	39,86	39,96	40,87	5,09	2,27	7,75	41,17	42,09	42,22	42,40	2,23	0,44	2,99
45-54	29,18	31,30	31,34	32,23	7,25	2,84	10,46	32,54	33,56	33,66	33,83	3,12	0,50	3,96
55-64	21,31	23,29	23,25	24,10	9,27	3,64	13,08	24,39	25,47	25,54	25,68	4,46	0,52	5,30
65-74	14,35	16,33	16,18	16,89	13,73	4,38	17,63	16,90	18,17	18,18	18,26	7,53	0,45	8,07
75+	8,97	10,71	10,47	10,91	19,35	4,25	21,58	10,69	11,86	11,83	11,82	11,00	-0,14	10,59

Source: own calculation

Table 4.20: Effect on the proportion of life lived without obesity with stable trend, per age and sex

	males							**females**						
	2000	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**	**2000**	**2008**	**2009**	**2015**	**00-08 %**	**09-15 %**	**00-15 %**
18-24	91,80	90,39	90,37	90,38	-1,54	0,01	-1,55	89,39	87,71	87,70	87,69	-1,89	-0,01	-1,90
25-34	90,95	89,47	89,45	89,48	-1,63	0,03	-1,62	88,46	86,97	86,96	86,96	-1,69	-0,01	-1,70
35-44	90,14	88,34	88,33	88,38	-1,99	0,06	-1,95	87,56	86,12	86,12	86,11	-1,64	-0,01	-1,65
45-54	89,52	87,99	87,97	88,05	-1,71	0,09	-1,64	86,86	85,56	85,56	85,56	-1,50	0,00	-1,50
55-64	90,07	87,91	87,88	87,99	-2,40	0,13	-2,30	85,96	84,79	84,79	84,79	-1,35	0,00	-1,35
65-74	91,42	89,25	89,21	89,32	-2,37	0,13	-2,29	85,18	84,60	84,60	84,60	-0,68	0,00	-0,68
75+	94,10	93,25	93,25	93,25	-0,90	0,00	-0,90	85,95	86,35	86,35	86,35	0,47	0,00	0,47

Source: own calculation

The proportion of remaining life lived without obesity for the periods 2000 up to 2008 and 2000 up to 2015 are almost similar for the male and female age groups (table 4.20). This is due to the fact that there has hardly been any change in the proportion in the projected period. Within the male age groups the 55-64 and 65-74 age groups show the most increase, though they are still very minor increases. The youngest female age groups show a decline of the size of a hundredth of a percent, the others are zero. Generally there is no influence on the proportion of remaining life lived without obesity due to the stable prevalence within the female and male age groups.

4.8.4 Effect on the Obesity Adjusted Life Expectancy with a declining trend

Within this scenario every age group experienced a decline in their obesity prevalence of 3.2 per cent by 2015. The effect of this decline on the OALE and the proportion of remaining life lived without obesity are shown in tables 4.21 and 4.22.
Table 4.21 clearly shows that there is an overall proportional growth for all the male age groups, with larger increases towards the higher age groups. In the projection period (2009-2015) there is an increase for every age group too, varying between two and five per cent.
For the female age groups a similar pattern occurs. Both the overall and the projected period show and increase of the OALE for every age group. Though the increase of the OALE for the females in the projected period is much smaller than that of the males, for the females no proportional growth over two per cent is recorded.

Table 4.21: Obesity Adjusted Life Expectancy with a declining trend, per age and sex

	males							females						
	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %
18-24	53,68	55,73	55,90	56,99	3,82	1,96	6,16	56,94	57,55	57,73	58,15	1,07	0,73	2,13
25-34	47,07	49,07	49,22	50,29	4,25	2,19	6,85	50,26	51,05	51,22	51,63	1,58	0,79	2,73
35-44	37,93	39,86	39,98	41,04	5,09	2,63	8,21	41,17	42,09	42,25	42,62	2,23	0,88	3,52
45-54	29,18	31,30	31,36	32,37	7,25	3,22	10,94	32,54	33,56	33,69	34,01	3,12	0,96	4,52
55-64	21,31	23,29	23,26	24,20	9,27	4,03	13,57	24,39	25,47	25,57	25,83	4,46	1,02	5,91
65-74	14,35	16,33	16,19	16,95	13,73	4,73	18,08	16,90	18,17	18,19	18,37	7,53	0,95	8,70
75+	8,97	10,71	10,47	10,94	19,35	4,46	21,86	10,69	11,86	11,84	11,88	11,00	0,29	11,15

Source: own calculation

Table 4.22: Effect on the proportion of life lived without obesity with a declining trend, per age and sex

	males							females						
	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %	2000	2008	2009	2015	00-08 %	09-15 %	00-15 %
18-24	91,80	90,39	90,41	90,69	-1,54	0,30	-1,21	89,39	87,71	87,76	88,09	-1,89	0,37	-1,46
25-34	90,95	89,47	89,50	89,82	-1,63	0,35	-1,25	88,46	86,97	87,02	87,37	-1,69	0,40	-1,23
35-44	90,14	88,34	88,38	88,75	-1,99	0,42	-1,54	87,56	86,12	86,18	86,56	-1,64	0,44	-1,14
45-54	89,52	87,99	88,02	88,43	-1,71	0,46	-1,22	86,86	85,56	85,63	86,02	-1,50	0,46	-0,97
55-64	90,07	87,91	87,93	88,37	-2,40	0,50	-1,88	85,96	84,79	84,86	85,28	-1,35	0,49	-0,79
65-74	91,42	89,25	89,26	89,67	-2,37	0,46	-1,92	85,18	84,60	84,67	85,09	-0,68	0,50	-0,10
75+	94,10	93,25	93,28	93,47	-0,90	0,20	-0,67	85,95	86,35	86,41	86,79	0,47	0,43	0,97

Source: own calculation

When looking at table 4.22 it becomes clear that for the projected period the proportion lived of the remaining life without obesity for the male age groups increases. They will spend more

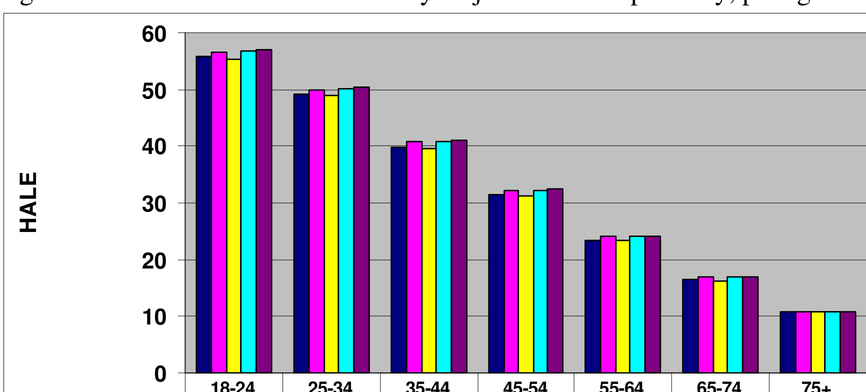
time living without obesity. Though when the overall period is considered (2000-2015) a minor decline for all age groups is shown, all declines remain under the two per cent. Hence the decline of the obesity prevalence has only a minor effect on the proportion of life lived without obesity.
The story for females is quite similar. In the projected period all the age groups show an increase in the proportion too, though in the overall period there is a small difference. For the 75+ age group a minor increase is visible, all the other age groups show small declines. A general trend of a smaller proportional decline towards the higher age groups is visible for the females.
The decline in prevalence has a larger positive effect on the proportion of life lived without obesity for females than for males, though for both the increases are very small. When the proportion of life lived without obesity is compared the males live longer without obesity than the females. For both 2009 and 2015 this varies from over two per cent in the younger age groups to over six per cent in the older age groups.

4.9 Comparison of effects on the Obesity Adjusted Life Expectancies and proportions of life lived without obesity

From the previous sections it has become clear that every scenario has a different influence on the OALE and the proportion of remaining life lived without obesity. In this section the results for 2015 are shown to indicate the differences. Besides that the proportional increases and decreases of all the scenarios are put together for a better view at the differences and similarities.

In figure 4.19 the projected OALEs for 2015 are shown for every male age group. The largest OALE for all age groups is projected with the decline scenario, though in some age groups the differences are very small with the second largest which is the stable prevalence. With the exponential scenario the lowest OALE is projected. Considering all scenarios the differences between the projected OALEs are not very large. Starting with the youngest age group the consecutive difference between the lowest and highest projected OALE are 1.57, 1.42, 1.38, 1.12, 0.96, 0.73, and 0.19. Hence the youngest age group shows the largest difference, the oldest the lowest.

Figure 4.19: Effect on the male Obesity Adjusted Life Expectancy, per age and scenario, 2015

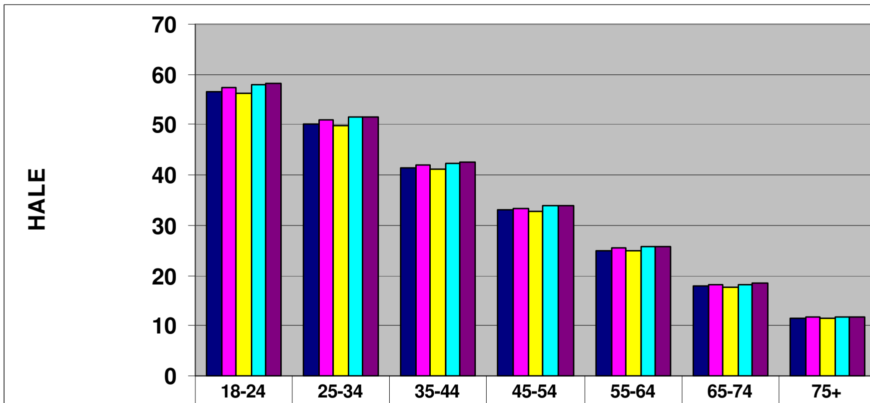


	18-24	25-34	35-44	45-54	55-64	65-74	75+
linear	55,73	49,14	39,93	31,47	23,46	16,41	10,77
power	56,54	49,90	40,72	32,10	24,03	16,88	10,90
exponential	55,42	48,87	39,66	31,25	23,24	16,22	10,75
stable	56,80	50,10	40,87	32,23	24,10	16,89	10,91
decline	56,99	50,29	41,04	32,37	24,20	16,95	10,94

Source: own calculation

Figure 4.20 shows the projected OALEs for 2015 for all female age groups. The largest OALE for all age groups is projected with the decline scenario, followed by the stable and power scenarios. For the female age groups too, there is only a very small difference between the decline scenario and the stable scenario. Similar to the males, the exponential scenario the projects the lowest OALE. Taking into account all scenarios the differences between the projected OALEs are not very large, though most are slightly larger than the difference of the males. Starting with the youngest age group the consecutive difference between the lowest and highest projected OALE are 1.94, 1.67, 1.38, 1.11, 0.87, 0.62, and 0.34. Thus the youngest age group shows the largest difference, the oldest the lowest.

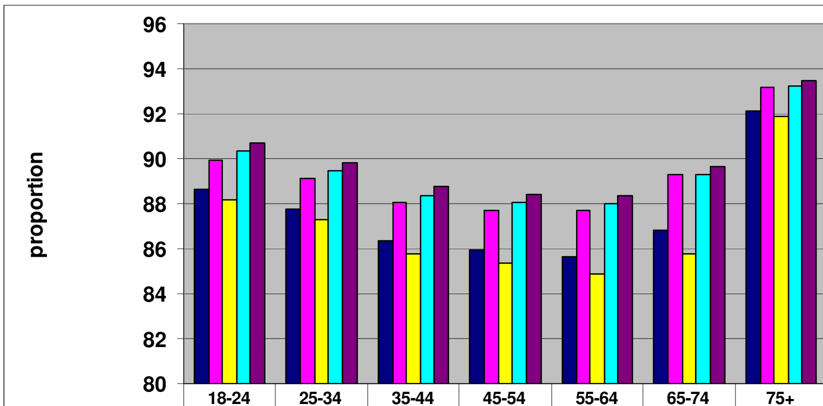
Figure 4.20: Effect on the female Obesity Adjusted Life Expectancy, per age and scenario, 2015



	18-24	25-34	35-44	45-54	55-64	65-74	75+
linear	56,53	50,15	41,37	32,99	25,03	17,79	11,55
power	57,39	50,89	41,97	33,42	25,38	18,09	11,72
exponential	56,21	49,96	41,24	32,90	24,96	17,75	11,54
stable	57,89	51,38	42,40	33,83	25,68	18,26	11,82
decline	58,15	51,63	42,62	34,01	25,83	18,37	11,88

Source: own calculation

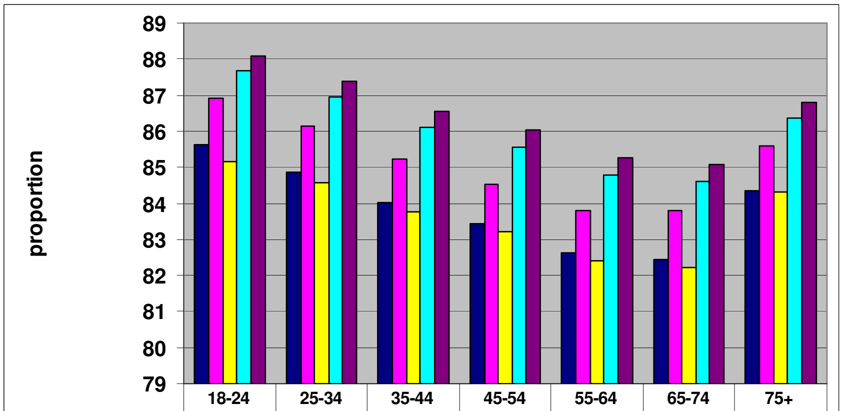
Figure 4.21: Effect on the male proportion of life lived without obesity per age and scenario, 2015



	18-24	25-34	35-44	45-54	55-64	65-74	75+
linear	88,67	87,75	86,36	85,95	85,66	86,81	92,09
power	89,97	89,12	88,07	87,69	87,73	89,32	93,15
exponential	88,18	87,27	85,77	85,35	84,87	85,78	91,91
stable	90,38	89,48	88,38	88,05	87,99	89,32	93,25
decline	90,69	89,82	88,75	88,43	88,37	89,67	93,47

Source: own calculation

Figure 4.22: Effect on the female proportion of life lived without obesity per age and scenario, 2015



	18-24	25-34	35-44	45-54	55-64	65-74	75+
linear	85,63	84,87	84,02	83,44	82,64	82,43	84,36
power	86,93	86,13	85,23	84,53	83,81	83,80	85,60
exponential	85,14	84,55	83,75	83,20	82,42	82,24	84,31
stable	87,69	86,96	86,11	85,56	84,79	84,60	86,35
decline	88,09	87,37	86,56	86,02	85,28	85,09	86,79

Source: own calculation

In the figures 4.21 and 4.22 the proportions of remaining life lived without obesity in 2015 of the different scenarios are shown. The most years lived without obesity are calculated with the decline scenario followed by the stable scenario, however the difference is very small. With the exponential scenario the least years lived without obesity are computed. This resembles the same pattern which appears in figure 4.19. The differences between the highest and lowest projected proportion per age group are larger than that of the OALE. In consecutive order they are, starting with the youngest age group, 2.51, 2.55, 2.98, 3.08, 3.50, 3.89, and 1.56. An upward trend towards the elder age groups is visible, though the 75+ age group is an exception with the smallest difference.
For the females the most years lived without obesity are calculated with the decline scenario too, followed by the stable scenario. For the females the differences are quite small too. With the exponential scenario the least years lived without obesity are computed. The same pattern is resembled in figure 4.22. The differences between the highest and lowest projected proportion per age group are larger than that of the OALE. In consecutive order they are, starting with the youngest age group, 2.95, 2.82, 2.81, 2.82, 2.86, 2.85, and 2.48. No real upward of downward trend is visible. The 18-24 age group has the largest difference, the 75+ age group the lowest. Compared to the difference of the males, the females have larger difference for the age groups 18-24, 25-34, 35-44 and 75+.

The following tables (4.23 up to 4.26) are concerned with the proportional changes that have occurred to the OALE and the proportion of life lived without obesity within the different scenarios.
Table 4.23 lists the proportional change in the OALE of the males. For the projection period the linear, power, stable and decline scenarios all indicate increases for all age groups. The exponential scenario shows minute declines of the OALE for the three youngest age groups. This scenario is also the one which projects the least increase of the OALE. Of all scenarios the decline projects the largest increase in the OALE for all age groups, when only the trend line projections are considered the power scenario projects the largest increase. In all of the scenarios an upward trend can be seen of an increase of the proportional change towards the older age groups. Thus despite the increase of the prevalence in the linear, power and exponential scenarios almost all age groups shows an increase of the OALE. In the scenarios

where the prevalence stabilizes and declines the proportional increases of the OALE are the largest though.
When considering the period from 2000 up to 2015, an increase of the OALE is indicated for every age group. Despite the increase in prevalence that has occurred in every age group the OALE is not affected negatively. The largest increases are with the stable and decline scenario, though within the older age groups the differences are quite small. For all scenarios the upward trend is visible, towards the older age groups there is more proportional increase. The differences in proportional growth between the youngest and eldest are quite large, much larger than in the projected period.

Table 4.23: Effect on the proportional change of the male Obesity Adjusted Life Expectancy, per age and scenario

males	linear	power	exponential	stable	decline	linear	power	exponential	stable	decline
	09-15 %	**09-15** %	**09-15** %	**09-15** %	**09-15** %	**00-15** %	**00-15** %	**00-15** %	**00-15** %	**00-15** %
18-24	0,21	1,15	-0,29	1,66	1,96	3,81	5,33	3,23	5,80	6,16
25-34	0,32	1,33	-0,16	1,86	2,19	4,39	6,02	3,82	6,45	6,85
35-44	0,34	1,61	-0,26	2,27	2,63	5,29	7,38	4,57	7,75	8,21
45-54	0,90	2,20	0,28	2,84	3,22	7,83	10,01	7,08	10,46	10,94
55-64	1,30	2,85	0,48	3,64	4,03	10,08	12,75	9,07	13,08	13,57
65-74	1,74	3,54	0,66	4,38	4,73	14,32	17,62	12,96	17,63	18,08
75+	3,22	3,96	3,03	4,25	4,46	20,06	21,45	19,83	21,58	21,86

Source: own calculation

Table 4.24: Effect on the proportional change of the female Obesity Adjusted Life Expectancy per age and scenario

females	linear	power	exponential	stable	decline	linear	power	exponential	stable	decline
	09-15 %	**09-15** %	**09-15** %	**09-15** %	**09-15** %	**00-15** %	**00-15** %	**00-15** %	**00-15** %	**00-15** %
18-24	-1,26	-0,27	-1,74	0,35	0,73	-0,71	0,79	-1,28	1,68	2,13
25-34	-1,18	-0,20	-1,49	0,38	0,79	-0,22	1,26	-0,59	2,24	2,73
35-44	-1,09	-0,13	-1,36	0,44	0,88	0,49	1,94	0,17	2,99	3,52
45-54	-0,95	-0,07	-1,19	0,50	0,96	1,38	2,71	1,09	3,96	4,52
55-64	-0,97	-0,04	-1,20	0,52	1,02	2,63	4,08	2,36	5,30	5,91
65-74	-1,09	-0,04	-1,29	0,45	0,95	5,29	7,04	5,05	8,07	8,70
75+	-1,28	-0,41	-1,36	-0,14	0,29	8,05	9,64	7,98	10,59	11,15

Source: own calculation

The change of the OALE for females is shown in table 4.24, and is very different to that of the males. For the projected period only the decline scenario predicts an increase of the OALE for all the age groups. Only the 75+ age group of the stable scenario shows a minor decline, all other age groups show a minute increase of the OALE. The remaining scenarios, linear, power and exponential, predict declines of the OALE for all age groups. Within the exponential scenario the largest declines are recorded, though the declines are still small. In none of the scenarios a general upward or downward trend can be seen.
Taking into account the overall period increases of the OALE are seen for every age group in all scenarios, except for the 18-24 and 25-34 age group. For the latter age groups small declines are projected in the linear and exponential scenario. Overall the projected declines in the projection period do not influence the OALE of the overall period very much. In this 2000 up to 2015 period a general upward trend is visible, the older age groups have larger proportional increases. As with the males, the difference in the proportional growth between the youngest and the eldest age group is quite large.

Table 4.25 represents the proportional change of the proportion of remaining life lived without obesity. The linear, power and exponential scenarios indicate a proportional decline of this proportion. This means that they all project that males will spend more of their remaining life suffering from obesity. For all three an upward trend is visible, the elderly show larger declines, though the 75+ age groups is an exception. The stable scenario projects very minor increases of the proportion, whereas the decline scenario shows somewhat larger increases. Of all scenarios the exponential scenario projects the largest decreases, the decline scenario projects the largest increases.
When the overall period is considered all scenarios show declines of the proportion. Again the exponential scenario projects the largest decline, the decline scenario shows the smallest declines. Despite the increase in the projected period the stable and decline now show declines too. For neither of the scenarios an upward or downward trend can be seen.

Table 4.25: Effect on the proportional change of the male Proportion of life lived without obesity, per age and scenario

males	linear	power	exponential	stable	decline	linear	power	exponential	stable	decline
	09-15 %	**09-15 %**	**09-15 %**	**09-15 %**	**09-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**
18-24	-1,42	-0,50	-1,91	0,01	0,30	-3,40	-1,99	-3,94	-1,55	-1,21
25-34	-1,49	-0,49	-1,96	0,03	0,35	-3,52	-2,01	-4,05	-1,62	-1,25
35-44	-1,82	-0,58	-2,41	0,06	0,42	-4,19	-2,29	-4,85	-1,95	-1,54
45-54	-1,79	-0,53	-2,39	0,09	0,46	-3,98	-2,04	-4,65	-1,64	-1,22
55-64	-2,13	-0,64	-2,92	0,13	0,50	-4,89	-2,59	-5,77	-2,30	-1,88
65-74	-2,41	-0,68	-3,44	0,13	0,46	-5,05	-2,30	-6,17	-2,29	-1,92
75+	-0,99	-0,29	-1,18	0,00	0,20	-2,14	-1,01	-2,33	-0,90	-0,67

Source: own calculation

Table 4.26: Effect on the proportional change of the female proportion of life lived without obesity, per age and scenario

females	linear	power	exponential	stable	decline	linear	power	exponential	stable	decline
	09-15 %	**09-15 %**	**09-15 %**	**09-15 %**	**09-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**	**00-15 %**
18-24	-1,62	-0,63	-2,09	-0,01	0,37	-4,21	-2,76	-4,76	-1,90	-1,46
25-34	-1,56	-0,59	-1,87	-0,01	0,40	-4,07	-2,64	-4,42	-1,70	-1,23
35-44	-1,53	-0,58	-1,79	-0,01	0,44	-4,04	-2,65	-4,34	-1,65	-1,14
45-54	-1,45	-0,57	-1,68	0,00	0,46	-3,94	-2,69	-4,22	-1,50	-0,97
55-64	-1,49	-0,56	-1,71	0,00	0,49	-3,85	-2,50	-4,11	-1,35	-0,79
65-74	-1,53	-0,49	-1,73	0,00	0,50	-3,23	-1,62	-3,45	-0,68	-0,10
75+	-1,14	-0,26	-1,22	0,00	0,43	-1,85	-0,40	-1,91	0,47	0,97

Source: own calculation

In table 4.26 the proportional change within the female age groups of the proportion of remaining life lived without obesity is listed. Similar to the male age groups the linear, power and exponential scenarios show declines for the projection period. The declines are the largest in the exponential scenario and the smallest in the power scenario. Of the other two scenarios the stable scenario shows very minor declines and stability in the proportions. Generally the stable scenario causes zero change in the proportions. The decline scenario is the only one showing increases, which are larger towards the older age groups, with the 75 age group being an exception.

Considering the whole period the three trend lines, linear, power and exponential, show declines. Within the younger age groups the declines are the largest. The stable and decline scenario show fairly small declines for all the age groups, except for the 75+ age group. There are large differences in the proportional change between the youngest and eldest age groups.

5 Discussion

5.1 Conclusion

In this research a look has been taken at the effect of the obesity epidemic on the present and future Obesity Adjusted Life Expectancy in the Netherlands. This has been researched for seven age groups for both sexes, for which the past obesity prevalence trend of 2000 up to 2008 has been projected until 2015, with which in turn the Obesity Adjusted Life Expectancy (OALE) has been projected. With the use of five different scenarios the future OALE has been projected based on the past trend.
Of the adult population in 2008 11 per cent was obese in the Netherlands. Within the male adult population 9.9 per cent was obese in that year, of the female adults 12.1 per cent was obese. The obesity prevalence of the males shows a gradual increase over the past years. For the females and total adult obesity a minute decline from 2007 to 2008 has been recorded. Though these declines are very small and could be considered as a stabilisation of the trend. When the different age groups are concerned many differences exists in obesity prevalence. In 2008 the prevalence's for the male age groups varied between the four and 15 per cent. For the female age groups the prevalence's are even higher, between seven and 19 per cent.
These large differences between the age groups can also be seen within the age groups over time. The obesity prevalence trend from 2000 up to 2008 has been very volatile for all age groups which has been reduced by smoothing. For both males and females is has become clear that the youngest age groups have the lowest prevalence and the oldest the highest. Only exception is the 75+ age group which is similar to the male 25-34 age group and the female 55-64 age group. The prevalence of the males varies between the one and 15 per cent, for the females the rage is slightly higher between the three and 20 per cent.

For all age groups the effect of the obesity epidemic of the Obesity Adjusted Life Expectancy (OALE) was positive. An increase was visible of the OALE within all age groups for the period 2000 up to 2008. Though for the males the proportional increase was almost twice as large as that of the females. An increase of the proportional growth of the OALE towards the older ages is visible for both males and females, besides that the differences are quite large between the age groups. Another indicator of the effect of the obesity epidemic on the Dutch health, the proportion of life lived without obesity, has declined, except for the female 75+ age group. Contrary to the OALE, the proportional decline of the males and females is about the same. Although the declines are very small, they do exist. This means that more or less all age groups have lived more of their remaining life with obesity in the period 2000 up to 2008.

The projection of the obesity prevalence trend with the various scenarios causes many differences between males and females and between the age groups.
With the most likely scenario, the power trend, an increase of the prevalence for all age groups is recorded. For both sexes the largest proportional increase is recorded for the 18-24 age group. The linear trend scenario causes an increase of the prevalence for all age groups, except the male 25-34 age group. The largest proportional increases are visible in the youngest and eldest age groups.
With the exponential projection almost the same results are shown, all prevalence's will increase, except the male 25-34 age group. With the stable prevalence there is no change in the projected prevalence by 2015, the decline scenario shows the similar decline for all age groups. When all scenarios are compared in 2015, the exponential projects the highest prevalence's followed by the power, linear, stable and decline scenarios. Overall all trend scenarios (linear, power, exponential) show increases for all age groups, exception is the male

25-34. For the male age groups there is no real order in proportional changes, with the females the youngest age groups increase the most and the eldest increase the least. Further it has become clear that within the trend scenarios the proportional increase of the obesity prevalence is larger in the younger female age groups than that of the males. Within the elder age groups it is the other way around. For the stable and decline scenario the proportional changes are that same for males and females.
With these five projection scenarios an indication is given of what the future obesity prevalence might be. For every age group the difference between the lowest and the highest projected prevalence is different in 2015, large differences are caused by the decline scenario. The rage of the projected obesity prevalence with and without the decline scenario is given in table 5.1.

Table 5.1: Obesity prevalence range per age group in 2015

	males			**females**		
Age group	highest	lowest	Lowest (excl. decline)	highest	lowest	Lowest (excl. decline
18-24	4,57	2,37	2,45	9,89	5,90	6,10
25-34	6,03	5,28	5,45	11,52	8,62	8,90
35-44	12,71	10,07	10,40	14,07	11,33	11,70
45-54	13,33	11,42	11,80	14,46	11,76	12,15
55-64	16,79	13,99	14,45	17,20	14,33	14,80
65-74	20,74	14,37	14,76	20,42	17,09	17,65
75+	8,09	6,53	6,75	15,69	13,21	13,65

Source: own calculation

The projected prevalence’s of all the five scenario have different effects on the Obesity Adjusted Life Expectancy and the proportion of remaining life lived without obesity in the period 2009 up to 2015.
The effects of the most likely future development, the power scenario, are positive for the males. For the males the results show a further increase of the OALE, with the largest proportional growth is towards the older ages. For the females the effect on health is negative, all age groups show a decline of the OALE, with the largest declines in the youngest and eldest age group. The proportion of life lived without obesity declines for both sexes. For both the decline is smaller than in the period 2000 up to 2008, the proportional declines are about similar for males and females.
Continuation of linear growth of the obesity prevalence does not affect the males negatively, for the period 2009 up to 2015 the OALE increases, though some with very small percentages. The OALE of the females on the other hand is affected negatively, for all age groups declines are recorded. For both males and females the proportional decline recorded in the proportion of life lived without obesity, for 2000 up to 2008 continues up to 2015. The proportional decline is about the same amount in both periods.
The continuation of an exponential trend causes a negative effect on the males. A small decline of the OALE in the three youngest male age groups is recorded, though for the other age groups small increases are recorded. For the females the effect is negative for all age groups, all show a decline of the OALE, with the largest decreases in the youngest age groups. The effect on the proportion of life lived without obesity is negative for both males and females. For both the decreases are larger than in the 2000 up to 2008 period.
With the stable prevalence the OALE of the males shows minor proportional increases for the period 2009 up to 2015, the largest increases are towards the oldest ages. Almost all females age groups are affected positively, the all show minor increases only the 75+ age group shows a minor decline. Generally there is not much effect on the female OALE. The stability of the prevalence causes very small changes in proportion of life lived without obesity. Generally

we could say that this scenario has no effect on the OALE and the proportion of remaining life lived without obesity in the period 2009 up to 2015.
In the scenario with the decline in prevalence the effect on the OALE is positive for both males and females, for both increases are recorded. The proportional increases of OALE for the male age groups are larger than those of the females. Proportional increases are larger towards the higher age groups. The decline also affects the proportion of life lived without obesity positively. Both the males and females can expect an increase of this proportion. The increases are larger for females than for males and an increase towards the higher age groups is visible.

The difference in the effect on the projected OALEs by the different scenarios are not very large. The range per age group of the OALE for 2015 is shown in table 5.2. The largest OALEs are predicted with the decline scenario and the lowest with the exponential. Differences are larger for females than males and the largest differences are with the younger age groups. Overall the OALE of the females is higher than the OALE of the males, the smallest differences are within the youngest and eldest age group, the age groups in between show the most difference.

Table 5.2: Obesity Adjusted Life Expectancy range per age and sex, 2015

	males			**females**		
Age group	highest	lowest	Highest (excl. decline)	highest	lowest	Highest (excl. decline
18-24	56,99	55,42	56,80	58,15	56,21	57,89
25-34	50,29	48,87	50,10	51,63	49,96	51,38
35-44	41,04	39,66	40,87	42,62	41,24	42,40
45-54	32,37	31,25	32,23	34,01	32,90	33,83
55-64	24,20	23,24	24,10	25,83	24,96	25,68
65-74	16,95	16,22	16,89	18,37	17,75	18,26
75+	10,94	10,75	10,91	11,88	11,54	11,82

Source: own calculation

Considering the proportion of life lived without obesity the decline scenario predicts the largest proportion by 2015 and the exponential the lowest. The difference between the highest and lowest is much larger than with the OALE, the highest and lowest projected proportions are listed in table 5.3. Overall the males show larger proportions than the females. Both sexes show a decline in the proportion towards the older age group, only the 75+ age groups stand out.

Table 5.3: Proportion of remaining life lived without obesity range per age and sex, 2015

	males			**females**		
Age group	highest	lowest	Highest (excl. decline)	highest	lowest	Highest (excl. decline
18-24	90,69	88,18	90,38	88,09	85,14	87,69
25-34	89,82	87,27	89,48	87,37	84,55	86,96
35-44	88,75	85,77	88,38	86,56	83,75	86,11
45-54	88,43	85,35	88,05	86,02	83,20	85,56
55-64	88,37	84,87	87,99	85,28	82,42	84,79
65-74	89,67	85,78	89,32	85,09	82,24	84,60
75+	93,47	91,91	93,25	86,79	84,31	86,35

Source: own calculation

In general the health of the females is more influenced by the increase in prevalence, all trend projections show declines of the OALE for the female age groups. For the males there were

only three age groups with minor declines. With the stable prevalence the OALE also remains more or less stable and with the decline scenario both sexes show an increase of the OALE. Though overall the OALE of the females remains around the two years higher than that of the males for all age groups.
The proportions of life lived without obesity decline for both males and females with linear, power and exponential. With the stable scenario they remain more or less the same and increase slightly with the decline scenario.

The effects of the obesity epidemic are harder on the females, they have a larger proportional decline of their OALE, while the males still show an increase of their OALE with most projection scenarios. This difference is possibly related to the difference in proportional growth of the life expectancy in the projection period and thus the proportional growth of the population and the number of deaths. The life expectancy of the males shows larger proportional increases than the life expectancy of the females. Moreover the remaining life expectancy is used in the calculations of the OALE, thus differences in the increase of life expectancy will carry over into the OALE.
Despite the increase of the OALE for all male age groups, the proportion of life lived without obesity decreases for all trend projections for both males and females. So eventually it will be very likely that up to 2015 all age groups will live more of their remaining life with obesity. When the prevalence stays stable the proportion is more or less the same, so there is no gain or loss of the OALE. The best scenario would be the decline of the prevalence, this would namely result in an increase of the proportion. However a decline of the prevalence is not very likely at this point in time, though a decline should set in to increase the OALE and so improve the health of the Dutch. With this decline scenario it is shown that the decline in obesity prevalence does have an influence on the overall health.

On the whole the future development and influence of the obesity epidemic has different effects on the males and females. Apart from the stable and decline scenario, in which the changes in prevalence are the same for males and females, the other three scenarios do show differences. In general the obesity prevalence of the females is higher than that of the males. Within the linear, power and exponential projection the younger female age groups increase more than the males, for the elder age groups it is vice versa.
Regarding the differences in the OALE some comments have already been made. Generally the OALE of the females is higher, though with the linear, power and exponential projections the females show proportional declines and the male show proportional increases. Within the stable and decline scenario the proportional increases are much larger for the males than for the females.
There are more differences when we take a look at the proportion of remaining life lived without obesity. For the linear, power and exponential projections both sexes show quite similar proportional declines and with the stable scenario they both show no change. Though for the decline scenario the proportional increases of the females are larger than that of the males.

The most affected group is often the 18-24 age group. In most cases this age group shows the largest proportional increase of the prevalence. This could relate to the fact that the obesity prevalence in this group is the lowest of all age groups, an small increase in prevalence in this groups often a larger proportional increase (i.e. from a prevalence of 2 to 4, compared to a prevalence increasing from 15 to 17). An age group which often stands out is the male 25-34 age group. Most likely this is due to the fact that no trend line fits the obesity trend very well.

Of all age groups and with every trend line it has the worst fit, so when the trend lines do not fit well the projection will be off too.

The obesity epidemic has had quite a lot of influence on the Dutch health and will most likely continue to do so. When the prevalence would stabilise the effect is none existing only with a decline in prevalence health gain in the form of an increase of the OALE and the proportion of life lived without obesity is likely for both males and females.
Nevertheless from the trend projections (linear, power and exponential), it has become clear that it is likely for the obesity prevalence to increase by 2015. Especially the women will suffer from a lower OALE, while for the males the increase in obesity prevalence does not affect their OALE negatively.

5.2 Reflection

5.2.1 Data and methods

Influence of the data and methods on the results in this research has been possible in multiple ways. The obesity prevalence data derived from the CBS has been collected by surveys and is self reported data. With self reported data there is always the possibility that the interviewee over or under estimates his or her weight and height. This influences the data considerably, which was visible in the very volatile prevalence’s in all age groups. In order to compensate for this smoothing has been applied, which in turn influences the results. Though due to the smoothing the prevalence trend is less volatile and better to base a trend on. Besides in every calculation the smoothed obesity prevalence is used, hence the results are comparable. Though the fact remains that the results in this research are based on adapted data, which has influenced the results.
Another influence of the data is the period over which the data was available is very short. Basing a trend on a longer period would result in more reliable outcomes, though they were not present in the case of obesity without using different sources. Use of different sources was no option due to different ways of data collection and measuring obesity. Thus the short period of nine years is used, which could be a little to short to base the projection on, this could have influenced the projected prevalence’s. Lastly the results can be influenced too by errors which could have occurred in the manual calculations, even though thorough checks have been conducted, errors can still slip through.
Lastly the outcome could be influence by the method used too. With the Sullivan method a hypothetical cohort is created with which the calculations are conducted, hence this is of influence too on the results. Besides that assumptions have been made within this method concerning the Health Adjusted Life Expectancy. The assumption has been made that health in this case is only influenced by obesity, no other factors have been considered, which could of course provide a distorted picture. It has been the aim to look only at obesity hence that is what it has been decided to change the name into Obesity Adjusted Life Expectancy.

5.2.2 Relation to previous research

As this research makes projections for different age groups and most previous research looks at the whole (adult) population comparing the results is not easy. Besides that much research is concerned with other countries than the Netherlands. Though the overall results and trend can be compared.
Dutch research by the Health Council of the Netherlands (2003) projects the adult prevalence to be around 15 per cent in 2015. No separate age groups are taken into account which makes

comparison on the age group level difficult, however comparing the overall adult prevalence is possible. None of the projections made in this research reach the 15 per cent by 2015, the exponential scenario comes the closest with 13.2 per cent. When the power scenario is considered to be the middle case scenario the adult obesity prevalence will be 11.7 in 2015. However the projection of the Health Council is based on different data and assumptions which could cause the differences.

In this research it has been indicated that an increase of the obesity prevalence within the elderly population is to be expected. According to research by Arterburn et al. (2004) an increase of obesity prevalence among the elderly Americans (60+) will be very likely too. Even though the Dutch and American prevalence’s can not be compared, the American is expected to be 37.4 per cent in 2010, they show the same increasing trend. An increase of the number of obese is also projected for the United Kingdom by Zaninotto et al. (2004). With non linear trend projections they project an increase of the number of obese to increase with 3.5 million by 2010. The Dutch obesity prevalence among elderly will never reach that of the United States, though they both still show an increase.

The increase of the obesity prevalence in the Netherlands, United Kingdom and the United States are no exceptions, in most countries around the world the obesity prevalence is increasing. As Kelly et al. (2008) mention in their research with a stabilisation of the prevalence the number of obese worldwide will be 573 million in 2030, with a continuation of the prevalence trend there will be 1.12 billion obese.

Overall most previous research conducted on the topic of obesity prevalence indicates an increase in the prevalence in the coming years. Whether or not this increase has an influence of the general health (i.e. the HALE) is not discussed in most of the articles, hence comparing this aspect of the research is difficult. A research on the HALE for healthy, smoking and obese people by Hoogenveen et al. (2006a) does indicate that the females have higher HALEs at every age. This is the same in this research, in the research by Hoogenveen et al. (2006a) no projection is made, hence comparing the proportional changes of the HALE occurring due to the prevalence change is not possible. Besides that other research on the HALE is mostly conducted on other diseases than obesity, which makes comparing complex.

What remains is the fact that it is useful that this research has been conducted. Most previous research just looks at the (future) prevalence and not further. Veerman et al. (2007) look at two scenarios for the prevalence of obesity in the coming decade, one with and one without interventions. Arterburn et al. (2004) use low, middle and high scenarios to indicate the development of the prevalence within the elderly. Hill et al. (2003) explore the determinants behind the epidemic and which changes that could be made. In the article by Schokker et al. (2006) trends in prevalence are shown for adults and children. In addition to that education level and the prevalence of obesity are looked at. So there is quite some research conducted on the obesity epidemic, though they do not all take the step to look at the effect on health.

This research has attempted to add on to the previous research by using more recent data. With the use of more recent data, projections about the future prevalence will be more up to date. Besides that after projecting the obesity prevalence in the future the effect on health is projected too. This research is definitely an addition to previous research regarding this latter aspect.

5.3 Implication and further research

With this research it has been indicated that a further growth of the obesity prevalence is likely and that is has an effect on the people’s heath. Having this idea of the development of obesity prevalence and the effect it has on health will be useful for policymakers assigned to obesity prevention. This is what makes this research relevant for society as well. The

government and other organisations need to look at their current obesity prevention programs again. How can the obesity prevention be improved and how can more people be reached? This does not need to be something the Dutch government has to work out alone. Many other countries surrounding the Netherlands do also have a rising number of obese people for whom programs need to be implemented. Hence exchanging policies and programs with other countries, which is called policy transfer, could be something the government could look at.
In order to counter the trend, which is the only way to generate health gain, more people need to be encouraged to lose weight. This is also where further research comes in. In order to involve more people it is vital to understand the people behind the obesity epidemic, hence qualitative research is important. With their input, on for example what they think should be done, what they miss in present programs, what help they need to start to lose weight and live healthy, new programs could be installed. What are the reasons people have not succeeded in their attempts to lose weight, what more initiatives do they need. This is related to the first step of intervention mapping, assessing the needs, which often involves the planners to communicate with the target group, i.e. the group for whom they are making new plans. How do they experience certain things and what are their needs. Besides that knowledge needs to be gathered on the behaviour and environmental causes of the health problem, moreover on the determinants of these. This way a clear picture of what needs to change will appear, not only in the health status, but also in behaviour and in the environment (Bartholomew, Parcel, Kok, 1998). Therefore research is an element that can not be missed in policy making. Before new programs can be installed, the policy makers need to know what is needed and which programs might be effective. Hence it is also important to know what has already been done and was (not) successful.
These programs of the government should not just target the young, which is a very important group, but prevalence's are also rising within the elderly. They also need the help to eat right and live healthy, if not this will cause more problems at higher ages. Also informing parents about their role and influence on their children's eating habits is of importance.
Overweight and obesity prevention requires an interdepartmental approach too. Not only the ministries of health care, sports and education are involved, the spatial planning, traffic, environment, youth and families, integration and economy departments are also involved. Only a joined treatment of all the departments will have a chance of solving the obesity problem. In an administrative way this is most excellent done at the municipality level, there all the parts come together. The ministry of Public Health, Wellbeing and Sports has drawn up a guide, which will help municipalities to tackle the obesity problem (Ministry of VWS, 2007b). This important element of the Dutch planning system, the relation between the different levels of government, is also applied to the obesity prevention. This way national plans can be tailored to a local program, to increase the implementation.
Another important aspect, which the government has mentioned it is working on, is the collection of good and reliable data on the obesity epidemic. As indicated self reported data has its flaws as does measuring the epidemic with the BMI, though often there are no other ways of measuring. Then collecting data on the epidemic as accurate as possible is an aspect that is of great importance.
All the policies and programs depend on the accuracy of the obesity data. Related to this the effectiveness of the installed programs and policies. Do they show results and what is the best way to measure this? It is of great importance to monitor the programs and their effects.
Further research could also be related to other fields of research. They could use the results of this research to look further into the obesity epidemic, by looking at different groups or adding other aspects to the HALE besides obesity. The prediction of the future OALE is a new aspect which maybe others could use for other illnesses than obesity. Besides that this

research can be used as a background for researchers who want to look more at the individual level of obesity and look more into the personal effects of it.
Another aspect of further research is research in to obesity related mortality and other diseases that are connected to obesity. In relation to this my own PhD research can be mentioned, which will be concerned with regional mortality forecasting using extensions of the Lee-Carter model. Within this research mortality of diseases related to obesity could play a part.
Thus many aspects for the government and other private parties to work on, which should eventually help to reduce the obesity prevalence. Besides that there are many ways in which other researchers could use this research as background for qualitative research or for further research into different fields.

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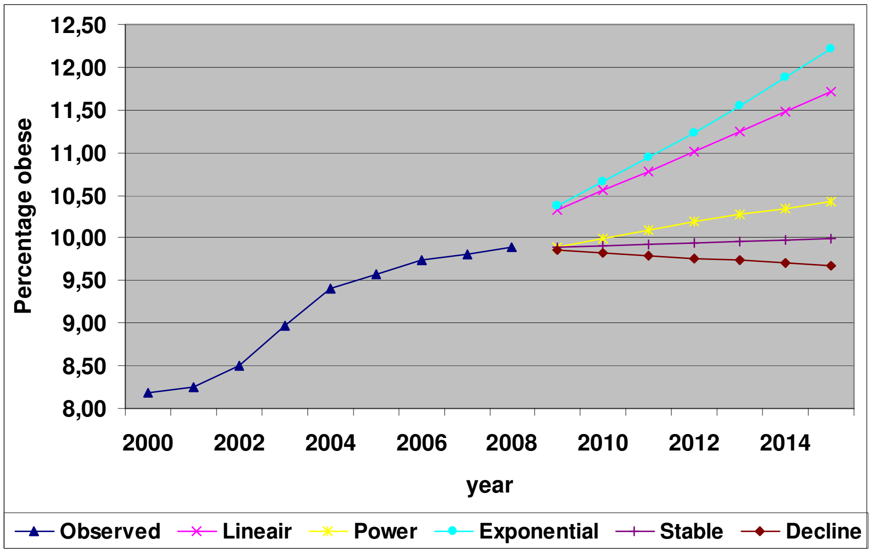
Appendix

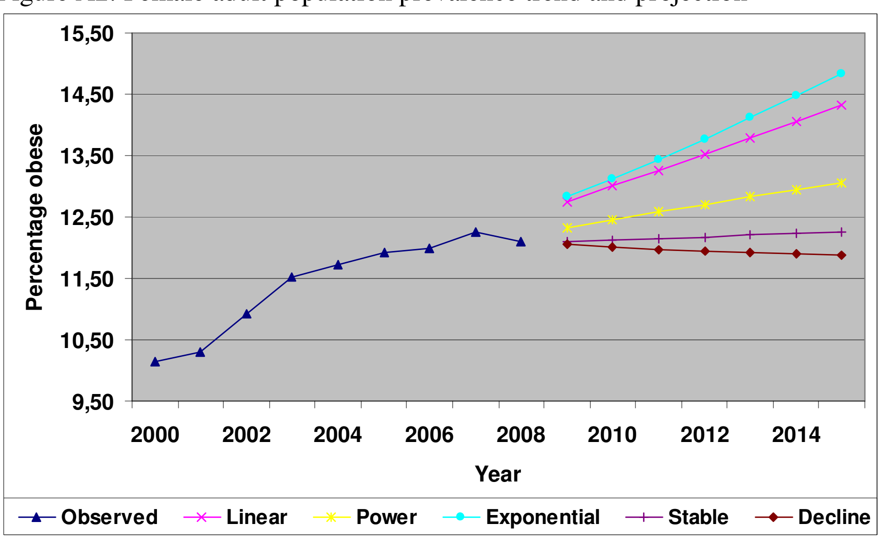
Appendix A. Adult obesity prevalence and projection

Figure A1: Male adult population prevalence trend and projection



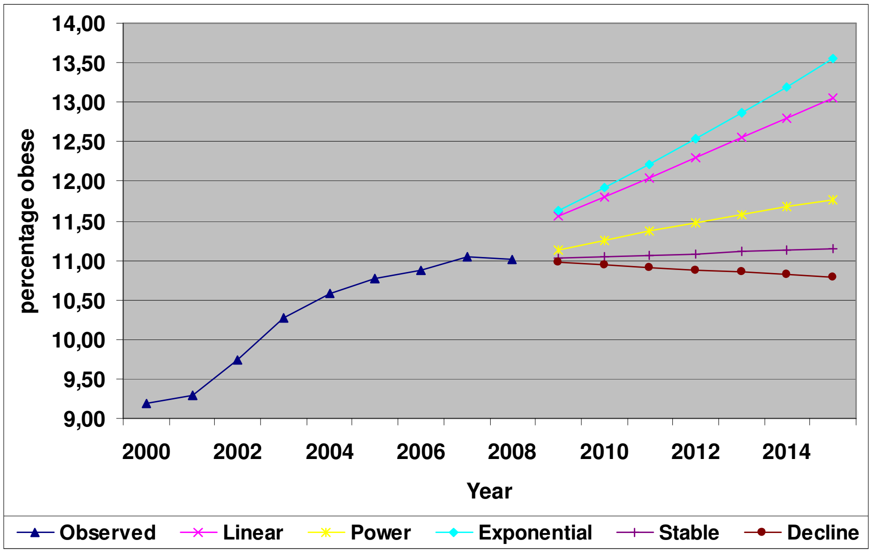
Source: own calculation

Figure A2: Female adult population prevalence trend and projection



Source: own calculation

Figure A3: Total adult population prevalence trend and projection



Source: own calculation