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FIT GAAF!
HET PLANMAATJE VOOR KIDS EN OUDERS BIJ EEN GEZONDE LEEFSTIJL
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SCIENCE BUSINESS & POLICY

Improving the effectiveness of the FitGaaf! program in the prevention of diabetes mellitus type 2 among children

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SBP internship report, Biomedical Sciences (MSc), University of Groningen

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Preface

On January 8th 2018, a new adventure started for me. Not only was I going to leave the comfortable environment of the university, I was also about to become part of the team of a small startup. What started as scary new experience soon turned into an exciting new adventure and before I knew it, I was doing the broccoli dance with toddlers at a school in Hoogeveen.

This advice report is written for FitGaaf! and is the result of a 6-month Science, Business and Policy internship for my master Biomedical Sciences. In these 6 months, I learned a lot about how startups in this field work and what issues they face. My personal goal was to use my knowledge of science and make it valuable for FitGaaf!.

I would like to thank my daily supervisor Tom Steffens for his enthusiasm, help, and support during my internship. Not only could I always ask him anything, he also offered all kinds of opportunities to take my internship one step further. I would also like to thank my colleagues at FitGaaf!, Koen, Mariët, Mariëtte and Amber for always being there whenever I needed tips or advice. I am very grateful for the way I was welcomed into the team.
Also, I would like to thank Sietse the Boer for his ideas and feedback about the beta-aspect of this report. And lastly, I would like to thank Albert-Jan Abma, my SBP supervisor. Although we didn't always completely understand each other, I realize that we worked towards the same goal: giving the best possible advice to FitGaaf! Therefore, I'm grateful that he always pushed me to do better. Also, I'm thankful for his open-mindedness and flexible attitude throughout the internship.

I hope you enjoy reading this report!

Esmee Castermans

Groningen, July 10th 2018

Executive summary

48,9% of Dutch adults and 11,9% of Dutch children between the ages of 4 and 11 are overweight. Overweight and obesity are associated with several complications, including diabetes mellitus type 2. In order to prevent overweight and its complications, many prevention programs aim to improve lifestyle, mainly in children. FitGaaf! is one of these programs. The company offers a calendar with stickers that addresses several aspects of lifestyle. This internship focuses on how the effectiveness of FitGaaf! can be improved.

Prevention can take place on three levels, primary, secondary and tertiary, that target respectively all people, people at risk and people with complications. FitGaaf! is mainly active in primary prevention, but hasn't been able to acquire a strong market position due to intense competition and the low availability of funding. The tertiary prevention market, which is also targeted to a lesser extent, is also a dead end because of high entry barriers. The secondary prevention market, which focuses on a target group with a low socioeconomic status, seems to suit FitGaaf! better because of previous successes and the opportunity of participating in a health impact bond.

It is very difficult to determine the effects of prevention on health. Therefore the FitGaaf! stickers are evaluated for their potential to prevent overweight and diabetes mellitus type 2, based on literature. The effects of sleep, breakfast, vegetables, fruits, moderate intensity exercise and vigorous intensity exercise can be backed up by literature and are expected to be effective lifestyle interventions. The effects of the water sticker and the "joker" sticker can't be confirmed or declined due to their broad interpretability. A potentially interesting addition to the program is a sticker that targets non-exercise activity thermogenesis.

Sufficient participation rates are crucial for high effectiveness. Whether a person will participate depends on several factors, including the degree of reward, whether or not someone is intrinsically motivated, whether the parents are involved, if someone knows how to participate, if someone is able to participate and if someone sees the need to participate. Participation rates in FitGaaf! are already high, based on a study at the last project in Hoogeveen. Parent meetings can be an interesting addition to FitGaaf!, because these can further improve participation.

FitGaaf! is advised to focus on the secondary prevention market. In order to obtain a strong market position, it is advised to apply for a higher rank in the Loket Gezond Leven database, work on FitGaaf!'s professional image and participate in a health impact bond. In addition, it is recommended to further improve the program by specifying the water sticker, changing the joker sticker, adding a non-exercise activity thermogenesis (household chores) sticker and introducing parent meetings. After establishment in the market, FitGaaf! is advised to start gathering biometric data to determine the actual effectiveness of the program, expand the team and initiate a new health impact bond. Optionally, FitGaaf! could develop an app to further improve participation, but only if FitGaaf! is also targeting the primary prevention market at that time.

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Abbreviations

ATP	Adenosine triphosphate
B2B	Business to business
B2C	Business to customer
BIG	Beroepen in de individuele gezondheidszorg
BMI	Body-mass index
BMR	Basal metabolic rate
DALY	Disability-adjusted life years
DM1	Diabetes mellitus type 1
DM2	Diabetes mellitus type 2
EAH	Eating in absence of hunger
EAT	Exercise activity thermogenesis
EE	Energy expenditure
EI	Energy intake
G-6-P	Glucose-6-phosphate
GGD	Municipal health service
GM	Germ-free mouse
HDL	High density lipoprotein
HIB	Health impact bond
IRS	Insulin receptor substrate
JGZ	Youth healthcare services
KVDVK	Kans voor de Veenkoloniën
LTD	Long term depression
LTP	Long term potentiation
NEAT	Non-exercise activity thermogenesis
NPDRP	Non-proliferative diabetic retinopathy

Npy	Neuropeptide Y
PE	Physical education
RIGG	Regional Purchasing Organization Groninger Municipalities
RIVM	National Institute for Public Health and the Environment
ROS	Reactive oxygen species
SES	Socioeconomic status
SKJ	Stichting Kwaliteitsregister Jeugd
TDE	Total daily energy expenditure
TEF	Thermic effect of food
VTA	Ventral tegmental area

Concepts

Action potential	Electrical charge that temporarily changes the charge of parts of a neuron
Adipose tissue	Body fat stores. Can be truncal (adipose tissue in the torso) or peripheral (adipose tissue in the limbs)
Adipocytes	Cells in the adipose tissue
Adipogenesis	Production of new adipocytes
ADP time constant	Blood-flow dependent mitochondrial function measure
Amino acid	“Building block” of proteins
Amygdala	Region of the brain that is involved in regulation of emotions
Antagonist	Substance which interferes with or inhibits the physiological action of another
Antioxidant	Molecule that inhibits damage caused by oxidative stress
Apoptosis	Controlled cell death
Atherosclerosis	Disease of the arteries characterized by the deposition of fatty material on their inner walls.

ATP	High-energy molecule
Bariatric surgery	Weight loss surgery
Beta-cells	Insulin-producing cells in the pancreas
Butyrate	Short-chain fatty acid, can be produced by gut bacteria
Ca2+ channel	Channel that transports calcium ions over the cell membrane
Capability approach	Determining what conversion factors are needed to enable people to make use of resources
DAL region	Area in the Netherlands consisting of the municipalities of Delfzijl, Appingedam, and Loppersum.
Depolarization	The negative internal charge of the cell temporarily becomes more positive
Direct dopamine pathway	Pathway in the mesocorticolimbic circuit with D1 receptors. Binding of dopamine leads to a LTP
Dopamine	Signaling molecule in the brain, involved in the reward system
Diabetes mellitus	Inability to maintain glucose homeostasis in the blood
Endothelial	Cells lining the inside of blood vessels
Enkephalin	Natural opioid that is released from the neostriatum as a response to food.
Extrinsic motivation	Tendency to engage in activities in order to gain some type of known, external reward
Free fatty acid	“Building block” of fat
Glucagon	Hormone that increases the blood glucose level by promoting glycogenolysis
Glucokinase	Enzyme in the beta-cells of the pancreas that phosphorylates glucose and transforms it into G-6-P
Gluconeogenesis	Conversion of amino acids to glucose
Glucose-6-phosphate	Phosphorylated form of glucose
Glucose	Simple carbohydrate (sugar), used by the body as energy source
GLUT-2	Glucose transporter in the membrane of beta-cells. Transports glucose from the blood into the beta-cells of the pancreas

GLUT-4	Glucose transporter in the membrane of liver and muscle cells. Transports glucose from the blood into the cells
Glycogen	Storage form of glucose, found in the liver and skeletal muscles
Glycogenesis	Conversion of glucose to glycogen
Glycogenolysis	Conversion of glycogen to glucose
Glycolysis	Metabolic process that converts glucose into pyruvate. ATP is produced in this process
HDL cholesterol	“Good” cholesterol that removes “bad” cholesterol from the blood
Health impact bond	A contract between the public and private sector in which a commitment is made by the public sector to pay for improved public health outcomes that result in public sector savings.
Hippocampus	Region of the brain that is involved in learning, spatial orientation and adjusting behavior to the environment
Homeostasis	Maintenance of the stable state of the internal environment of an organism
Hyperglycemia	Too much glucose in the blood
Hypertrophy	Enlargement
Hypoglycemia	Too little glucose in the blood
Hypothalamus	Region of the brain that operates as the main control center for the autonomic nervous system
Incretins	Molecules that are released from neuroendocrine cells in the gastrointestinal tract after food ingestion that inhibit glucagon
Indirect dopamine pathway	Pathway in the mesocorticolimbic circuit with D2 receptors. Binding of dopamine leads to a LTD
Insulin	Hormone that decreases the blood glucose level by promoting glycogenesis
Insulin receptor substrate	Signaling molecule that get released into the cell after binding of insulin to an insulin receptor
Intrinsic motivation	Stimulation that drives an individual to change a behavior for his/her own internal satisfaction or fulfillment
K+ channel	Channel that transports potassium ions over the cell membrane

Leptin	Signalling molecule, involved in appetite regulation
Lipogenesis	Conversion of glucose to fat
Lipolysis	Conversion of fat to FFA's
Lipostatic theory	An increase in fat stores leads to reduced appetite
Long term depression	Deactivation of a neural circuit
Long term potentiation	Activation of a neural circuit
Neostriatum	Brain area, involved in reward
Neovascularization	Formation of new blood vessels
Neuroendocrine cells	Cells that receive neural input and, as a consequence of this input, release message molecules (hormones) to the blood
Neuromodulator	Substance that influences the function of neurons but does not act as a neurotransmitter
Neuron	Nerve cell
Neuropathy	Nerve pain
Neuropeptide Y	Signaling molecule, involved in appetite regulation
Neurotransmitter	Small molecule that can signal between neurons and activate or inhibit brain areas by binding to a receptor
Nucleus accumbens	Area in the brain involved in motor function
Mesocortical dopaminergic pathway	Brain circuit involved in reward. Part of the mesocorticolimbic system
Mesocorticolimbic circuit	Brain circuit involved in reward. It consists of two parts; the mesolimbic and the mesocortical dopaminergic pathway
Mesolimbic dopaminergic pathway	Brain circuit involved in reward. Part of the mesocorticolimbic system
Microbiome	Community of microorganisms, for example in the large intestine
Mitochondrion	Organelle in the cytoplasm of cells that functions in energy production
Optogenetics	Technique that is used to activate neurons with light, independent of neurotransmitters
Orexin	Neuropeptide that regulates arousal, wakefulness, and appetite.

Osmosis	Tendency of water to pass through a semipermeable membrane into a solution where the solvent concentration is higher
Oxidative phosphorylation	Synthesis of ATP in the mitochondria for which energy is obtained by electron transport
Oxidative stress	Damage to cells caused by ROS
Palatability	Hedonic reward (pleasure) provided by foods or fluids
Peptide	Small protein-like molecule
PESTEL analysis	Business model, used for assessment of the macro environment of a company
Phosphorylation	Chemical process of adding a phosphorus group to a molecule
Phytochemicals	Molecules produced by plants. they have anti-obesity and antioxidant properties
Porter's five forces	Business model, used for assessment of the micro environment of a company
Retina	Area at the back of the eye that receives light and sends pictures of what the eye sees to the brain
Retinopathy	Loss of vision due to leakage and/or obstruction of the small blood vessels in the eye
RIGG	Organization that is responsible for purchasing care for youth in the municipalities of the province of Groningen
ROS	Unstable oxygen-containing molecules that can react with other molecules and damage them
Saturated fats	Unhealthy fats in the diet
Serotonin	Signaling molecule in the brain, involved in mood regulation
Skinner box	Classical experiment used to look at reward in animals
Subcutaneous fat	Fat below the skin, the more healthy type of fat
Sucrose	Simple carbohydrate (sugar), used by the body as energy source
Synaps	Region where a nervous impulse passes from one neuron to another
Temporal medial lobe	Region of the brain that is involved in declarative memory
Thermogenesis	Production of heat in the body

Triglycerides	Molecules derived from FFA's. Serve as a source of energy
Ventral tegmental area	Area in the brain involved in the mesocorticolimbic circuit
Visceral fat	Fat around the organs, the unhealthy type of fat
WIJ-teams	Neighborhood organizations that support families with issues of all kinds in the municipalities of the province of Groningen

Chapter 1

Introduction and background

This chapter introduces the problem that FitGaaf! aims to tackle and describes the content, goals, and methods of the internship project.

1.1 Motivation of the project

1.1.1 Overweight and obesity in the Netherlands

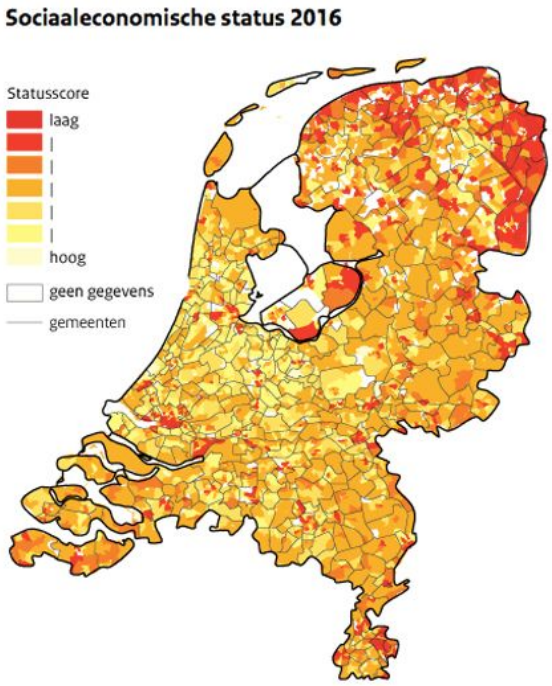
Overweight and obesity are common health problems in the Netherlands of which the prevalence has increased sharply in time. In 2016, 48,9% of all Dutch adults was overweight and 13,8% was obese. 25 years earlier, these numbers were 33% for overweight and 5,5% for obesity (CBS, 2016a). Weight gain originates from an imbalance between the use of energy and the uptake of energy. A global study by Hallal et al. showed that physical activity has decreased over time, mainly because of the development of technology. The necessity of physical activity has diminished, which has led to the current situation; one-third of adults worldwide don't reach public health guidelines for physical activity. The percentage of inactive adults is highest in high-income countries like the Netherlands with an average of 45% (Hallal et al., 2012). Besides a decrease in physical activity, energy uptake might also have contributed to the increase in the prevalence of overweight. Studies found that the declared energy intake in Western European countries has decreased, not increased, but the macronutrient composition of the diet had shifted to relatively more saturated fat and animal protein and less fiber and carbohydrate (Rolland-Cachera et al., 2000).

1.1.2 Children with overweight and obesity

The problem of overweight and obesity is not only present among adults. In 2016, 11,9% of Dutch children between the ages of 4 and 11 was overweight and 2,6% had a body mass index (BMI) in the obese range (CBS, 2016b). Because parents have a lot of influence on what their children eat and how much they exercise, the increasingly unhealthy lifestyle of adults is likely to reflect on their children. A study on Australian families found that the average BMI of 9-year-old children was higher if the father or mother was overweight or obese. At 18 years old, BMI of the offspring was significantly predicted by the BMI of fathers and mothers. Also, in daughters, fat intake was positively associated with fat intake of the parents (Burke et al., 2001). Therefore, it is not surprising that the overweight prevalence in children shows the same pattern as seen in adults.

1.1.3 Socioeconomic status

A factor that is known to be related to lifestyle is socioeconomic status (SES). The SES score is calculated from the average income, the percentage of citizens with a low income, the percentage of citizens with low-level education and the percentage of unemployment in a ZIP-code region (Knol, 1998). A study on dietary intake in the Netherlands found that low SES is associated with lower intake of vegetable protein, dietary fiber, and most micronutrients compared to high SES. Also, low SES is associated with increased intake of fat (Hulshof et al., 2003). The link between SES and overweight is clearly visible in figure 1 and 2, which show the average SES score (figure 1) and the prevalence of overweight (figure 2) in the Dutch municipalities. In general, regions with a low SES score have a higher prevalence of overweight.



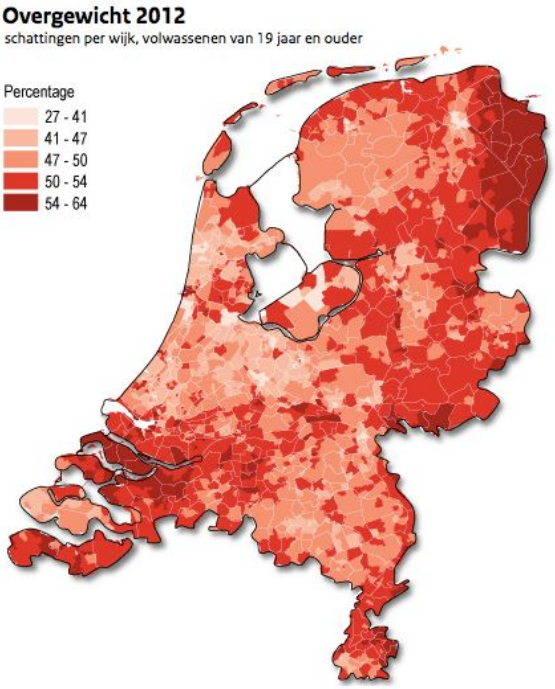


Fig. 1) Socioeconomic status (SES) score in the Netherlands per municipality in 2016 (Volksgezondheidenzorg, 2016).	*Fig. 2) Prevalence of overweight among adults (19 years and older) in the Netherlands per municipality in 2012 (Volksgezondheidenzorg, 2012).*

1.1.4 Overweight and diabetes mellitus type 2

Overweight is known to be the major risk factor for diabetes mellitus type 2 (DM2) (Blokstra and Baan, 2008). In the Netherlands, the rise in the prevalence of overweight and obesity has been accompanied by a rise in the prevalence of DM2. Based on prescriptions for diabetes medication, the prevalence of diabetes among Dutch men has more than doubled between 1991 and 2014. Among women, a 50% increase in prevalence was observed (Volksgezondheidenzorg, 2018). The number of diabetes medication prescriptions is highest in municipalities where the prevalence of overweight and obesity is highest. (Volksgezondheidenzorg, 2011; Volksgezondheidenzorg, 2012).

DM2 is uncommon among children, but a study on American children found that the prevalence is increasing (Tillotson and Boktor, 2017). In the Netherlands, not much is known about the epidemiology and future perspectives of this disease among children. However, according to Frieda van der Jagt, knowledge specialist of the Dutch *Diabetes Fonds*, the number of children with DM2 in the Netherlands has increased and will likely increase more in the future because of the strong link between overweight and DM2 (see Appendix 2 for the complete interview). This link is also shown in a study by Malecka-Tendera et al. on Caucasian children with DM2. The majority of these children was overweight and had a family history of DM2 (Malecka-Tendera et al., 2005).

1.1.5 Prevention of overweight and diabetes mellitus type 2

Diabetes has a severe impact on health and brings along massive healthcare costs. In the Netherlands, the costs for both types of diabetes combined were close to 1,7 million euros in 2011 (RIVM, 2013). Tackling the problem of obesity is a way to decrease the prevalence of DM2. Several governmental policies exist to prevent obesity, mainly focussing on children because prevention is most effective if it takes place early in life. There is a wide range of prevention programs with “Jongeren Op Gezond Gewicht” and “Gezonde School” being two of the biggest programs (Volksgezondheidenzorg, 2017). A problem at this level of obesity prevention is that it is difficult to see the effects of prevention measures because the effects might take years to become visible. Also, the urgency of prevention is often not recognized because of the lack of impairment of the quality of life at the moment that prevention usually takes place. Despite this, early signs of the effectiveness of prevention measures are usually present, which allows for fine-tuning of obesity prevention policies. One form of fine-tuning is to collaborate with other prevention programs that focus on different aspects of lifestyle. This is where FitGaaf! comes into play, the company that this project focuses on.

1.1.6 The role of FitGaaf!

FitGaaf! offers a product that provides support in nutrition, exercise and sleep in the home situation of children. The product is a calendar on which children and their parents can paste stickers if they perform certain healthy behaviors (figure 3). The calendar introduces children and their parents to a healthy lifestyle in a fun and easy way. The feasibility of the product has been tested and the market has been explored. This has led to collaborations with projects like “Gezonde School” and “Alles is Gezondheid”.

Fig. 3) The FitGaaf! calendar

Putting FitGaaf! in the box of business or policy is difficult because the company often operates as a business in a policy network. Nationwide, there are several policy programs for tackling obesity. These policymakers work together with businesses that can provide the needed tools. FitGaaf! is one of these companies. This report looks at FitGaaf! from a business perspective, but it also highlights some policy aspects that are important for FitGaaf! as a business.

1.2 Goals of the project

1.2.1 Problem definition and the innovation cycle

At this moment, FitGaaf! is in the strategic decision phase of the innovation cycle (figure 4). A choice has to be made about the future of the product and the strategy. The current strategy of the company is to present itself in a very broad way. The program can be used for all levels of prevention of obesity and DM2, varying from large school projects to individual coaching. A problem that the company faces now is that new collaborations are difficult to start because the product is too diverse to fit in specific boxes. Also, because there has been a lack of focus, FitGaaf! has not had the opportunity to specialize in a certain area. These are clear indications that a strategy needs to be chosen at this point if the company wants to continue innovation.

In the strategic phase, there are two interacting steps that need to be taken. Firstly, the company should continue exploration of the market to identify all options for collaborations and the requirements that the market has for the product. Secondly, the product could be altered to fit this market demand. This can allow the company to fit better in a specific box and acquire a strong market position. In other words, the strategic decision that needs to be made concerns fitting the product to the demand of a specific market to allow growth of the company.

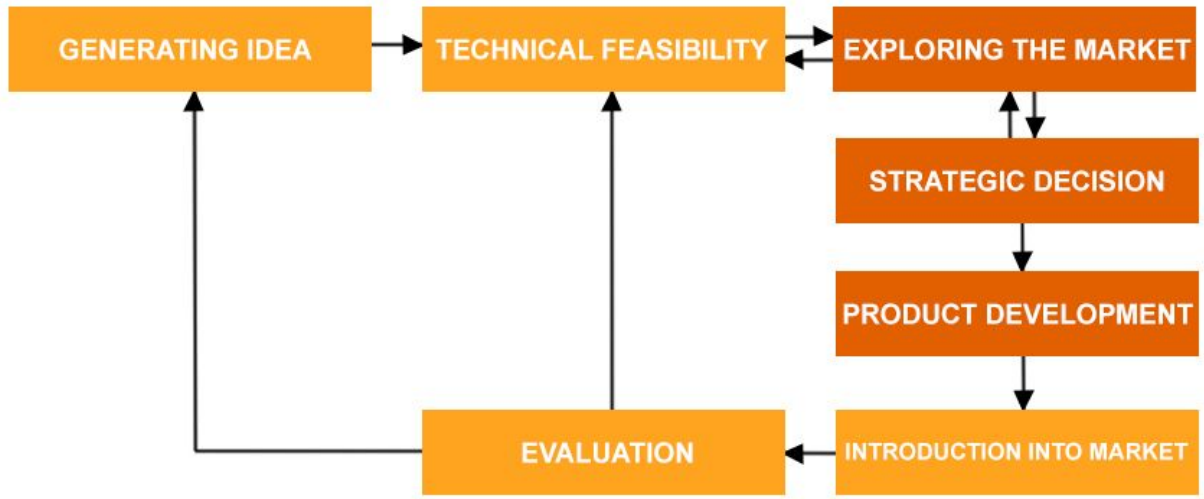


Fig. 4) The business innovation cycle. This project focuses on three steps of the cycle; exploring the market, strategic decision and product development.

1.2.2 The project

This advice report focuses on the evaluation of strategic options for FitGaaf!. The goal is to advise the company on several aspects, all related to improving the effectiveness of the program. Effectiveness is approached from two different sides; the effectiveness of the intervention in the prevention of DM2 and the effectiveness of the strategy to grow the company. The following main question and sub-questions are answered in this report, leading to a concrete advice.

How can the effectiveness of the FitGaaf! program be improved?

1) *What strategy should FitGaaf! follow to acquire a strong market position?*
2) *Are the current core concepts of the program effective in the prevention of diabetes mellitus type 2?*
3) *How can participation in the program be further improved?*

1.3 Formal framework

This internship took place in the context of the specialization Science, Business & Policy of the master's degree program Biomedical Sciences at the University of Groningen. The goal of the internship was the integration of economic and managerial aspects with scientific-based knowledge. The final product is an advisory report. As part of the internship, the intern worked on the preparation of the actual implementation (as gaining support) of the advice. The internship took place in the period of 08-01-2018 to 31-07-2018 and took a total of 24 full-time weeks. Table 1 lists the supervisors for the internship.

Table 1) Supervision of the internship at FitGaaf!

Name	Institute	Function	Role in supervision
Drs. T. Steffens	FitGaaf!	CEO	Daily supervision
Dr. S.F. de Boer	University of Groningen, Behavioral neurobiology, GELIFES	Associate Professor	Science supervision
Drs. A.J. Abma	University of Groningen, Professional Training 'Science+ Business & Policy'	Teacher	SBP teacher/supervision

1.4 Methods

1.4.1 Business aspect

The business aspect of this report is an extensive market analysis. The focus is on identifying what the market wants and what FitGaaf! can offer in order to make a strategic decision. An internal and external analysis in the form of McKinsey's 7S model, Porter's five forces and the PESTEL model were performed. Beside this, literature and expert opinions were used to define threats and opportunities for FitGaaf!.

1.4.2 Beta aspect

The first scientific part focuses on the effectiveness of the program in the prevention of DM2. The second scientific part focuses on the effects of reward, punishment, and parental involvement on participation. The required information was mainly acquired by means of literature research and expert interviews. The scientific research should provide academic support to the foundations of the program, which might be a requirement for some markets that FitGaaf! could target. Also, implications for improvement of the core concepts of the intervention and for increased participation rates have been identified.

1.4.3 The Hoogeveen project

This report pays some extra attention to a recent large FitGaaf! project that took place during the internship at three elementary schools in Hoogeveen; *de Sprong*, *de Juliana van Stolbergschool* and *het Palet*. A total of ±300 children, group 1 to 8, participated in a 4-week project with FitGaaf! to learn about a healthy lifestyle. During the project in Hoogeveen, a small study was executed among the children and their parents. The children were questioned with exercises and games (depending on their age) and the parents and teachers were questioned with short questionnaires. The aim of this study was to get an indication of the effectiveness of the current program and the effects of parental involvement.

Also, the Hoogeveen project was used to look at SES involvement in the effectiveness of the FitGaaf! program. In Hoogeveen, the prevalence of overweight is above the national average with 57% in 2015. Also, the average SES score in Hoogeveen in low (CBS, 2016a). The SES scores of the ZIP-code areas of the three schools in Hoogeveen are presented in table 2. Compared to the Dutch average, these scores are all very low.

Table 2) Socioeconomic status scores in the ZIP-code regions of the Hoogeveen project schools (Sociaal en Cultureel Planbureau, 2017)

School	ZIP-code	SES score	Position in Dutch SES ranking list (low to high)
Het Palet	7901	-2,31	171 / 3565
De Sprong	7906	-2,57	124 / 3565
Juliana van Stolbergschool	7902	-3,26	58 / 3565

1.4.4 Ratio science/business

This report contains approximately 60% science and 40% business. The focus is on business, not policy, but because FitGaaf! operates in a policy environment, some aspects of policy are taken into account as well. Figure 5 shows the distribution of science and business topics throughout the report.

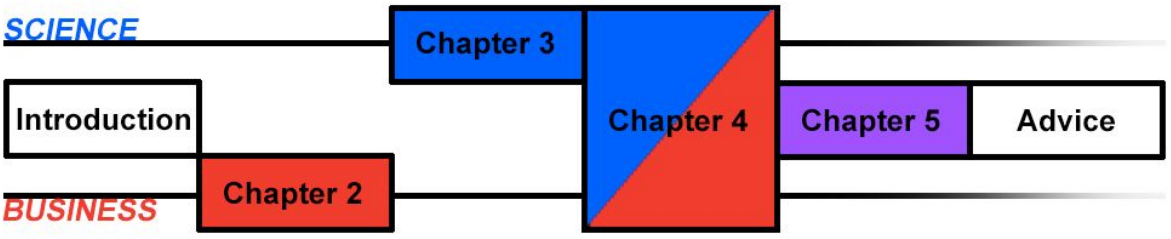


Fig. 5) Distribution of the science and business topics in the report. Chapter 2 focuses solely on business, chapter 3 focuses solely on science and chapter 4 has a transition from science to business. Chapter 5 integrates science and business.

1.5 Reading guide

After this introduction to the problem and the project, **Chapter 2** describes FitGaaf! as a company in an internal analysis, followed by an analysis of the different markets of obesity prevention. The best market option is determined by evaluating the potential role of FitGaaf! in each market. As an addition, FitGaaf!'s threats and opportunities in this specific market are evaluated in an external analysis. Finally, the current national policies regarding obesity prevention are determined to find out how FitGaaf!'s strategy should be fitted to them. **Chapter 3** gets into detail about obesity, DM2 and the influence of lifestyle on the development of these diseases. The various aspects of lifestyle that FitGaaf! targets are evaluated on their role in obesity and DM2. To conclude, this chapter discusses what the findings mean for FitGaaf! and how they can be used to improve the effectiveness of the biomedical core of the FitGaaf! program. **Chapter 4** discusses participation rates and how they can be improved. First, the role of reward and punishment in motivation is evaluated based on neurobiological literature, followed by actual data of the participation and motivation in the Hoogeveen project. Afterward, the role of parental involvement and some factors that influence participation independent of motivation are evaluated. **Chapter 5** integrates the findings of chapter 2 to 4 and evaluates options for improvement of the program and strategy. To conclude, **Chapter 6** provides a concrete advice for FitGaaf! regarding improvement of the effectiveness of the program.

Chapter 2

The right strategy in the right market

This chapter describes FitGaaf! as a company in an internal analysis, followed by an analysis of the different markets of obesity prevention. The best market option is determined by evaluating the potential role of FitGaaf! in each market. As an addition, FitGaaf!'s strengths, weaknesses, threats, and opportunities in this specific market are evaluated in an external analysis. Finally, the current national policies regarding obesity prevention are determined to find out how FitGaaf!'s strategy should be fitted to them. Sub-question 1 will be answered in this chapter: *What strategy should FitGaaf! follow to acquire a strong market position*?

2.1 The story of FitGaaf!

2.1.1 History

In 2012, Tom Steffens entered health insurance company VGZ's "VoorGoedeZorg" competition for innovative ideas about improvement of healthcare. His idea, FitGaaf!, reached the finals of this competition. A year later, VGZ offered Tom the first funding from the RVVZ-fund for a pilot of FitGaaf!. During this pilot, the first version of the FitGaaf! calendar was tested as a prevention method at elementary schools and as an addition to interventions by caregivers. Since October 2015, Tom is an independent entrepreneur.

2.1.2 FitGaaf! as a recognized intervention

Several governmental organizations have recognized FitGaaf! as an intervention for obesity and DM2. The program is in the intervention database of *Loket Gezond Leven*, a department of the *National Institute for Public Health and the Environment* (RIVM). The company is also a partner of "Alles is Gezondheid", a program of *Nationaal Programma Preventie* since 2016. Lastly, FitGaaf! is one of the programs that are part of a nationwide school project that promotes healthy lifestyle; the "Gezonde School" project.

2.1.3 Earnings model

FitGaaf! has a very broad market, and therefore, several different types of earnings. The most important source of income is B2B sales. The company sells the program (a combination of the calendars and online coaching) to schools, caregivers, and governmental organizations. The main customers at the moment are schools. There are three packages to choose from; 1) FitGaaf! provides the calendars and manuals, the school does everything else, 2) FitGaaf! provides the calendars and manuals, comes to the schools to explain the program to the teachers and sends newsletters with reminders to the children and parents and 3) FitGaaf! does everything, including handing out the calendars, explaining the program, opening and closing the project with an event, and gathering data. This last package is the most expensive, but also the one that most schools choose.
Beside B2B sales, the company also offers the calendar and online coaching directly to customers via the website (B2C sales). This is thus far only a small source of income.
Lastly, FitGaaf! has some earnings in the form of fee for referrals to local professionals and licensing out the name and online tools.

The income that FitGaaf! generates is currently not enough for Tom Steffens to live on. Therefore, FitGaaf! can't be Tom's only job at the moment and there is no money to expand the team. The operational costs of FitGaaf! are partly covered by own income and the rest of the costs are covered by funds. Tom is very active in gathering these funds, which allows FitGaaf! to subsist despite the dissatisfaction income.

2.1.4 Vision and mission

FitGaaf! believes in structure, insight, reward, and fun in reducing overweight and DM2 among children, aged 4 to 12. Its mission is to contribute to the lifestyle knowledge of children to reduce overweight and obesity. FitGaaf! wants to achieve this via both preventative and curative measures.
What makes FitGaaf! unique is a combination of four key features; structure, approachability, the at-home approach and the fun factor. FitGaaf! believes that this combination of features will help in achieving its mission.

2.2 Internal analysis

2.2.1 The need for an internal analysis

Each company has its own way of operating. Despite the fact that FitGaaf! is relatively small, a clear pattern of internal features has developed in the past years. An important factor in the success of a company is how well the strategy of the company fits with the strengths and weaknesses. Only if the foundations of the company are in order and if the strategy is a perfect fit to these foundations, a company can grow into a successful business.

FitGaaf! has been around for 6 years, but so far, no stable and strong market position has been acquired. The income still largely dependents on temporary projects, which are difficult to obtain in the competitive market of obesity prevention. In order to earn enough money, all sorts of opportunities are seized. The strategy seems to be more focused on survival than on growth. Therefore, there appears to be a need for a new strategy that suits the foundations of the program better and that can lead to a stronger market position. In order to do this, the first step needs to be to define these foundations.

2.2.2 McKinsey's 7S model

Because of the previously mentioned need to define the methods and foundation of FitGaaf!, McKinsey's 7S model is used for an internal analysis of the company. This model describes three "hard" elements (strategy, structure, and systems) and four "soft" elements (shared values, style, skills, and staff) of a company (Peters and Waterman, 1979). Each element is described in the context of FitGaaf! in the next section.

Strategy

The strategy of FitGaaf! is to provide a new type of solution for the growing health problems obesity and DM2. Many companies aim to tackle obesity, but most use comparable methods. FitGaaf! wants to proliferate by taking a different approach. This approach is based on a number of strategic decisions.

Firstly, the FitGaaf! program takes place at home instead of at school, which is the approach of most other obesity prevention programs. This strategy is chosen because of the importance of parental involvement in changing the lifestyle of children. Also, providing an at-home program relieves some of the burden on teachers. For schools, this is a large benefit.

Another strategic decision was to make the product very easy to understand and use. This way, young children can be targeted. People are likely to maintain a healthy lifestyle as adults once they have learned this as a child. Also, old habits die hard, so evoking lifestyle changes in adults is often more difficult. By providing a product that can be used by children, FitGaaf! offers a potentially more effective program. Another benefit of this strategy of simplicity is that the program is more likely to be understood by families with low education. Therefore, this program is easily applicable in low SES areas, where the problem of obesity is the largest.

Thirdly, the product is strategically chosen to be very flexible. This flexibility allows for a custom fit to different situations. The product can be used in prevention or curation, in low or high SES regions, as a solo program or as part of a bigger program and in its original form or in an adapted form. This strategy has led to being as diverse as possible and being able to address many different customers.

The final main strategy is affordability. According to the companies vision, the program has to be affordable for everyone. Besides this, in B2B sales, being inexpensive is a strength over the competition, who often offer more expensive programs.
FitGaaf! chooses a combination of two of Porter's generic strategies; cost leadership and differentiation (Porter, 1979).

Structure
Since FitGaaf! is a very small company, the structure of the organization is functional, but not very strict. Each employee and intern works on separate projects and tasks, but collaboration takes place on relatively large tasks like school projects. The structure is relatively informal and non-bureaucratic, so there is plenty of room for creativity and open innovation. This type of structure is desired because it allows for proper execution of the strategy of FitGaaf!.

Systems
Systems refers to all types of procedures within a company. Since FitGaaf! has been a one-man company until recently, there are no clear procedures in place yet. However, now that more people work and do internships at FitGaaf!, there is now a team meeting every Monday morning. In this meeting, all relevant topics are discussed. Besides this, Tom does weekly one-on-one meetings with the employees and interns.

Shared values
FitGaaf! is a company that strongly builds on values. The most important shared value is that the product should help children in acquiring a healthy lifestyle. Of course, the company wants to make money, but not at the cost of the health of these children. The company believes in open innovation, so partnerships are valued and brainstorm sessions with others are seen as an important source of new ideas. FitGaaf! is very keen on sharing its ideas with others. This is risky because the product is relatively easy to copy by others, but it also helps to get feedback and develop the product to better fit the market demand.
The way in which FitGaaf! wants to present itself is low-key, friendly and fun. The company wants to be perceived as approachable and child-friendly and does so by choosing colorful designs and informal language towards customers.

Style
The style of FitGaaf! is informal and non-hierarchical. The employees and interns work together as a team and each person has a certain degree of responsibility. Communication between the employees is informal as well. There is room for questions and learning experiences. For example, if someone has a meeting, others are almost always welcome to join. The team is also open to suggestions and feedback.
For the interns, each interesting opportunity for them is presented. This way, the interns are given many opportunities to learn. Failure is seen as something that is sometimes part of that. I experienced the style of FitGaaf! as very welcoming, inspiring, and motivating.

Skills
The FitGaaf! team has a broad range of skills. Both employees have a bachelor's degree in Sports, Health and Management and one of them also has a master's degree in Strategy and Innovation. One intern is studying Nutrition and Dietetics at Hanze University of Applied Sciences, The second intern studies Applied Psychology and the third intern (me) is a master's student in Biomedical Sciences with a Science Business and Policy specialization.

This set of skills covers a large part of the content of the intervention (diet, exercise, and upbringing) and the business aspects. However, the company misses some skills like strategic finance, healthcare, and graphic design. Tasks that require these skills need to be executed by external parties, fitting the strategy of open innovation.

Staff

Currently, there are two staff members at FitGaaf!: Tom Steffens, who is the CEO of the company and works for 1 FTE and Mariët ten Wolde, who works alongside Tom for 0,2 FTE. In the duration of this project, there were two full-time interns for most of the time; Koen and myself. Koen started one month later than me. Finally, there is one student who does a school project at FitGaaf!

Plans for the future are to expand the staff to a total of 3 FTE. Depending on what developments will take place, a financial expert is a logical next employee, because this is an important but missing skill in the company.

2.3 The obesity prevention market

The internal analysis in the previous chapter objectively described the foundations of the program. A crucial next step in identifying what strategy would fit FitGaaf! best is to look at the markets that FitGaaf! could target. Like mentioned before, the strategy of FitGaaf! is to provide prevention projects to a broad range of customers. However, different types of customers might require different approaches. Therefore, it is important to define the different target groups and the different markets that they are in. Before choosing the right strategy within a market, it is important to determine which market to target first. In this chapter, the different prevention markets and their requirements are described. This provides arguments for which market fits FitGaaf!'s internal strengths best.

2.3.1 Three levels of prevention

FitGaaf! is one of the many lifestyle intervention programs that are around these days. In chapter 2.2, the specific approach of FitGaaf! was discussed, but each company in this field offers a slightly different program. Therefore, policymakers and customers can choose from a broad range of programs and choose the one that suits the target group best. One of the first considerations in choosing an intervention program is the level of prevention of a program. The RIVM describes three levels of prevention (figure 6) (RIVM, 2015);

1) *Primary prevention;* targets healthy people with no specific complications.
2) *Secondary prevention;* targets people with an increased risk of some sort of complication (like overweight).
3) *Tertiary prevention;* targets people who are having certain complications that need to be tackled (like overweight and obesity).

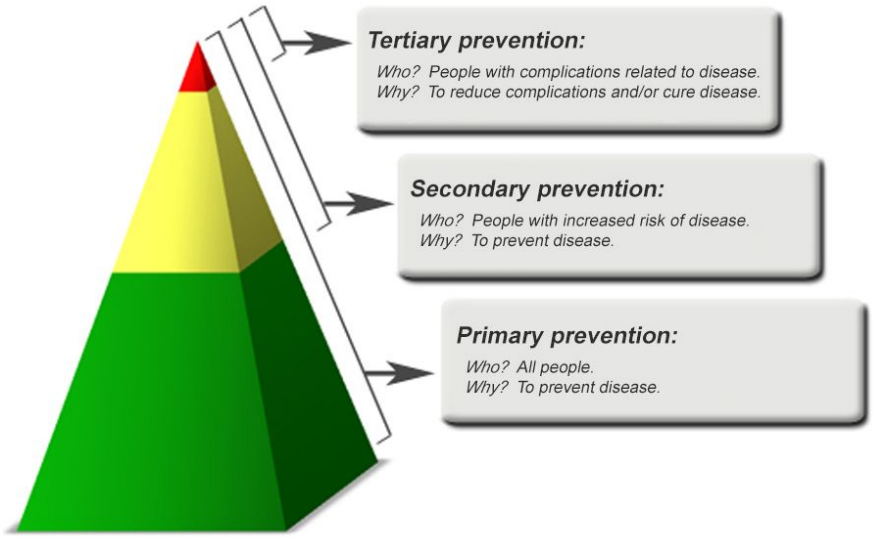


Fig. 6) The three levels of prevention; primary, secondary and tertiary prevention. The cone represents a population, for example, children, and the colors represent the part of this population that is targeted by each level of prevention. Sizes of the target groups are general estimations.

At this moment, FitGaaf! mainly focuses on primary prevention at schools. Besides that, the FitGaaf! program is in its early stages as a tertiary prevention method. In order to thoroughly examine the market, the next section elaborates on the requirements and competition at each level of prevention.

2.3.2 Primary prevention

Most Dutch projects that aim to prevent obesity are on the level of primary prevention. Children are often reached via their schools or at an individual level. The aim of these projects is to teach children how to live a healthy lifestyle to prevent them from getting overweight. If primary prevention is successful, children will improve their lifestyle or will be more motivated to maintain their already healthy lifestyle, which will eventually lead to less overweight later in life. Primary prevention can be offered in several ways. Companies can sell their programs directly to the customers (for example, schools) or to intermediate parties like GGDs. Some companies participate in large collaboration projects. In these projects, the companies usually work together with local and national policymakers.

There are some important **pros** in primary prevention:

- The target group is very big. Via the schools and municipalities, almost all children can be reached. Therefore, a lot of children can be helped and the potential effect on the health of the population is big. The market is very big and opportunities for growth of a company are therefore high.
- The target group doesn't have very specific needs, because they don't have complications that need to be dealt with. The main goal is to educate children, which requires relatively little effort compared to treating a child.
- Primary prevention is the cheapest form of prevention. It requires little personal assistance and time and the methods are often cheap.

Of course, there are also some **cons**:

- The most important issue at the primary prevention level is that the results are difficult to measure. Firstly, it is difficult to track the health of children during and after a primary prevention program. The burden on the children cannot be too high, because participation to primary prevention programs is usually on a voluntary basis. This complicates the collection of data about the effects. There needs to be a good balance between burden and benefit to get sufficient participation. Secondly, the effects on disease (or weight) might take many years to become visible. For example, if a primary prevention program for DM2 is effective, a person might develop DM2 ten years later than he would have without the prevention program, but this person might be 80 by then. The participants need to be followed until their death to get complete results, which is nearly impossible, especially for smaller companies.
- The urgency for primary prevention is low, both from the perspective of funding bodies and from the perspective of the child. The target group doesn't have specific needs or complications, so primary prevention is mostly a long-term investment in health. If a limited amount of money is available, policymakers tend to choose for programs with direct effects over projects with future effects. Also, the child and parents often don't feel the urgency to participate in primary prevention programs, because they have no health-related issues that impair their quality of life. This leads to low participation rates.
- It is difficult to make a program that works for everybody because of the diversity of the target group (school children). If children at school need tertiary prevention but are approached with primary prevention for the entire school, the program might not work for them, even though they might need it the most.

An overview of the pros and cons of primary prevention is provided in table 3.

Table 3) Pros and cons of the primary prevention market

Pros	Cons
Very large target group	Difficult to measure the results
No specific needs	Low urgency (policymakers and child)
Cheaper than curation	Large variety in target group → program might not fit children with complications

Apparently because of the large target group and the absence of specific needs, primary prevention of obesity is the largest prevention market. Most nationwide programs focus on managing primary prevention project at school, at home, and in the environment. These large programs work together with several small-scale programs, each with a different approach, focus, and method, but all with the goal of preventing overweight and obesity. Because of the difficulty to measure the effects of primary prevention, this integrated approach is recommended for (potentially) optimal results. An integrated approach to prevention should focus on 4 pillars (figure 7) (Loket gezond leven, 2018a).

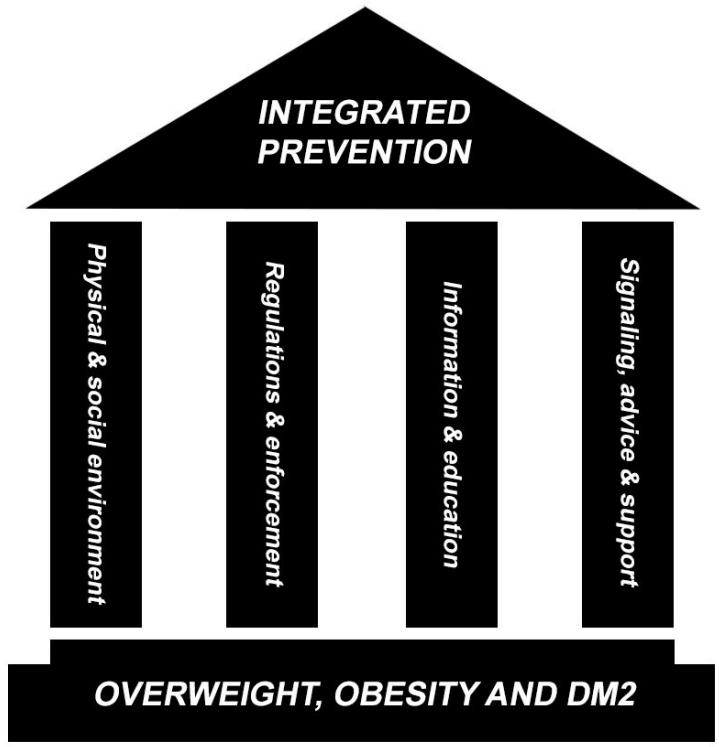


Fig. 7) Visual representation of the four pillars that need to be addressed to support integrated prevention of overweight, obesity, and diabetes mellitus type 2

1) Physical and social environment. This pillar focuses on creating an environment that facilitates a healthy lifestyle. Poor accessibility of supermarkets and recreation areas, high prices for healthy food and poor social contacts in the area are all related to an unhealthy lifestyle and overweight (VUmc 2016). For this reason, many nationwide primary prevention projects collaborate with programs that aim to improve this physical and social environment. Examples are *EU Schoolfruit*, a program that provides fruit and vegetables for elementary school children, *Smakelijke Moestuinen*, a program that provides kitchen gardens at schools and daycare facilities and *PLAYgrounds*, a program that provides the tools for exercise during school breaks. These are only a couple of examples, but many more programs exist in this pillar (Loket gezond leven, 2018b).

2) Regulations and enforcement. The pillar of regulations and enforcement is about laws and restrictions as part of primary prevention. In the case of overweight prevention, this pillar is not yet applicable. There are laws on food safety and food content transparency, but there are no specific laws that regulate the sales, availability, and marketing of unhealthy foods (Loket gezond leven, 2018b). However, the first careful steps are taken in the form of permits. Municipalities have the right to decline permits for food trucks and mobile snack bars to limit the availability of fast food in a certain area, for example near schools. Amsterdam is one of the municipalities that has implemented this policy (Gemeente Amsterdam, 2018). A recent example of a law conflict concerning unhealthy food was a case in 2017 between the municipality of Amsterdam and the fast food chain *New York Pizza*. The chain wanted to open a new restaurant in a shopping center in Amsterdam, but

the municipality wanted to improve the food offer in this shopping center and refused. After a long case, the municipality won (NOS, 2017). This illustrates the need for a law concerning fast food and other unhealthy food items. The city of Philadelphia in the USA is one of the first cities with laws about unhealthy food. Citizens have to pay a tax of $0,50 per liter soda, which is used to invest in playgrounds and recreation areas (NOS, 2016). This soda-tax, as well as a fat-tax, is a topic that is under debate in several countries, but implementation is not yet achieved in the Netherlands.

3) Information and education. The information and education pillar is one of the major pillars in nationwide primary prevention programs. It includes programs that inform and educate children about ways to prevent overweight, like with exercise and diet. Many different methods can be applied to achieve this. The most basic method is the incorporation of lessons about lifestyle in the normal curriculum. The teachers are in this case responsible for the education. A large program that operates this way is *Lekker Fit!*. Some programs teach in an interactive way, like *Smaaklessen*. Smaaklessen is a program in which children can explore different flavors to learn about what they like. The children are given knowledge and experience in the field of eating healthy. This hands-on approach is also often used in interventions that focus on exercise, like *B-fit*. B-fit works together with sports clubs in the region and stimulates children to try different sports. Most interventions use a combination of theoretical learning and practical learning. A broad approach that includes diet, exercise and other aspects of a healthy lifestyle is common. Some examples of these kinds of programs are *B.slim*, *LEFF*, *Cool 2B Fit* and *JUMP-in* (Loket gezond leven, 2018b).

4) Signaling, advice, and support. The fourth pillar of overweight prevention focuses on the signaling of overweight and the support of these children. This pillar is mainly relevant in tertiary prevention and is, therefore, discussed later. However, some primary prevention programs do some data collection, which can be used for signaling. *Lekker Fit!* and *JUMP-in* are examples of programs that gather data about effectiveness and BMI. These programs don't aim to use this data themselves for tertiary prevention. Instead, external parties like the *Youth Healthcare Services* (JGZ) can use the data for signaling of overweight and take the necessary steps (Loket gezond leven, 2018b).

The Loket Gezond Leven intervention database lists a total of 99 recognized interventions in the categories nutrition, exercise, and overweight. 73 of these interventions are active in primary prevention (Loket gezond leven, 2018c). Because of this large offer of programs, the market is very competitive. Only the best programs can survive.

2.3.3 Secondary prevention

The methods of secondary prevention are often quite similar to those of primary prevention. Therefore, most secondary prevention programs participate in primary prevention as well. The main difference is that secondary prevention focuses on a target group at risk (RIVM, 2015). These risk factors bring along some challenges when it comes to effective execution of the program. Secondary prevention programs are, therefore, often more specialized and more customizable. Companies that offer secondary prevention can use the same sales platforms as primary prevention; direct sales (B2C), indirect sales (B2B) and sales via collaboration projects with policymakers and health insurances. Because of the increased risk of disease in the target group, B2B sales and sales via collaboration programs are more common than B2C sales. The target group can be reached more easily this way.

Some **pros** of secondary prevention are:

- The size of the target group. Although the group is much smaller than the target group of primary prevention, there are a lot of children at risk for obesity. There can be several reasons for this increased risk, but most of them are related to socioeconomic status. In low SES regions, children and parents are overweight or obese more often compared to high SES regions (CBS, 2016a). Also, knowledge about their own health and a healthy lifestyle is limited (G.J. Navis, personal communication, 2018). These are all important risk factors for obesity, and therefore, DM2.
- Because the group at risk mainly consists of low SES children, the group is much more uniform that the target group of primary prevention. Therefore, secondary prevention programs can be more specialized, which is positive for the effectiveness of the programs.
- The urgency for prevention is much higher in groups at risk compared to the general population.
- Prevention is cheaper than curation. The health impact of obesity and DM2 is well recognized, as well as the related costs. Policymakers are more likely to invest in prevention for risk groups because the urgency and consequences are clearer.

Secondary prevention also has some **cons**:

- The difficulty of measuring the results of prevention programs. Although these children are at risk, they are not experiencing health impairments yet, so they will not be supervised by health professionals. Besides this, long-term tracking of these children is difficult, just like in primary prevention.
- Low SES children have more specific needs. Not only is their baseline level of knowledge about healthy living relatively low, they are also at risk for several other complications. Upbringing skills of the parents are often limited, which can lead to behavioral problems in the children. Risk of substance abuse, psychological problems and sexual problems is also increased for these children (Adler et al., 1994). All this needs to be taken into account when implementing an obesity prevention program in low SES areas. Beside this, prevention programs for other complications are part of the competition, as schools often don't pay attention to several different topics at the same time.
- It is questionable whether the high urgency for prevention is felt by the low SES families at risk. There is a large gap between how healthy people are and how healthy people think that they are, especially in low SES areas (G.J. Navis, personal communication, 2018). Therefore, participation rates might not be higher than in primary prevention programs.

An overview of the pros and cons of secondary prevention is provided in table 4.

Table 4) Pros and cons of the secondary prevention market

Pros	Cons
Large target group	Difficult to measure the results
Uniform target group	Specific needs
High urgency (policymakers)	Low urgency (child)
Cheaper than curation	

Just like primary prevention, secondary prevention programs often focus on 4 pillars; physical and social environment, regulation and enforcement, information and education, and signaling, advice, and support (Loket gezond leven, 2018a).

1) Physical and social environment. The first pillar, physical and social environment, is a crucial pillar in secondary prevention. In low SES areas, the environment is less likely to facilitate healthy behavior. For example, some children might not be able to join a sports club because their parents can't afford it. The neighborhood might also be an unsafe place to play outside. These environmental factors can limit the amount of exercise a child gets significantly, even if the child is willing to exercise more. Extra emphasis on the physical and social environment is therefore unavoidable. Programs like *EU Schoolfruit* and *PLAYgrounds* are therefore often active at schools in low SES neighborhoods (Loket gezond leven, 2018c). A favorable social environment is also very important in the secondary prevention of obesity. By involving parents and teachers, programs like *JUMPin*, *Voor je het weet zijn ze GroOt* and *Eetplezier en Beweegkriebels* create a social environment that is healthy for the child (Loket gezond leven, 2018c).

2) Regulations and enforcement. Just like in primary prevention, the regulations and enforcement pillar is not applicable when it comes to secondary obesity prevention.

3) Information and education. The third pillar is very important. This pillar includes programs that teach children about a healthy lifestyle. Not all prevention programs that fit in this pillar will suit the low SES target group. In general, low SES children and parents have little health literacy, so the provided information should be very basic. It is better to take small steps towards a healthy lifestyle than to teach participants that everything that they do now is wrong (Adler et al., 1994). Secondary prevention programs are on a voluntary basis, so participants will only participate if they feel like it can help them. Also, there is a fine line between patronizing and providing useful information. According to dr. S. Tauber, associate professor in Human Resource Management & Organizational Behaviour at the University of Groningen, policymakers believe that low SES people feel patronized sooner than they actually do. Low SES people indicate that they want to be guided strictly and be taught basic information much more than what is happening now (S. Tauber, personal communication, 2018). Programs that fit the information and education pillar on the secondary prevention level should, therefore, be easy to understand and follow, customizable to the target group and relatively strict. Besides this, aspects like budget need to be taken into account as well.

Some examples of programs that are active in this pillar of secondary prevention are *B.Slim*, *DOiT*, and *JUMP-in* (Loket gezond leven, 2018c).

4) Signaling, advice, and support. Just like in primary prevention, the signaling, advice, and support pillar is not applicable when it comes to secondary obesity prevention.

Out of the 99 intervention programs that are listed in the Loket Gezond Leven database in the categories nutrition, exercise, and overweight in youth, only 20 are recognized as suitable for low SES (Loket gezond leven, 2018c). For this reason, the market of secondary prevention is a lot less competitive than the flooded primary prevention market.

2.3.4 Tertiary prevention

Tertiary prevention is different from primary and secondary prevention because it is often part of treatment. This form of prevention is for individuals that have a certain disease or condition, like obesity, and experience complications related to this. By means of tertiary prevention, symptoms can be reduced by improving the health of patients. This will also reduce the chance that these patients will experience more symptoms or complications related to the disease, like DM2 in case of obesity (RIVM, 2015). Because of the different goal of tertiary prevention, companies rarely address both tertiary and primary/secondary prevention at the same time. It requires a very different approach.

Because tertiary prevention of obesity among children is part of treatment, the "jeugdwet" applies. This law, which is in place since January 2018, states that care for youth and parents in the fields of prevention, support and help with parenting issues, psychological issues and disorders is the responsibility of the municipalities (Jeugdwet, 2014). This so-called decentralization of care is meant to provide more coherent and suiting medical support for children. In Groningen, the *Regional Purchasing Organization Groninger Municipalities (RIGG)* is responsible for purchasing this care for youth (RIGG, 2018a). They mainly focus on heavier care and leave lighter care, like lifestyle interventions, to the local *WIJ teams*. WIJ teams are neighborhood organizations that support families with issues of all kinds (Wij Groningen, 2018). Comparable structures of decentralized care can be found in all municipalities in the Netherlands. Companies that offer intervention programs need to approach the regional care purchasing organizations if they want their programs to be implemented as tertiary prevention measures by policymakers (Jeugdwet, 2014).

The most important **pros** of tertiary prevention are:

- The urgency for prevention is very high in the target group. The group that could benefit from tertiary prevention of obesity is often experiencing several complications related to obesity. Children can have difficulties with exercise and playing, feel insecure, have pain in their knees, hips or back, have problems with sleeping, suffer from DM2 and have problems with several organs (van Tinteren, 2016). The parents of these children often look for professional help to improve the quality of life of their children. If these parents are offered help in a way that suits them, participation is high.
- Not only the parents and children experience a high urgency. Policymakers are aware that children with severe overweight and obesity are at risk for several complications, which impairs their quality of life and brings along large healthcare costs.

- Tertiary prevention has both short-term effects and long-term effects, so the effects of tertiary prevention are visible earlier than those of primary and secondary prevention. Also, the effects are usually measurable, because children with severe overweight are often monitored by healthcare professionals. Therefore, data about BMI, waist circumference, blood glucose levels and several other parameters are available.

Of course, there are also some **cons** related to tertiary prevention:

- The target group is smaller than the target group of primary and secondary prevention. Only a small percentage of children is overweight to a degree that they experience complications (CBS, 2016b). However, the expected high participation rates compensate partly for this issue.
- The target group has quite specific needs. In case a child is severely overweight, he/she will not be able to exercise as intensively as lean children. Pain in joints, DM2, sleeping problems and special diets need to be taken into account as well. Because each child is different, a customized approach is needed for each child. This requires programs to be flexible and focused on individuals. Tertiary prevention is often part of a bigger treatment plan (RIVM, 2015). Healthcare professionals need to be able to incorporate the programs into their treatment plans. Therefore, the prevention plan should not only be custom-fitted to the child, but also to the healthcare professional's skills, knowledge and methods.
- Because the program needs to be so customized and personal, the costs of tertiary prevention exceed those of primary and secondary prevention.

An overview of the pros and cons of tertiary prevention is provided in table 5.

Table 5) Pros and cons of the tertiary prevention market

Pros	Cons
High urgency (policymakers and child)	Small target group
Measurable results	Specific needs
	Expensive

The four pillars of prevention (physical and social environment, regulation and enforcement, information and education, and signaling, advice, and support) can be applied in tertiary prevention as well (Loket gezond leven, 2018a).

1) Physical and social environment. When it comes to tertiary prevention, very little attention is paid to the physical environment. This is because tertiary prevention is on a much more individual level than primary and secondary prevention. Of course, children who participate in tertiary prevention programs will also benefit from primary and secondary prevention projects that improve the physical environment at school or in the neighborhood like *PLAYgrounds* and *EU-schoolfruit* (Loket gezond leven, 2018b). The social environment, however, is a very important target in tertiary prevention. Because parents play a big role in

the lifestyle of their children, participation of the parents is needed to evoke changes in the lifestyle of children. Several tertiary prevention programs for children aim to motivate the parents to provide a positive environment for their children. This might have the indirect effect of improving the (micro) physical environment as well, for example, if parents are willing to buy healthier food or toys for playing outside. Examples of tertiary prevention programs that also target the parents are *LEFF*, *Realfit*, and *WEET en BEWEEG* (Loket gezond leven, 2018c). Support by professionals can also be a positive addition to the social environment. In the Realfit program, for example, children are supervised by dieticians and have regular meetings with them (Loket gezond leven, 2018c).

2) Regulations and enforcement. Just like in primary and secondary prevention, the regulations and enforcement pillar is not applicable when it comes to tertiary obesity prevention.

3) Information and education. Providing information and education to children and their parents is crucial in tertiary obesity prevention. If a child is severely overweight, lack of knowledge about a healthy lifestyle is often an underlying cause. Parents who sign up their children for tertiary prevention programs are motivated to change their lifestyle, but can't do this on their own. Therefore, most tertiary prevention programs focus on providing the needed tools. The previously mentioned programs LEFF, Realfit and WEET en BEWEEG spend a lot of time on providing information and letting families learn from positive experiences. There are also projects that focus solely on the parents. *Eetplezier en Beweegkriebels* is an example because this program focuses solely on workshops for parents. Dieticians can also use tertiary prevention programs as a way to teach children about a healthy lifestyle in a very practical way (Loket gezond leven, 2018c).

4) Signaling, advice, and support. The signaling, advice and support pillar is relatively small in primary and secondary prevention, but in tertiary prevention, it plays a key role. Since the target group of this type of prevention has medical complaints, there is a need to relieve the symptoms and improve the situation. Therefore, monitoring of the child is very important. Based on the observed effects of a program on a child, healthcare specialists can be given advice about what the next step in the treatment plan should be. This is the point where prevention turns into treatment, which is the task of professionals like dieticians, sports coaches, and doctors. However, a prevention program can provide insight into the situation of the child and can highlight the issues in their lifestyle. Examples of programs that collaborate with healthcare professionals and play a role in signaling are *Realfit*, *Gewichtige Gezinnen Jongeren*, and *Skills4Life* (Loket gezond leven, 2018c).

In the Loket Gezond Leven intervention database, 21 out of the 99 recognized interventions in the categories nutrition, exercise, and overweight are active in tertiary prevention. This is about the same number of competitors as in the secondary prevention market but the target group of tertiary prevention is much smaller. Therefore, this market is likely slightly more competitive than the secondary prevention market, but still less competitive than the primary prevention market (Loket gezond leven, 2018c).

2.4 Market options for FitGaaf!

The primary, secondary and tertiary prevention markets have some similarities, but there are also some major differences. Therefore, in order to obtain a strong market position, it seems favorable to focus on one market and finetune the product to fit the requirements of this market. However, can FitGaaf! meet the requirements of one or more of these markets? The next section looks into this.

2.4.1 FitGaaf!'s current market position

Currently, FitGaaf! is mainly active in the primary prevention market. The FitGaaf! intervention is listed in the intervention database of Loket Gezond Leven as a primary prevention method in four categories; exercise, nutrition, overweight, and nurture for youth. The intervention is not listed in the category diabetes for youth. Only one intervention, *Gewichtige Gezinnen Jongeren*, can be found in this category. In the intervention database, FitGaaf! is marked as a "well-described" intervention (level 0) since 2015. 60 out of the 99 interventions in the categories nutrition, exercise and overweight are at this level. Most others are rated as "well-founded" (level I). A couple are ranked as "first indication for effectivity" (level II) and "good indication for effectivity" (level III) and none have the rank "strong indication for effectivity" (level IV) (Loket gezond leven, 2018c).

Within the field of primary prevention, FitGaaf! mainly operates in the *information and education* pillar. The program is meant to teach children about a healthy lifestyle by letting them experience healthy living, showing them what they are doing well and showing them what aspects of their lifestyle can be improved. Because FitGaaf! also targets the parents, the program can also lead to improvement of the *physical and social environment* of the child. If the parents become enthusiastic and supportive about improving the lifestyle of the family, the child will benefit from the positive social environment and the potentially improved physical environment at home.

FitGaaf! has done several primary prevention projects at schools. The biggest projects were in Delfzijl, Appingedam and, recently, Hoogeveen. Participation rates of children and parents were high in all projects. FitGaaf! doesn't have the means to measure the effects of the program on the health of the children objectively, but the subjective health was measured in Appingedam and Hoogeveen. In all schools, participation to the FitGaaf! program improved the subjective health of the children.

Despite promising results at school projects and FitGaaf!'s effort to establish itself in the primary prevention market, the position of FitGaaf! in this market remains weak. The overwhelming number of competitors and the underwhelming amount of available money make it very difficult for small companies like FitGaaf! to obtain a strong position in this market. The low rank in the Loket gezond leven database also holds FitGaaf! back in building a reputation in this market because the offer of comparable programs with a higher rank is simply too high. The primary prevention market doesn't appear to be a good fit to FitGaaf!'s strengths and has too many threats that FitGaaf! cannot overcome.

Currently, the secondary prevention market is not actively targeted by FitGaaf!. Entry in the tertiary market, however, is in its early stages. FitGaaf! is collaborating with *Team050*, a social work organization that provides care and information for youth with all sorts of

complications, including overweight, in Groningen (Team050, 2018). Local WIJ teams are responsible for signaling of problems among youth and referral to Team050, if needed. FitGaaf! organizes parent meetings for Team050 to hand parents of overweight children the tools that can help them to improve their lifestyle. A more extensive collaboration with Team050 and comparable parties is currently work in progress.

FitGaaf! is taking a very broad approach. By being as versatile as possible, FitGaaf! can offer several different services, target several different markets and collaborate with several different partners. FitGaaf! is mainly focussing on the primary prevention market, which has been a rough road. However, the program might have more potential in the secondary or tertiary market. In order to give a considered advice about what market to focus on, FitGaaf!'s potential in these two markets is examined.

2.4.2 FitGaaf!'s options in the secondary prevention market

FitGaaf! is currently not active in the secondary prevention market, although there are some indications that this might be an interesting path to take. The primary prevention market is flooded and despite all effort, FitGaaf! hasn't been able to rise above the competition. Since the size of the competition appears to be the number one threat that FitGaaf! cannot overcome, targeting a less competitive market can make a big difference in the success of FitGaaf!. In the secondary prevention market the competition is a lot less fierce because only few projects can meet the requirements for low SES interventions. If FitGaaf! could meet these requirements, a door might open to this much less competitive market. To determine if this is an option, the match between FitGaaf! and low SES intervention requirements is determined.

Because FitGaaf! has mainly focussed on primary prevention, the program has been fine-tuned and improved based on previous experiences. This strong basis is very important to have before considering to take the step to secondary prevention because this should be the backbone of the program. Although the basis of a primary and secondary prevention program can be the same, the way in which the program gets presented needs to be more specific in secondary prevention. The low SES target group has some specific needs that need to be taken into account in the design of the program.

Gera Nagelhout, researcher at Maastricht University did a delphi study to identify the most important requirements for prevention programs in low SES areas. This type of study summarizes the opinions of experts on a topic. In this case, the opinion of 26 researchers who regularly publish about prevention in low SES areas was asked. Consensus about several suggested requirements was sought. Experts agreed on 4 broad aspects that are required for low SES interventions: Interventions should be well prepared, accessible, should use easy materials, and should have a large reach (figure 8) (Nagelhout et al, 2018). Although this study did not specifically focus on children, Gera Nagelhout mentioned in an interview that these requirements should also apply for children. Also, she mentioned that for children it is important that intervention programs fit the imagination of children and that the parents are involved (The complete interview can be found in appendix 3). FitGaaf! seems to be able to meet these requirements quite well. The intervention takes place in the perception of the child and takes the means of the parents into account. The focus lies on what you can do to improve your lifestyle with the means that you have, not on what you can't do. The program is very accessible because the program is inexpensive, focuses on

small steps of improvement, gives very concrete advice and provides a platform for personal support from parents and teachers. The materials used are easy to understand and the language used is simple.

Although some aspects fit a low SES target group, there are also some aspects that need some extra attention if FitGaaf! wants to enter the secondary prevention market. An important aspect to work on is the reach within the target group (figure 8). Collaboration with a large or national invention program would offer a great platform to achieve this reach. Also, FitGaaf! doesn't yet tackle the underlying problems that cause an unhealthy lifestyle in low SES groups (figure 8). According to professor G.E. Navis, no one truly understands the link between SES and health, so no one knows how to tackle this properly (G. Nagelhout, personal communication, 2018). What could be a step in the right direction is to organize parent meetings for low SES parents whose children participate in the FitGaaf! program. By teaching them how to cook healthy for little money, showing them options for exercise that are free and perhaps working together with dieticians, lifestyle coaches or psychologists, the parents can be taught some things about a healthy lifestyle. This seems to be a good way to target some of the underlying causes of overweight in low SES children and a very reasonable goal to strive for.

Well prepared	Accessible	Easy materials	Large reach
			
• Take the daily worries and domestic situation of the participants into account • Refer to the perceptions, incentives, wishes and needs of the target group • Involvement of the target group in the development of the intervention • Based on preparatory survey under the specific target group within the low-SES group • Take (other) social standards and (lack of) social support into account • Also focus approach on the underlying causes of an unhealthy lifestyle	• Keep the price of participation very low or make it free • Make the intervention accessible • An intervention that is close-by, not too far away for the target group • A lot of personal support and oral communication during the intervention • Focus on small and feasible changes • Focus on concrete activities and less on knowledge transfer	• Use of simple language in the intervention materials • Ensure the intervention material is in line with the level and skills of the target group • Avoid patronizing language	• A good recruitment strategy to get into and retain contact with more members of the target group • A long intervention period ensuring the activities are offered for a long time

Fig. 8) The most important requirements for low socioeconomic status intervention programs, according to Nagelhout et al., 2018

The low SES intervention requirements mentioned above are based on the opinions of experts. However, when it comes to designing or adjusting an intervention, it is very important to listen to the opinion of the people with a low SES score as well. Linda de Ruyter did a study on what a lifestyle intervention should look like, according to low SES people. She did focus group interviews to identify what factors lead to the best participation rates in low SES people. The results were surprising. Although it is commonly thought that a nosy approach leads to defensive behavior, low SES people seem to actually appreciate it. They

think that the government should take more responsibility and get more involved in improving their lifestyle. A nosy approach might not seem the nicest, but low SES people indicate they learn more from this approach, feel taken more seriously and feel, in a good way, more obliged to participate. High SES people indicate that they don't like this approach and are more defensive to programs with a nosy approach (de Ruyter, 2018).

FitGaaf! doesn't have a very nosy approach, because the program takes place at home. During the four weeks that the children participate, FitGaaf! doesn't have much influence. However, FitGaaf! does provide a group calendar for discussions in the class and there are several newsletters to the parents with information and tips. Possibly adding parent meetings could also increase the involvement of FitGaaf!. Therefore, this option should be considered in case FitGaaf! wants to enter the secondary prevention market.

At Loket Gezond Leven, interventions that are suitable for low SES are marked (Loket gezond leven, 2018c). FitGaaf! currently doesn't have this mark, although there is a clear indication that it is possible to fit low SES target groups after minor adjustments to the program. According to Carolien de Jager, advisor healthy lifestyle at RIVM, intervention owners can mention if they think that they are suitable for low SES when they apply for a position in the invention database at Loket Gezond Leven. A committee scores interventions and decides whether they think low SES suitability is the case, based on the target group and the content of the intervention (C. de Jager, personal communication, 2018). FitGaaf! seems very suitable for secondary prevention and has already had some successful projects in Delfzijl, Appingedam and Hoogeveen, which all happens to be low SES. Recently, FitGaaf! has also been added to the "intervention menu" in the Low SES DAL-region (Delfzijl, Appingedam, and Loppersum) because of the successful project in Appingedam. Receiving the low SES mark in Loket Gezond Leven seems within reach for FitGaaf!, which can boost FitGaaf!'s position in the secondary prevention market.

Altogether, it appears that the FitGaaf! program is very suitable for a low SES target group. Some alterations are needed, but these are small adjustments that are easily within reach for FitGaaf!. The potential of obtaining a low SES mark in the Loket Gezond Leven database can give the company a big boost in the market entry phase, which might lead to new opportunities and partnerships. Because of the less competitive nature of the secondary prevention market and the match between FitGaaf! and the low SES target group, focusing on the secondary prevention market is a very good option.

2.4.3 FitGaaf!'s options in the tertiary prevention market

Although FitGaaf! is mainly active in the primary prevention market, the first steps towards tertiary prevention are being taken by collaborating with Team050. Before this collaboration, FitGaaf! had already tried to be more active in the tertiary prevention market. Like mentioned before, health-promoting programs like FitGaaf! need to approach regional healthcare purchasing organisations if they want to take part in government-funded healthcare. In Groningen, the RIGG is responsible for buying healthcare. In the case of the RIGG, there are a couple of moments each year when organizations can apply for funding. The programs need to meet several requirements to apply and only the ones that are most suitable are selected (RIGG, 2018b). Because the RIGG buys all kinds of healthcare, a company also has to compete with companies that offer different types of healthcare. FitGaaf! applied for a collaboration with the RIGG in the beginning of 2018. Unfortunately, the request was

denied. The most important reasons were the fact that the RIGG doesn't buy prevention programs and because FitGaaf! lacks staff with the right certifications and background (Team inkoop RIGG, past communication, 2017). According to the RIGG guidelines for entry, the care needs to be executed by a SKJ-registered (Stichting Kwaliteitsregister Jeugd) or BIG-registered (Beroepen in de Individuele Gezondheidszorg) healthcare professional. Although one of the staff members is currently in the process of becoming SKJ-registered, this step is not completed yet. Another requirement is that the program needs to be guided by a certified GZ psychologist (RIGG, 2018b). Because of lacking financial means, FitGaaf! is not able to hire a GZ psychologist at this point.

At this moment, FitGaaf! cannot meet the requirements of the RIGG. Another option to enter the tertiary prevention market is by approaching local WIJ teams, which buy lighter care like prevention. FitGaaf! has been in contact with WIJ teams but so far, hasn't been successful in establishing a partnership. The main issue is that WIJ can only spend money on FitGaaf! for children that have a so-called "indication" to need specifically what FitGaaf! offers. In practice, most children have different indications. If children are still interested in FitGaaf! but don't have a matching indication, no money is available for this. Because not enough children have the right indication, WIJ is not willing to invest in FitGaaf!.

At this stage it is very difficult for FitGaaf! to enter governmental healthcare programs from the RIGG and WIJ teams. There are, however, other options to participate in tertiary prevention. FitGaaf! can collaborate with an organisation that does meet the requirements of the RIGG and WIJ teams. Once FitGaaf! has established itself in this collaboration, it is likely to be more easy to develop the program towards a level that meets the requirements of the RIGG and WIJ teams. This might, however, be a time consuming route, since it quite difficult to prove yourself under the wing of a bigger partner. Also, it might be difficult to engage in such a partnership. FitGaaf! doesn't have many resources, so an equal partnership with a large established organisation is difficult to create. Therefore, a bigger organisation needs to believe in the ideas of FitGaaf! and should feel sympathy for the team. This route towards governmental funding is more suiting considering where FitGaaf! stands now, but whether or not a partnership will lead to a collaboration is always uncertain and not in the hands of FitGaaf!. Approaching the tertiary prevention market via this route requires a lot of faith and goodwill.

A final option to enter the tertiary prevention market is by collaborating with a company that makes a profit from own income and is not (fully) dependent on governmental funding. An option that comes to mind is to collaborate with youth dieticians. FitGaaf! has the potential to be a puzzle piece in their treatment plans for children with overweight. This way, FitGaaf! is the provider of a tool and is not responsible for the actual treatment, which requires certifications. A disadvantage of this approach is the fact that FitGaaf! needs to give up a lot of its independence. Also, the profit for FitGaaf! per client will be small, so if this collaboration should be the primary source of income, FitGaaf! needs to get a lot of customers. It is uncertain whether this is possible because FitGaaf! has very little experience in this field. Therefore, complete focus on this strategy is risky.

Entering the tertiary market is not favorable at this stage, because FitGaaf! lacks the certifications for governmental funding and has too little experience in this field to be an interesting partner. FitGaaf! will needs to depend on goodwill, which is simply too risky.

2.5 External analysis

2.5.1 The need for an external analysis

So far, the internal analysis of FitGaaf! and the exploration of the different market options (primary prevention, secondary prevention, and tertiary prevention), have provided some implications for a potential strategy. However, a strategy should also take the external situation into account. Chapter 2.4 concluded that it could be interesting for FitGaaf! to enter secondary prevention market. In order to further investigate the seemingly good match between FitGaaf! and the secondary prevention market, a PESTEL analysis of this specific market is performed. The aim of this analysis is to identify how various macro environmental factors might affect FitGaaf! and its competitive position in the secondary prevention market. In addition, a Porter's five forces analysis is performed to identify where the power of FitGaaf! lies in the secondary prevention market. The aim of this external analysis is to define the threats and opportunities of FitGaaf! in the secondary prevention market.

2.5.2 PESTEL analysis

A PESTEL analysis describes macroenvironmental factors that can influence the market position of a company. In this case, these are factors that can influence FitGaaf! as a player in the secondary prevention market of obesity. The macro environment is assessed on five levels; political, economic, social, technological, environmental and legal (figure 9).

Fig. 9) The content of a PESTEL analysis. Source: https://www.paypervids.com/pestel-analysis-nikes-external-environment

Political: All types of lifestyle interventions are regulated by the government to some extent. The RIVM is the governmental institute that operates at the highest level of intervention regulation. The RIVM determines the requirements for lifestyle interventions on the primary, secondary and tertiary level and evaluates whether interventions meet these requirements. If they do, they can obtain a place in the intervention database of Loket Gezond Leven, which is part of the RIVM Centrum Gezond Leven (Loket gezond leven, 2018d). The RIVM also provides toolkits for implementation of these interventions. The toolkits help lower-level governmental organizations like municipalities and GGDs to choose interventions that fit the population. An example of such a toolkit is the "Toolkit Preventie in de Wijk". This toolkit describes the types of interventions that are valuable and suitable in certain neighborhoods (RIVM, 2018). Like mentioned before, the RIGG and WIJ teams are responsible for purchasing intervention care for youth in Groningen. Other municipalities have comparable systems of decentralized purchasing of care. Intervention programs can also be purchased by customers directly. In this case, the role of the government is smaller and only involves validation of intervention programs.
Besides the regulations for interventions, there are also some policies that are focussed on obesity prevention in a more direct way, like the restriction of sales of unhealthy food in schools (Swinburn, 2008).

Economical: There is money from the government available for prevention of obesity, which is distributed via organizations like the RIGG and WIJ teams (RIGG, 2018a; Wij Groningen, 2018). However, there are a lot of interventions available and not all get selected to receive money from the government. There are, however, other ways to receive funding. Health insurances sometimes give funding to companies with good ideas to improve the health of a target group. An example is the VGZ fund that FitGaaf! received in 2012. Health insurance companies benefit from healthier people, so they are willing to spend money to improve health, often in collaboration with governmental organizations. An example of a (partly) governmental project that is funded by health insurances is *Kans voor de Veenkoloniën*, which focuses on secondary prevention in high-risk areas (KVDVK, 2018a). Although there are several funds available, there is a lot of competition between interventions to receive these funds. Because of the large offer, criteria for interventions are high. If an intervention is not able to obtain funds, profit has to be made via B2B and B2C sales. This can be tough because single customers don't bring in enough money and larger organizations (like schools) often don't have a very large budget for these kinds of interventions.
A more direct economical factor that needs to be considered is the fact that low SES individuals have little money to spend on healthy food and sports. In the case of secondary obesity prevention, the budget of the target group needs to be taken into account.

Social: The target group for secondary prevention is quite big, as there are many people in the Netherlands who are at risk for obesity. Obesity prevalence is tightly associated with low SES. People with low SES are not evenly spread across the country, but often live together in neighborhoods. This makes it relatively easy to target low SES children. In these low SES areas, the level of education and wealth is quite low. Interventions need to be easy to use and cheap to fit the target group, which complicates secondary prevention compared to primary prevention. The urgency for obesity prevention in low SES areas is high (Adler et al., 1994). Therefore, there is a higher demand for intervention programs in these areas compared to high SES areas.

Technological: The level of technology used in secondary prevention of obesity seems quite low. Intervention programs seem to mainly use offline material, face-to-face contact, and easy-to-use intervention measures. In low SES areas, people don't always have access to technology, because devices like phones and computers are expensive. Analog methods, therefore, seem to fit the target group better. This is different in primary prevention, where several health-promoting interventions use an app that supports their program. Some examples are the *VitalinQ Food & Health app* (VitalinQ, 2018) and the *Eetmeter* from the Voedingscentrum (Voedingscentrum, 2018).

Environmental/**E**thical: Environmental factors are strongly involved in causing obesity. The Netherlands is a well-developed country, so we need to spend very little energy to move around, obtain our food and do our daily activities. In addition, unhealthy food is readily available. Each small town has its own snack bar and the prices of these food items are low. In low SES areas, this is not different. What makes matters worse is the fact that healthy resources, like healthy food and sports clubs, are expensive. There is also often a cultural factor involved. If no one in your town does sports, then why would you? These are some factors that make the environment in low SES areas even more obesogenic (Adler et al., 1994). The environment is an important target for obesity prevention interventions. Therefore, several programs aim to improve the environment to allow people to become more active and eat more healthily (Loket gezond leven, 2018c). Although most obesogenic environmental factors can be improved, this costs a lot of money, which is not available unlimited. Also, improvement of the social environment can only be achieved when people are willing to change. The unfavorable environment will always be a limitation in the prevention of obesity, and therefore, in the success of programs like FitGaaf!.

Legal: In the Netherlands, obesity prevention is barely supported by law. This has to do with the fact that an individual's weight is seen as his/her own responsibility, not the responsibility of the government. There are, for example, no tax regulations regarding sugary of fatty foods in the Netherlands. According to a study by Swinburn, the legal regulations regarding the emission of carbon dioxide do indirectly have an effect on obesity. Obesogenic foods are often processed and packaged foods, which have high carbon costs. The regulation of carbon emission increases the price of these foods. However, whether this effect is strong enough to have an effect on obesity, is unclear (Swinburn, 2008). Because legal regulations are lacking, it is very difficult for programs like FitGaaf! to be effective.

Based on this PESTEL analysis, the main threats in the external environment are:

- Intense competition for funding
- Negative impact of obesogenic environmental factors and
- Lack of health-promoting/protecting laws

However, there are also some opportunities if FitGaaf! manages to establish itself:

- Large target group
- High urgency for prevention
- Strict political regulations for prevention programs.

2.5.3 Porter's five forces analysis

The five forces model, as described by Michael E. Porter (Porter, 1979), is used for assessment of the microenvironment of a company. It provides an overview of the position that a company has or can have in a certain market. In this report, Porter's five forces model

is used to determine the potential position that FitGaaf! could obtain in the market of secondary obesity prevention. Also, microenvironmental threats are identified, which is crucial for choosing the right strategy in this market. The five forces that influence this are the competitive rivalry within the industry, the threat of new entrants, the threat of substitutes, the bargaining power of suppliers and the bargaining power of customers (figure 10).

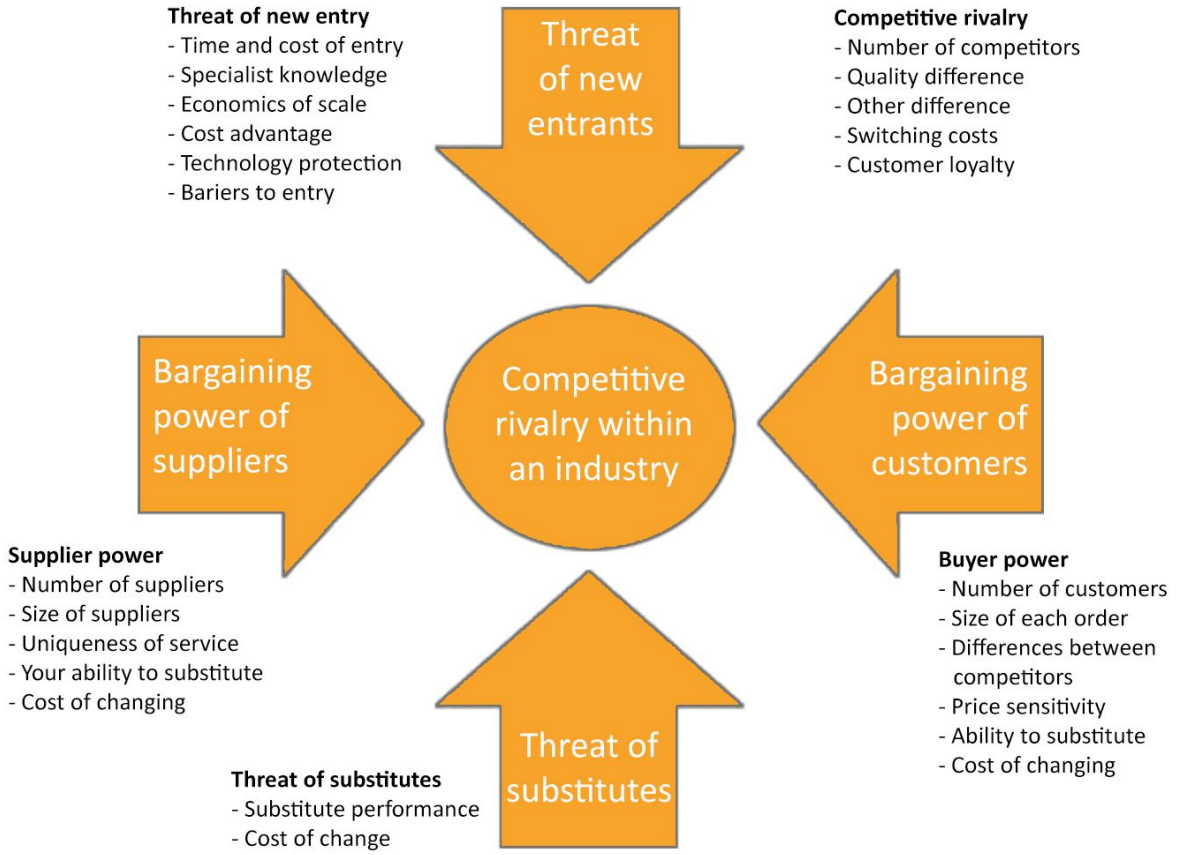


Fig. 10) Porter's five forces model.

Competitive rivalry: In the secondary prevention market, there is a lot of competition. Although most obesity prevention programs aren't suitable for low SES, there are still a lot that are suitable and that have proven their effectiveness. FitGaaf!, as a potential new player in this market, hasn't established a name for itself yet. Also, the intervention is only a level 0 "well described" intervention, whereas some other programs have higher levels in the invention database. Although there is a lot of competition, there is also a lot of variety between programs. Most programs focus on different aspects of lifestyle and take a different approach. Therefore, not all rivals will have the exact same target group. Participation in most programs is short, so switching from one program to the next is easy and happens a lot. Some programs can even work in parallel. In other words, despite the large number of competitors, the rivalry level of the competition is not so high that FitGaaf! doesn't get a chance to participate in this market.

Threat of new entrants: In the secondary prevention market, there is a relatively big threat of new entrants. The step from primary prevention to secondary prevention is small because it doesn't cost much time or money to adjust the program to fit the low SES target group. There is much more competition in the primary prevention market, so taking the step to the secondary prevention market is a logical decision for programs that can be made suitable for a low SES target group. Entry barriers in the market are low. All programs can quite easily apply for the "suitable for low SES" mark in Loket Gezond Leven. Even without this, entry is possible as long as customers and partners can be found. FitGaaf! should obtain a strong position in the market to protect itself from new entrants.

Threat of substitutes: There are a couple of substitutes for secondary prevention lifestyle interventions. Think, for example, of lifestyle blogs, which are available on the internet for free. Another example is the large offer of informative videos about lifestyle on YouTube. By watching these videos, people can learn the same things about lifestyle as what FitGaaf! can teach them. It is, however, important to keep in mind that young children will probably not read blogs or watch informative videos. These substitutes mainly target parents, which can influence the lifestyle of their children as well. Substitutes for children are very uncommon. Instead of a threat of substitutes, a threat of non-compliance is a more realistic risk.

Bargaining power of suppliers: The bargaining power of suppliers is, in case of FitGaaf!, very low. The only suppliers that FitGaaf! needs right now are a supplier of the calendars (printing), a graphic designer and a sports coach/entertainer for the openings and closings at school projects. These suppliers are very easy to replace because they are not rare and the costs of switching are low. In case FitGaaf! wants to start doing parent meetings with experts, this brings along a higher bargaining power of these suppliers. Lifestyle specialists that can work with children are still not extremely rare, but they need training about the FitGaaf! program, which is an investment for FitGaaf!. Switching to other experts brings along switching costs because new experts have to be trained again.

Bargaining power of buyers: The buyers have a lot of power in this market. There is a lot of programs to choose from, all with different focus points and approaches. A buyer can bargain on the contents and price of the program because the program is usually bought for big groups of children at once (like schools). If one program doesn't want to compromise, buyers can easily approach a different program that is comparable or has the same goals. For FitGaaf!, it is best to accept that buyers have this power and try to find a compromise with potential buyers. Also, the bond with the customer is very important, because a good relationship can decrease the chance that they will switch to another supplier or a substitute.

Based on Porter's five forces, the threats within the secondary prevention market are:

- Intense competition
- Threat of new entrants
- High bargaining power of buyers

The only way to circumvent these obstacles is to be better than the competition, which is not an easy task. However, the market also has some opportunities:

- Low threat of substitutes
- Buyer loyalty can decrease the bargaining power of the buyers

This analysis emphasizes the need for FitGaaf! to obtain a strong market position within this competitive market.

2.6 Policies regarding overweight prevention

So far, this chapter has evaluated internal and external factors that could influence FitGaaf!'s market position. Based on this thorough evaluation, a focus on the secondary prevention market seems to be the most suitable strategy for FitGaaf!. This market seems to be the best fit to FitGaaf!'s strengths and weaknesses and the market threats are not impossible to work with. However, before drawing this conclusion, one final factor needs to be taken into account; current policies regarding secondary obesity prevention. FitGaaf! is highly dependent on policymakers, because policymakers are important customers in case FitGaaf! wants to enter the market of secondary prevention. Therefore, it is important to know what policymakers want and what their limitations are.

2.6.1 The complex world of obesity prevention policy

Obesity prevention is a very complex field within healthcare policy. The field is broad because of the different levels of prevention and the target group is very diverse. Also, there are a lot of different factors that can cause obesity, which can all be targets for obesity prevention. Each program takes a different approach, uses different methods and has a different vision. And to make it even more complicated, the effects of obesity prevention are usually not direct, so effectiveness is difficult to prove en and savings on healthcare will also take many years to arise. For national policymakers, it is nearly impossible to write a policy plan that takes all these factors into account and still facilitates effective prevention.

The "jeugdwet", which was mentioned before, is an attempt to make policy writing a little easier. This law, which states that care for youth and parents is the responsibility of the municipalities, allows for an approach that suits the citizens of each specific municipality best (Jeugdwet, 2014). This way, the diversity of the target group is decreased and policymakers can more easily select the types of interventions that suit this group. There is, however, also a disadvantage to the decentralization of care for youth. Since the available money is split over all municipalities in the Netherlands, relatively small amounts of money are available per municipality. The people in the municipalities who are responsible for buying healthcare are not always specialized enough to know how the money should be distributed over different types of healthcare. Also, because of the lack of direct effects of prevention, the available money is more likely to be spent on healthcare that does have direct effects. This has to do with the fact that the municipal council is re-elected every four years, so municipal councils want to achieve as much as they can within their four years. Effects of prevention usually take much longer to become visible. Buying expensive intervention programs is therefore often not an option. Prevention programs need to provide cheap options if they want to obtain money from the municipality, but these programs are not necessarily the best fit to the target group (I. Dijkstra, personal communication, 2018). The jeugdwet has had a large impact on companies that provide prevention and the people who need interventions. Companies should ask themselves whether their strategy fits the jeugdwet and act accordingly.

2.6.2 Ecosystem innovation

The policymakers and prevention providers seem to have different agendas. Policymakers mainly want to improve short-term health in their municipality during the four years that a municipal council is in place. Prevention providing companies want to receive funding from these policymakers and try to outcompete each other by being the most effective. What

seems to be forgotten is the bigger picture; preventing obesity to improve the health of Dutch citizens. The gap between policy goals and business goals is difficult to overcome, leading to suboptimal obesity prevention and a smaller-than-possible impact on health.

In hospitals, this is often an issue as well. Departments try to be the best at what they do and compete with other departments. This urge to be the best stands in the way of what is really important; the patients. Policymakers in hospitals can implement a policy that stimulates collaboration between the departments; a shift from ego to eco, as described by Otto Scharmer. This way, the ecosystem within a hospital can be improved, leading to better care for the patients (Scharmer & Käufer, 2013).

This form of ecosystem innovation might also be an interesting option to improve collaboration between policymakers and obesity prevention programs. In this case, a higher policy maker, for example a municipality, needs to stimulate prevention programs to work together. The competitive element (funding) needs to be taken away and the prevention programs need to operate as an ecosystem instead of a market. In case ecosystem innovation gets implemented, prevention programs should fit their programs to the wishes of policymakers and policymakers should spread funds evenly over all programs. This way, improving health is the common goal. There are, however, a couple of reasons why this is unfavorable.

- The amount of money that each municipality can spend on prevention is too small to spread evenly over all prevention programs. In this case, most programs will not be able to survive and will leave the market. This will have a large impact on the diversity of programs because only the ones with the least costs will remain. Therefore, policymakers will still work together with the cheapest, but likely not the most suitable, programs.
- The nature of the market doesn't suit this type of policy. In hospitals, the management divides money over the departments and receives all income. Therefore, there is no competition between departments for money. The only competitive element that there is is the urge of people to want to be better than others. Ecosystem innovation aims to make people realize that this feeling of competition is not necessary and impairs the outcomes for patients. In the obesity prevention markets, this is very different. There is actually a lot of competition for funds and customers because this is the source of income for prevention providers. Whether a company can survive in this tough market depends on whether it can outcompete the others.
- The strong competition in the prevention markets forces programs to be effective. Equal distribution of funds will not motivate prevention providers to improve their product, leading to less effective programs and a negative impact on health.

In this field, the only way in which ecosystem innovation could work is if the competitive element is completely removed. In order to achieve this, a lot of governmental funding is needed. Because of the lack of political interest in prevention, it is very unlikely that the government is willing to spend a lot more money on prevention, especially considering that it is uncertain if the Dutch citizens will even benefit from it. And even if ecosystem innovation would be favorable, FitGaaf! would not easily be able to make higher policymakers implement it. Therefore, there is a need for a different approach.

2.6.3 An alternative approach; public/private collaborations

Like mentioned before, there are some health-promoting programs within the field of secondary prevention that are collaborations between health insurances and the government. These projects are based on *health impact bonds (HIB's)* (figure 11); the party who will benefit from health innovation in the long run is the one who has to invest in the first place (Nationale DenkTank & Social Impact, 2014). Because prevention leads to decreased healthcare costs in the future, health insurances are the ones who will benefit in the end. They want more prevention and have money to invest in it, but they often lack the platforms to implement prevention programs. Municipalities do have these platforms because governmental organizations are in contact with the target group. However, as mentioned before, they have a limited amount of money available for investment in health innovation. If health insurances and governmental organizations collaborate, they can combine their resources and provide optimal health promotion. In this situation, a HIB is more effective than ecosystem innovation and benefits all parties.

Several different measures were taken to promote collaboration in the field of obesity prevention. In 2005 the Covenant Healthy Weight (CGG) was signed. This led to the birth of a steering group that aimed to promote collaboration of public and private parties in the prevention of overweight. After the expiration of the covenant, the collaborating parties continued their efforts as the foundation JOGG (Spaans, 2015). Partnership Overweight Netherlands (PON) and Care for Obesity (C4O) are other examples of organizations that support collaborations between health insurances, health providers, and knowledge institutes to prevent obesity (PON, 2018).

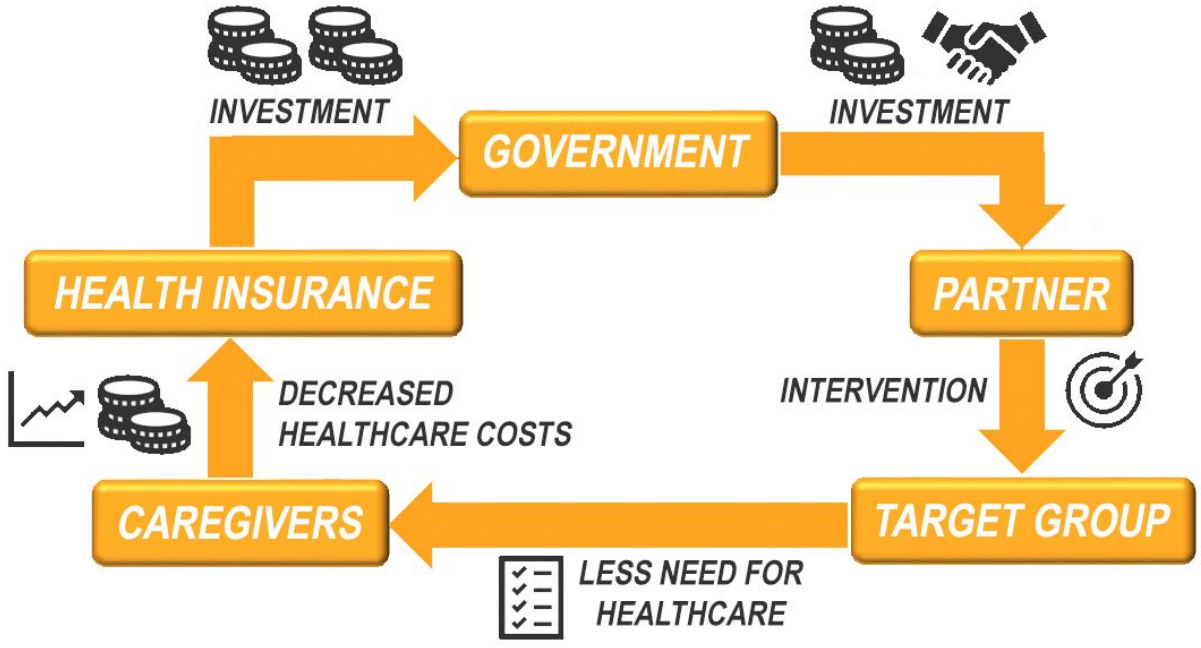


Fig. 11) Schematic overview of a health impact bond (HIB). A health insurance organization invests money that the government uses for healthcare. The government provides money to partners who have the means to do an intervention in a target group. If successful, this causes a decreased need for healthcare among these people. Ultimately, this saves money for the health insurance company that invested in the first place.

Several HIB-based obesity prevention projects have arisen in the past couple of years. A good example that is also relevant for FitGaaf! is the previously mentioned Kans voor de Veenkoloniën (KVDVK) project. This project was started after a proposal by Agnes Wolbert, PvDA member of the House of Representatives, to pay more attention to health in low SES areas. In Groningen and Drenthe, there is a large low SES area called “de Veenkoloniën” on which the project mainly focuses. KVDVK is a collaboration between municipalities, health insurances, and care/prevention providers. The project started in 2015 and will take 8 years in total (KVDVK, 2018b).

If FitGaaf! wants to become active in the secondary prevention market, it is interesting to explore the options for collaboration in a project like KVDVK. This way, the company can strengthen its position in the secondary prevention market and develop itself further. Like mentioned before, FitGaaf! offers a program that is suitable for low SES groups. Besides that, the company has already completed a successful project in Hoogeveen, which is targeted by the KVDVK project (despite not being part of the Veenkoloniën). This makes the KVDVK project an interesting option for entry in the secondary prevention market. After entry and establishment, doors to other public and public/private prevention projects might open up.

2.7 Conclusions

The three levels of prevention (primary, secondary, and tertiary preventions) each have very specific requirements and features. Several obesity prevention programs are active in one or more of these prevention markets. The best strategy in this field, especially for smaller companies, is to find out which market is the best fit to the nature of the company and to establish itself in that market first.
In the primary prevention market, the competition is overwhelming for a small company like FitGaaf! with a low rank in the Loket Gezond Leven database and the low urgency for prevention at this level results in low availability of money.
The tertiary prevention market is also difficult to enter because FitGaaf! doesn’t have the necessary certifications and experience to obtain funding. Options to circumvent these issues in this market leave FitGaaf! with too little independence and a low income.
The secondary prevention market seems to be a better fit, because FitGaaf! can meet the requirements for low SES interventions and the competition in this market is less fierce.

Figure 12 summarizes the strengths, weaknesses, opportunities and threats for FitGaaf! in this market as identified in the internal analysis, external analysis, and policy analysis.

- Some promising strengths are FitGaaf!’s suitability for low SES, high participation rates and agile nature.
- The main weaknesses are related to the small size of the company and the fact that FitGaaf! lacks the means of some of the “big guys” in the secondary prevention market.
- The market offers some opportunities for FitGaaf!, including a higher urgency compared to the primary prevention market and the option of participating in a HIB.
- Major threats are the intense competition for customers and funds and the high bargaining power of the buyers.

If FitGaaf! wants to enter the secondary prevention market and establish itself in this market, these are the major factors to keep in mind. FitGaaf! needs to emphasize its strengths, tackle/avoid its weaknesses, grab opportunities and work around the threats.

Strengths	Weaknesses
S1: Suitable for low SES S2: First indications of effectivity S3: High participation rates S4: Agile nature that allows for adjustments S5: Flexible and personizable product S6: Unique approach	W1: Small team W2: Lack of financial means W3: Lack of focus in business strategy W4: Low ranking in the Loket Gezond Leven intervention database W5: Inability to obtain biometric data to determine effectivity
Opportunities	**Threats**
O1: High urgency for tackling overweight, obesity and DM2 O2: Large target group O3: Strict political regulations O4: Low threat of substitutes O5: Buyer loyalty can decrease the bargaining power of the buyers O6: Emergence of HIBs	T1: Intense competition for funding T2: Negative impact of obesogenic environmental factors T3: Lack of health promoting/protecting laws T4: Strong rivalry between competitors T5: High threat of new entrants T6: High bargaining power of buyers T7: Decreased political interest in prevention due to the Jeugdwet

Fig. 12) SWOT-analysis of FitGaaf! in the secondary prevention market. Strengths and weaknesses are derived from the internal analysis of FitGaaf!. Opportunities and threats are derived from the external analysis (PESTEL and Porter's five forces) and the policy analysis.

Chapter 3

Overweight, diabetes mellitus type 2, and lifestyle

This chapter gets into detail about obesity, diabetes mellitus type 2 and the influence of lifestyle on the development of these diseases. The various aspects of lifestyle that FitGaaf! targets are evaluated on their role in obesity and diabetes mellitus type 2. To conclude, this chapter discusses what the findings mean for FitGaaf! and how they can be used to improve the effectiveness of the biomedical core of the FitGaaf! program. This chapter tackles sub-question 2: *Are the current core concepts of the program effective in the prevention of diabetes mellitus type 2?*

3.1 Overweight and obesity

3.1.1 Weight gain as an evolutionary trait

Weight gain is usually considered to be a bad thing. Overeating or inactivity can lead to body fat accumulation, which can have negative effects on a person's health. Although excessive weight gain can be problematic, the trait of being able to store energy has been an important trait in evolution. In prehistoric times, energy demands were often high and availability of nutritional resources was irregular. Humans were able to survive in periods of famine by burning their body fat to acquire the needed energy for survival (Van Dijk & Buwalda, 2008).

Nowadays, this trait is no longer a necessity. For most people, food is readily available at all times, so the fat reserves are not addressed in normal situations. This means that excessive energy intake will not be compensated by periods of insufficient energy intake, leading to constant fat accumulation. Eventually, this may lead to overweight or obesity. The useful trait of energy storage has become maladaptive in current times (Ravussin, 1995).

3.1.2 Disturbed energy homeostasis

It is common knowledge that taking up more energy than you use leads to weight gain. Therefore, logical explanations for the increased prevalence of overweight and obesity are decreased exercise, increased calorie intake, or a combination of both. Despite this logic, the exact mechanisms of weight gain remain largely unknown. Interactions between genetic, environmental, cultural, behavioral, metabolic and socioeconomic factors play an important role in this uncertainty (Morrill & Chinn, 2004) (figure 13). These factors are responsible for the difference in weight between people who might have a rather similar lifestyle. Despite the uncertainty about certain aspects of weight regulation, some basic mechanisms can be identified.

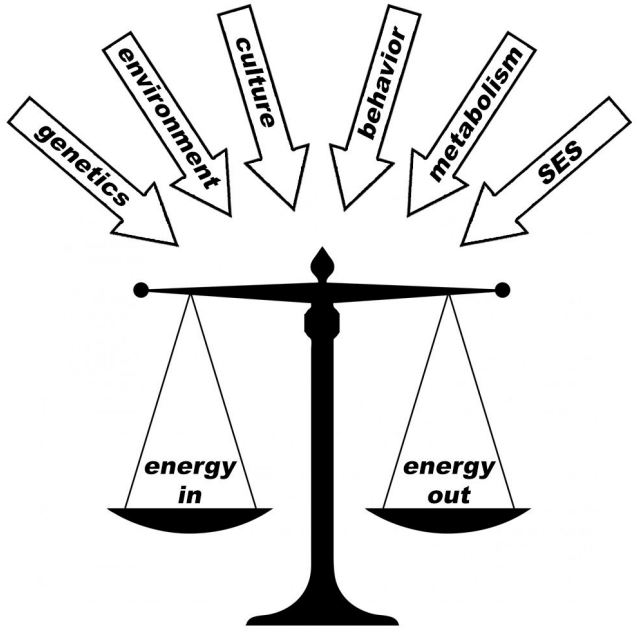


Fig. 13) The energy balance is under the influence of genetic, environmental, cultural, behavioral, metabolic and socioeconomic factors.

3.1.3 Usage and storage of energy

The energy that we take up in our body originates from several different types of nutrients in our diet. The chemical bonds of proteins, complex carbohydrates, fats, and glucose contain energy that the body can extract. The extracted energy is used for activity, growth, and maintenance of cells and tissues. Depending on the degree of activity of the body, more or less energy is required for these processes. If the energy uptake exceeds the needs of the body, this energy will be stored for later (Silverthorn, 2012).

Dietary carbohydrates get metabolized by the body into *glucose*. Glucose, which is an important energy source for the body and the only energy source for the brain, can get stored as *glycogen* in the liver (±100g) and the skeletal muscles (±200g) after glycogenesis under the influence of the hormone *insulin*. Glycogen can be metabolized back to glucose via glycogenolysis in case the glucose pool of the body runs low. The total glycogen storage of the body can only provide sufficient energy for 10 to 15 hours. In case the glycogen and glucose storages run low, *amino acids* can be metabolized into glucose via a process called gluconeogenesis. These amino acids are derived from protein in the diet or the breakdown of muscles (Silverthorn, 2012).

The body also has a more stable storage of energy; fat. Dietary fat can be metabolized into *free fatty acids* (FFA's), which provide the energy that is needed for metabolism. Excess FFA's can be stored in the body as fat, also known as *adipose tissue*. These fat molecules contain 9 kCal of energy per gram, which is more than twice as much as carbohydrates (4 kCal) and protein (4 kCal). The metabolism of fat is slower than that of carbohydrates, which makes the adipose tissue a relatively stable energy storage. In the case of excess carbohydrate consumption, glucose can also be metabolized into fat via a process called lipogenesis. Therefore, carbohydrate consumption can also lead to increased fat stores. If a person's fat stores become too large, this person becomes overweight (Silverthorn, 2012). Figure 14 provides an overview of these metabolic processes in the human body.

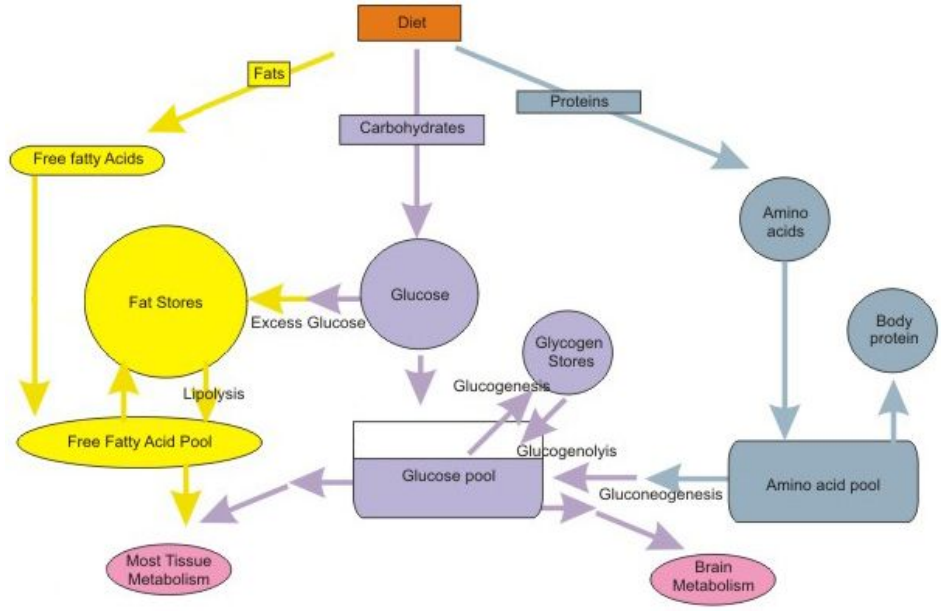


Fig. 14) The uptake, usage and storage of dietary fats, carbohydrates and proteins. Source: http://large.stanford.edu/courses/2012/ph240/khan1/ (modified)

3.1.4 Appetite and satiety

The metabolic system is a complex system that needs to work very precisely to maintain energy homeostasis. Only a small excess or lack of energy can lead to weight gain or weight loss. The body controls the intake of food via several feedback mechanisms that control appetite. Two centers in the hypothalamus of the brain are responsible for appetite; the *feeding center*, which is constantly active, and the *satiety center*, which inhibits the feeding center in case of sufficient energy availability. The activity of these centers has a strong influence on our eating behavior (Silverthorn, 2012).

Feedback to the hypothalamic centers takes place via several peptides. One theory about appetite related to body fat is the *lipostatic theory*. This theory describes a feedback loop that involves the feeding center in the hypothalamus. The center is stimulated by *neuropeptide Y* (Npy), a signaling molecule in Agrp/Npy neurons in the arcuate nucleus in the brain. Stimulation of the feeding center by Npy causes a person to eat and store excess energy in the adipose tissue as fat. The adipose tissue secretes a molecule called *leptin*, which inhibits Npy. If Npy gets inhibited, it becomes less active in stimulating the hypothalamic feeding center, leading to decreased appetite. In other words, if the fat stores increase, more leptin is released and appetite is reduced. This mechanism prevents excessive growth of the fat stores (Silverthorn, 2012). A simplified version of the mechanisms of the lipostatic theory is presented in figure 15.

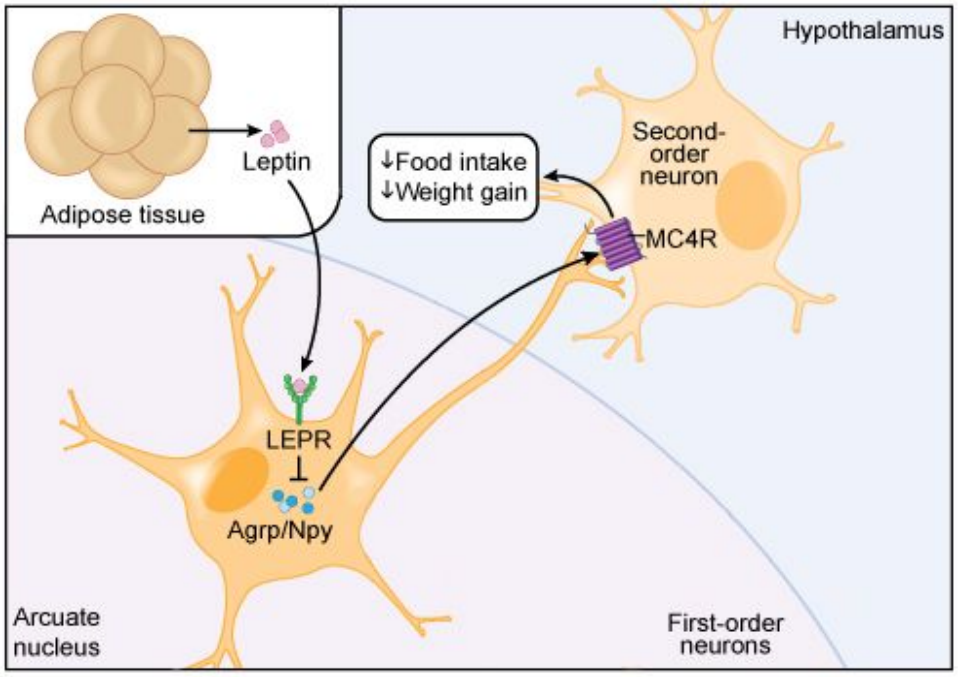


Fig. 15) Simplified mechanism of the lipostatic theory. Leptin inhibits Agrp/Npy neurons, leading to a decrease in the stimulation of the feeding center in the hypothalamus.
Source: https://mutagenetix.utsouthwestern.edu/phenotypic/phenotypic_rec.cfm?pk=109 (modified)

Many more of such feedback mechanisms exist. All have the goal to stimulate or inhibit the feeding center or satiety center in the hypothalamus to maintain homeostasis in the body.

3.1.5 Dietary, behavioral, and cultural factors influencing food intake

If the control of appetite would only depend on the previously mentioned feedback loops, then why do people gain or lose weight? An indication for the suboptimal functioning of the appetite feedback loops is the finding that progressive overeating leads to increased appetite, despite an increase in body fat and fasting leptin levels in an individual (Jebb et al., 2006). Apparently, there are factors influencing the feedback loops.

Several studies looked at the effects of carbohydrate content, fat content, and energy density of food on satiety. A study by Stubbs et al. found that if the energy density is kept constant, the fat and carbohydrate content of the diet does not influence the total energy intake (Stubbs et al., 1996). However, a later study found that if the fat to carbohydrate ratio is kept constant, variations in energy density do influence the total energy intake. They found that foods with high energy density didn't provide sufficient satiety to prevent overeating (Rolls et al., 1999).

Another known factor that influences food consumption is the *palatability* (tastefulness) of food items. The palatability is primarily defined by the content of simple carbohydrates and fat. palatable food stimulates the release of *dopamine* in the brain, which activates the *reward system*. Palatable food has a high hedonic value, which leads to overeating. Withdrawal of high palatable food leads to a stress-response, which shows the addictive effect of palatable foods (Morris et al., 2015). A recent study found that variety in the diet also influences appetite. A palatable high-fat, high-sugar diet doesn't always cause obesity in preclinical studies if only one food choice is available. This seems to be an indication that the feedback control of appetite works better if only one type of food is consumed. If the diet is more varied, like the diet of most people in current times, this has a negative impact on the functionality of the feedback control (Barrett et al., 2016).

The complex link between stress and eating behavior has been studied extensively, mainly in non-human studies. A rat study by Ulrich-Lai et al. showed stress-relieving properties of sucrose via stimulation of the reward system. Twice-daily limited access to 30% sucrose solution led to synaptic remodeling within the *amygdala*, the brain region involved in emotions, via reward signaling (Ulrich-Lai et al., 2015). This illustrates the well-known concept of how "comfort food" can make you feel better. In contrast, a different study found that long-term excessive consumption of dietary fat led to increased stress levels in mice (Ulrich-Lai et al., 2015). There appears to be a similarity to drug use; occasional doses activate the reward system, but chronic use desensitizes this system and diminishes the response. It is, however, important to underscore that the mechanisms of drug use and food intake also differ on several levels (Rogers, 2017).
A study among low SES children (age 4-8) looked at the influence of stress on eating in absence of hunger (EAH) behavior. Their levels of stress, as reported by the parents, were positively correlated to EAH and emotional overeating. EAH increased with age among children with high stress levels (Miller et al., 2018). This illustrates the influence of stress on eating behavior, even in young children.

An important non-biomedical factor that influences food consumption is culture. People have norms about food that they obey, even if they don't feel hungry. Think of finishing your plate, not wasting food, eating something that someone cooked for you as a sign of politeness and

not eating much more or less than others at the table. Several traditions also involve food. Eating popcorn at a movie, eating cake at a birthday, drinking champagne at new years eve and eating pepernoten during Sinterklaas are just a few examples. People are likely to eat in these situations, even if they are not hungry and even if they feel completely satiated. This shows how food intake can be strongly influenced by conscious choice and behavior as well (Crowther, 2013).

The availability of palatable, unhealthy food, combined with stress and cultural factors are some important factors involved in the development of obesity. The number of children with overweight and obesity is increasing, which brings along some serious health issues. One of them is diabetes mellitus type 2 (DM2).

3.2 Diabetes mellitus type 2

3.2.1 What is diabetes?

Diabetes mellitus is a disease related to the glucose levels in the blood. As explained in chapter 3.1.3, the glucose level of the blood is kept under tight control via glycogenesis, glycogenolysis, and gluconeogenesis. If a person is not able to maintain homeostasis of the blood glucose level, this person is said to have *diabetes mellitus*. Diabetes mellitus is associated with *insulin*, the hormone that is responsible for glycogenesis (Diabetes Fonds, 2018).

3.2.2 Glucose metabolism and insulin

After eating a meal, the body breaks down the carbohydrates from the meal into glucose molecules. These molecules get absorbed into the blood in the small intestine. Glucose travels through the body via the bloodstream and will eventually reach the *pancreas*. GLUT-2 glucose transporters in the *β-cells* of the pancreas transport glucose into the cell. Here, the glucose gets phosphorylated by glucokinase and becomes *glucose-6-phosphate* (G-6-P). In the mitochondria of the β-cells, G-6-P enters *glycolysis*, a process that generates *ATP*, a high-energy molecule. The β-cell membrane contains K^+ channels that are inhibited by ATP. Therefore, an increase in ATP will lead to less K^+ secretion, and therefore, to *depolarization* of the β-cell membrane. Voltage-dependent Ca^{2+} channels open and Ca^{2+} flows into the β-cell. This stimulates the release of insulin from the β-cells (figure 16). Insulin secretion is further stimulated by *incretins*, molecules that are released from neuroendocrine cells in the gastrointestinal tract after food ingestion. These incretins also inhibit glucagon, the molecule that has the opposite role of insulin (increasing the blood glucose level via glycogenolysis) (Berg et al., 2011).

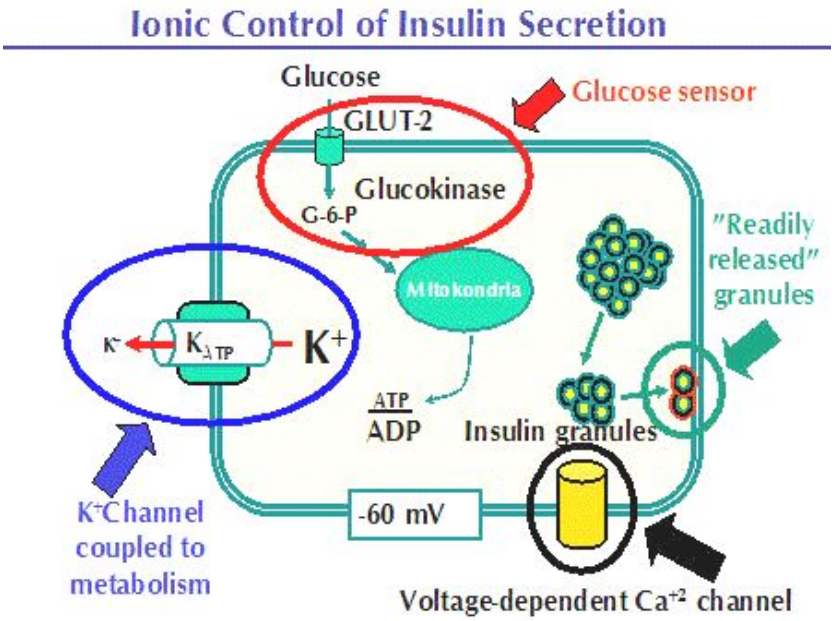


Fig. 16) Mechanisms of insulin release from the β-cells in response to glucose. Source: http://www.namrata.co/insulin-biosynthesis-secretion-and-action/

After insulin is released into the bloodstream, it can bind to insulin receptors. these receptors can be found on the membrane of cells from tissues that can store glucose as glycogen, including the muscles and the liver. Once insulin has bound to its receptor, signaling molecules (*insulin receptor substrates*, *IRS*) get released into the cell. These molecules start a cascade of metabolic processes. Also, IRS causes a translocation of *GLUT-4* transporters from the cytoplasm of the cell to the cell membrane. Glucose can enter the cell via these newly available transporters. This leads to a decrease of the blood glucose level (figure 17) (Berg et al., 2011)

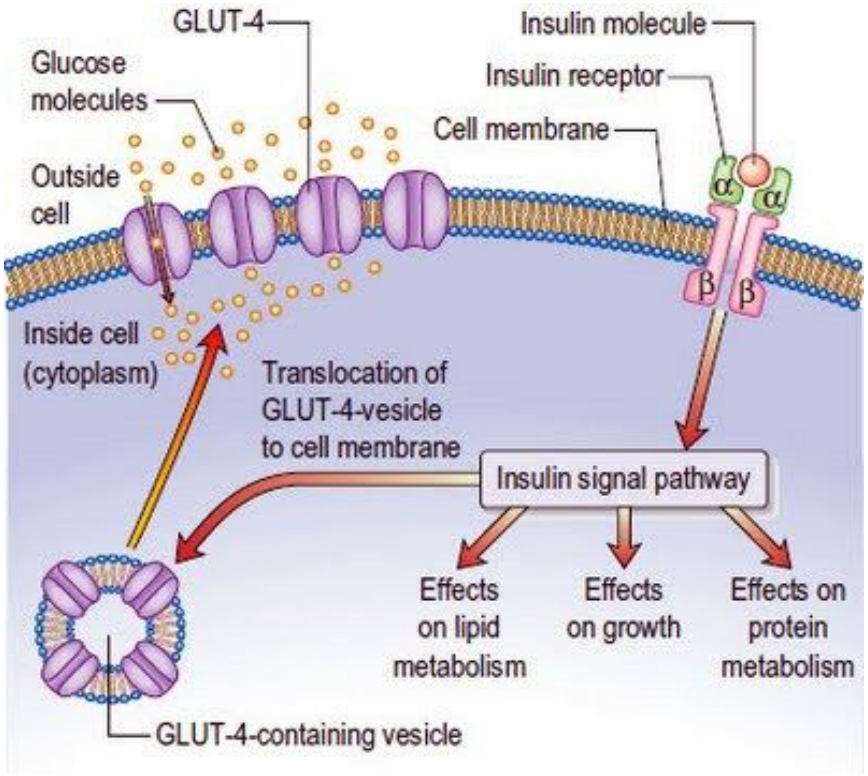


Fig. 17) Uptake of glucose in the cell under the influence of insulin. Source: http://www.namrata.co/insulin-biosynthesis-secretion-and-action/

3.2.3 Diabetes mellitus and insulin

There are two types of diabetes mellitus; diabetes mellitus type 1 (DM1) and diabetes mellitus type 2 (DM2).

- **DM1** is a disease that is characterized by an autoimmune reaction directed to the β-cells of the pancreas. Since the β-cells are responsible for insulin release, damage to these cells decreases or stops insulin release. With no insulin available, the body is unable to take up glucose from the blood. This leads to dangerously high blood glucose levels. Patients with DM1 have to inject insulin after glucose consumption and monitor their blood glucose levels closely to prevent hypoglycemia (too little glucose in the blood) and hyperglycemia (too much glucose in the blood). There is no cure for DM1 (Silverthorn, 2012).
- **DM2** is also related to insulin, but the mechanism of this disease is different. Patients with DM2 don't have an autoimmune disease that damages the β-cells, but they have less insulin and/or are less sensitive to insulin. Usually, patients become insulin resistant before the disease progresses to DM2. Unlike DM1, DM2 is reversible (Silverthorn, 2012). Like mentioned before, overweight is an important risk factor for DM2 (Blokstra and Baan, 2008).

3.2.4 Overweight and diabetes mellitus type 2

Overweight is strongly associated with insulin resistance. Children that are overweight or obese are known to have low HDL cholesterol (the "good" cholesterol) levels, high triglyceride levels and elevated fasting insulin levels. The levels of these parameters are more extreme in more severe degrees of overweight (Salvatore et al, 2014). A similar metabolic profile can be found in individuals with insulin resistance (Patel & Abate, 2013).

The distribution of the body fat plays a role in the severity of insulin resistance. The body fat, also known as adipose tissue, can be divided into *truncal* and *peripheral adipose tissue*. Truncal adipose tissue includes visceral fat around the organs and subcutaneous fat on the torso. Peripheral adipose tissue is the subcutaneous fat on the upper and lower extremities (Garg, 2004). Many studies have shown that visceral fat is a major contributor to metabolic risk (Matsuzawa, 1995). The visceral fat metabolizes fat into FFA's via lipolysis. If excess visceral fat is present, excess FFA's will enter the bloodstream and inhibit glucose uptake in the skeletal muscles. This leads to peripheral insulin resistance (Garg, 2004).

Although a wide range of studies has described the role of visceral fat in blood FFA levels, one should remain careful in claiming that visceral fat is the major contributor to metabolic risk. The visceral fat contributes to only 15% of the total systemic FFA's (Garg, 2004), so it is likely that it is not the only determinant of peripheral insulin sensitivity. A study by Patel & Abate suggests a role of the subcutaneous adipose tissue as a metabolic buffer. In case of a positive caloric balance, this subcutaneous tissue becomes dysfunctional due to hypertrophy (enlargement) of the adipocytes. Therefore, the tissue loses its buffering function and excess FFA's "spill" into the bloodstream (Patel & Abate, 2013). The buffering or protecting function of subcutaneous fat in insulin resistance has also been shown more directly. More thigh fat (subcutaneous) is shown to be negatively correlated with the odds of being insulin resistant (McLaughlin et al., 2011).

Besides FFA levels, the mitochondrial function is also associated with insulin resistance. A study on children found that the *ADP time constant*, a blood-flow dependent mitochondrial function measure, was lower in children with DM2. Also, *oxidative phosphorylation* rates in the mitochondria were lower. Both parameters indicate decreased mitochondrial functioning (Cree-Green et al., 2017).
Oxidative stress is thought to be related to insulin resistance via mitochondrial dysfunctioning. Excess FFA's cause insufficient transport of ATP out of the mitochondria, causing them to make reactive oxygen species (ROS) (Heine, 2018). These mitochondrial ROS cause oxidative stress that can lead to a decreased insulin response of the insulin signaling pathway. In an antioxidant mutant mice model, insulin signaling was better compared to controls. This illustrates the direct involvement of ROS in insulin signaling. (Styskal et al., 2012). Controversially, a different study found that tissue from individuals with DM2 had lower oxidative stress markers. This might be attributed to an upregulated antioxidant defense, but more research is needed to confirm this hypothesis (Jones et al., 2014).

A newer insight into the link between obesity and DM2 is that the gut microbiome might play a causal role in the development of insulin resistance. There is a large body of evidence from animal studies that shows that the microbiome is involved in metabolic processes and that it has an influence on weight (Meijnikman et al., 2017). Because most of the studies that

show causality use germ-free mice (GM), mice with no microbiome, it is difficult to replicate them in humans. In humans, most studies aim for correlations, not causations. A human study, published in Nature, found that people with DM2 have significantly more *Lactobacillus* and less *Clostridium* species in their microbiomes (Karlsson et al., 2013). Also, it has been shown that patients with DM2 have less butyrate-producing bacteria, which are thought to be health-promoting species (Qin et al., 2012). These findings imply that the microbiome might be an interesting target for the prevention and/or treatment of DM2.

3.2.5 Symptoms

Having DM2 means that your blood glucose level is elevated. This in itself doesn't cause direct symptoms, but it can leads to complications if these levels remain high. Most people find out that they have DM2 because they have complaints related to these complications. In this case, the disease has already proceeded to a far stage and permanent damage might have been caused already. Therefore, blood glucose levels of people with an increased risk for DM2 (genetic proposition and overweight) are often monitored (Diabetes Fonds, 2016).

Many complications are associated with DM2. Almost all of them are related to damage to the vascular system and the nervous system. This damage happens because glucose increases the viscosity of the blood, which in turn allows FFA's to stick to the endothelial (lining) of the blood vessels. This causes *atherosclerosis* in the blood vessels. The blood flow to the organs decreases and tissues are depleted of oxygen. Also, the blood vessels will leak, which damages the nerves (Diabetes Fonds, 2016).

Besides cardiovascular disease and neuropathy as direct consequences of damage to the blood vessels and nerves, some more indirect complications can arise as well.
A very common complication is *diabetic retinopathy*. Diabetic retinopathy is the loss of vision due to leakage and/or obstruction of the small blood vessels in the eye. This causes the retina to swell and the vision to decrease. In this stage, the disease is called *non-proliferative diabetic retinopathy* (NPDRP). If the disease proliferates, new blood vessels will be formed in the retina, a process called *neovascularization*. If these fragile new vessels break, black spots will occur in the vision, causing partial or complete blindness (Boyd, 2017).
Another common complication it the so-called *diabetic foot*. Due to nerve damage, patients with a diabetic foot have decreased sensation and suboptimal autonomic nervous system functioning in this foot. Without being aware of it, pressure points and ulcers arise and the foot can get infected. Because of the damage to the vascular system, blood flow to the feet is decreased. Therefore, infections take much more time to heal or might not even heal at all. In this case, a toe or foot needs to be amputated (Pendsey, 2010).
Much more complications are associated with neural and vascular damage caused by diabetes, including problems with the gut, stomach, kidneys, heart, ears, skin and even the brain (figure 18) (Diabetes Fonds, 2016).
In 2015, diabetes mellitus had the third highest disease burden in the Netherlands with a DALY score of 3,7. On average, patients with diabetes mellitus lost 1,7 life years and lived 4,5 years in illness (Volksgezondheidenzorg, 2015).

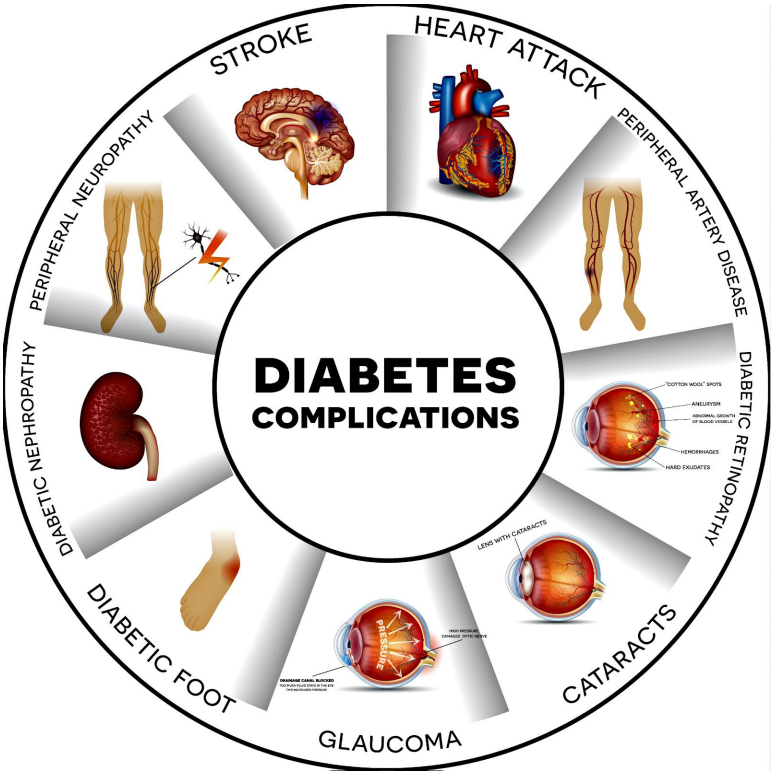


Fig. 18) Common complications of diabetes. Source: http://www.diabetocracy.com/complications-of-diabetes.html

3.2.6 Treatment

Several types of medication that can improve insulin sensitivity and increase insulin secretion are available. Still, patients need to monitor their blood glucose levels closely and inject insulin if the blood glucose level raises too much. The severity of insulin resistance increases in time because the damage of each moment of high blood glucose adds up. Therefore, each moment of high blood glucose should be avoided to postpone complications as much as possible. This makes DM2 a lifelong struggle.

However, unlike DM1, DM2 can be reversed. Losing a significant amount of weight, either via a bariatric surgery or a healthy lifestyle, can completely normalize the blood glucose levels. Therefore, an important part of the treatment of DM2 is living a healthy life. Living healthily and having a normal BMI is also the most effective ways to prevent DM2 (WebMD Medical Reference, 2016).

FitGaaf! promotes a healthy lifestyle in several different aspects. The calendar has stickers for healthy activities that can be broadly categorized as sleep, diet, and exercise. In the next part, each sticker is evaluated on its potential to prevent or reverse DM2 in children.

3.3 The FitGaaf! lifestyle and diabetes mellitus type 2

3.3.1 The stickers

The FitGaaf! program is based on stickers that symbolize healthy actions. Each sticker has its own explanation, goals, and rules, based on recommendations of the Dutch Voedingscentrum. Together, the stickers are supposed to represent a healthy lifestyle which can prevent or reverse DM2. The stickers are presented in figure 19.

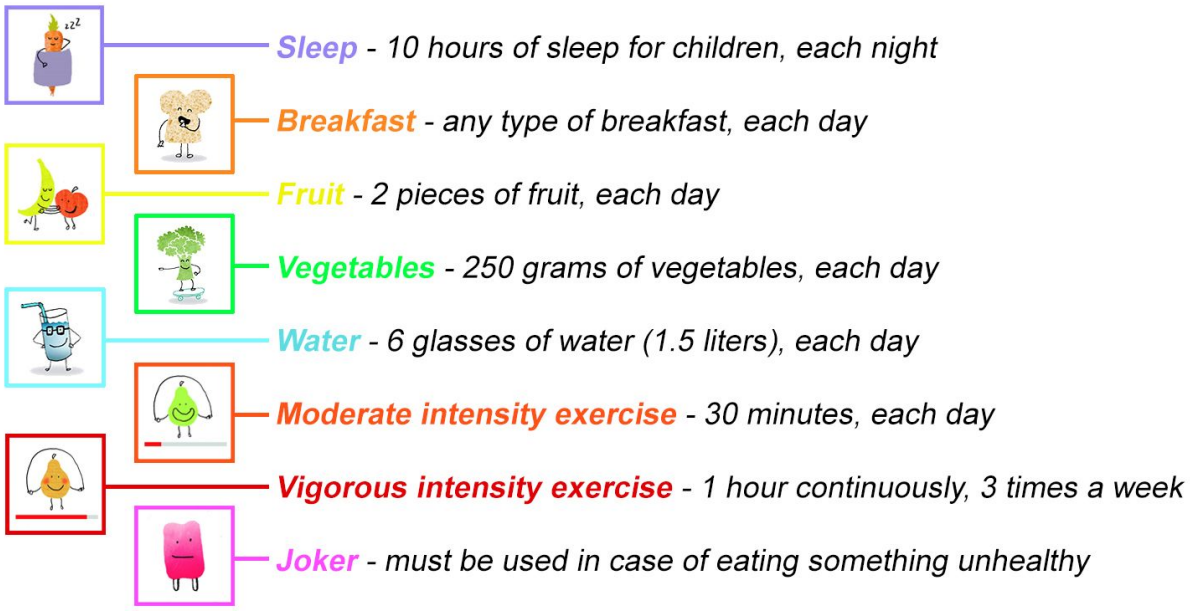
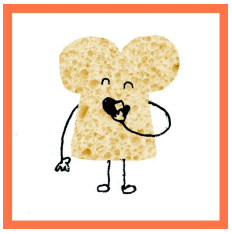


Fig. 19) Overview of the FitGaaf! stickers and what they represent

It is difficult to determine the effects of the FitGaaf! program on DM2 for several reasons:

- Gathering data about the health of the children is difficult for FitGaaf! because of privacy regulations. It would be interesting to know the BMI and blood glucose levels of the children, but this is simply not within reach for FitGaaf! at this point.
- Many effects of a healthy lifestyle are seen only at a much older age. Children with DM2 are rare, but an unhealthy lifestyle might still lead to DM2 when someone is much older. Therefore, to know the effects of the FitGaaf! program on DM2, children need to be tracked lifelong, which is out of reach as well.
- If monitoring would be possible, very precise documentation of diet, sleep and exercise behavior is needed for each child to be able to attribute findings to the program.
- A broad interpretation of the program is possible, so not everyone will follow the program in the same way.
- The intensity of participation varies strongly among children.

In other words, determining the effects of a program like FitGaaf! based on self-generated data is, at this stage, impossible. There is, however, another option to evaluate the effectiveness of the program; with a literature study. By evaluating the stickers (and what they stand for) and looking into previous studies that looked at these topics, this report aims to shed a light on the theoretical effectiveness of the program.



3.3.2 Breakfast

The breakfast sticker is meant to prevent breakfast skipping, not to change the content of the breakfast. For a normal portion size of any type of breakfast, the child can paste a sticker on the calendar. The importance of breakfast has been examined intensively. There is considerable evidence that breakfast consumption is associated with lower BMI and a reduced risk of becoming obese in children and adolescents. Therefore, stimulating breakfast consumption can be effective in the prevention of obesity (Szajewska & Ruszczynski, 2010). The frequency of breakfast consumption has been shown to decrease with age in children (Barr et al., 2014). If a habit of eating breakfast can be created at a young age, this might have a positive effect on the breakfast consumption frequency later in life.

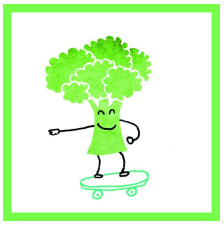
The association between breakfast skipping and obesity was examined in a study by Kesztyüs et al. on ±2000 German first- and second graders. An association was found between breakfast skipping and the consumption of soft drinks and screen media use, which are obesogenic behaviors. Eating breakfast was associated with higher physical activity levels (Kesztyüs et al., 2017).
One would expect that skipping breakfast leads to increased energy intake (EI) during the other meals. However, a study on adults found insufficient compensation of the missed breakfast calories, leading to a shortage of calories at the end of the day. Despite this, skipping breakfast lead to increased hunger, so the part of the missed calories that is compensated might be compensated in the form of (unhealthy) snacks. In other words, not the total calorie count but the diet composition might be influenced by breakfast skipping (Levitsky & Pacanowski, 2013).

The role of breakfast in the prevention of DM2 has been shown by several studies. Karatzi et al. found an inverse association between breakfast consumption and insulin resistance risk. Correcting for waist circumference, birth weight, parental BMI, and SES score led to loss of this correlation, which suggests that the effects of breakfast on DM2 risk are indirect, not direct (Karatzi et al., 2014). A different study found an increased risk of DM2 in breakfast skippers, even after adjustment for differences in nutrient intake (Donis et al., 2014). Several studies agree that breakfast consumption protects against DM2, but whether this effect is direct, indirect or a combination of the two is not clear yet.

The study of Kesztyüs et al. also looked at the association between breakfast skipping and involvement of the parents. Parents have a big influence on the lifestyle of children, including breakfast consumption. If the parents don't support breakfast consumption, children are less likely to eat breakfast (van der Horst et al., 2007). Keztyüs et al. found an association between breakfast skipping in parents and breakfast skipping in their children. The role of the parents might also explain the association between breakfast skipping and increased soda consumption and screen media time; parents who allow their children to skip breakfast

are more likely to allow them to drink more soda and watch more tv as well (Keztyüs et al., 2017). Low SES score of the family has also often been shown to be associated with more breakfast skipping. An important factor involved in this association is the lack of knowledge about health in low SES families (Tin et al., 2011).

In conclusion, stimulating breakfast consumption in children is likely to be effective in the prevention of DM2, especially if the parents are involved.



3.3.3 Vegetables

Vegetables are generally accepted as healthy food because they contain fibers, vitamins, potassium, folate, and antioxidants, but little to no saturated fats and sugar (Van Duyn & Pivonka, 2000). In the FitGaaf! program, consumption of 250 grams of vegetables is recommended. The protective effects of vegetable consumption on cardiovascular disease (CVD) have been shown in several studies (Hartley et al., 2013). However, the role of vegetables in the prevention of overweight is less extensively studied.

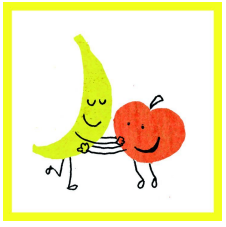
Most studies that look at the association between vegetable consumption and metabolic parameters are performed on obese individuals, not on lean individuals. Several of these studies found an association between the intake of nutrient-rich vegetables and the metabolic profile of obese children. Consumption of more nutrient-rich vegetables decreased visceral fat, liver fat, and risk factors for DM2, even when consumed in small amounts (Cook et al. 2014). The only found study that looked at the effects of vegetable intake on the risk of becoming overweight was a study on middle-aged and older women. This study found no link between vegetable consumption and the risk of becoming overweight or obese (Rautiainen et al., 2015). This indicates that vegetable consumption might not protect against overweight in individuals with normal metabolic parameters, but has a health promoting effect once metabolic parameters are abnormal. However, much more research is needed, also on children, before the protective effects of vegetables on overweight can be either confirmed or declined.

It is important to keep in mind that stimulating a certain lifestyle behavior can have two goals; achieving a protective effect on health and learning a healthy behavior. According to current (limited) research, vegetable consumption will not protect against overweight (Rautiainen et al., 2015), but if a person gets overweight, he or she will benefit from a diet with plenty of vegetables (Cook et al., 2014). If eating vegetables becomes a habit at young age, this can have a positive health impact later in life.

The role of vegetable consumption in DM2 has been studied more frequently, mainly in epidemiological studies. Some studies found an inverse association between the intake of vegetables and risk of DM2 (Cooper et al., 2012; Montonen et al., 2005), others don't find an association (Kurotani et al., 2013). A large recent meta-analysis found no association between total vegetable intake and DM2 risk, but they did find an association between the intake of green leafy vegetables, yellow vegetables, cruciferous vegetables (figure 20) and vegetable fiber and DM2 risk. This is an indication that the type of vegetable matters. Despite the growing body of epidemiological evidence for the role that vegetables can have in the prevention of DM2, no study has aimed to identify the mechanisms behind this association yet (Wang et al., 2016).

Fig. 20) Examples of cruciferous vegetables. Source: http://www.diagnosisdiet.com/is-broccoli-good-for-you/

Although the protective effects of vegetables on overweight are uncertain, an association between certain types of vegetables and DM2 has been shown repeatedly. Also, the positive effects of vegetable consumption on metabolic parameters in overweight individuals have been identified in several studies. Therefore, the vegetable sticker in the FitGaaf! program suits the goal of preventing DM2. For children that are overweight or have an increased risk of becoming overweight, the urgency for the stimulation of vegetable intake is even bigger. If the FitGaaf! program is used to teach overweight children about a healthy lifestyle, the vegetable sticker should get some extra emphasis. In addition, there needs to be more emphasis on the consumption of green leafy vegetables, yellow vegetables and cruciferous vegetables in particular.



3.3.4 Fruits

Fruits are in some aspects rather similar to vegetables. Just like vegetables, fruits contain fibers, vitamins and several minerals that are important components of a balanced diet. The most obvious difference is the much higher simple sugar content of fruits (Van Duyn & Pivonka, 2000). Overconsumption of simple sugars like those found in fruits is known to be one of the major causes obesity (Bosy-Westphal & Müller, 2015). Despite the high simple sugar content in fruits, there is a large body of evidence from epidemiological studies that shows an inverse association between fruit intake and obesity. Rautiainen et al. found a protective effect of fruit consumption on obesity in lean middle-aged and older women (Rautiainen et al., 2015). Several clinical studies in overweight and obese individuals showed that increased fruit consumption led to weight loss (Alinia et al., 2009). Eating too little or too much fruit is associated with an increased risk for overweight. In a 10-year follow-up study, Vioque et al. found that consumption of 80% to 130% of the recommended amount of fruit in Spain (300 grams of fruit) is associated with the lowest risk of obesity (Vioque et al., 2008).

Several different mechanisms have been proposed that contribute to the anti-obesity effects of fruit (Sharma et al., 2016) (figure 21):

- The energy density of fruit is low, because it contains no fat and a lot of water. Replacing energy-dense food with fruit can lead to a negative energy balance.
- Fruit contains a lot of fibers. Fibers are known to delay gastric emptying and prolong the excretion of satiety hormones. For this reason, fruit provides a feeling of satiety for a long time, which can further decrease the total EI.
- Fruit is high in micronutrients like vitamins, calcium, zinc, and iron. Vitamin A, E, and C are inversely associated with obesity. This trait is attributed to the positive effects of these vitamins on leptin resistance and adipogenesis.
- Fruits contain phytochemicals. These are molecules that plants produce to protect themselves against the environment. Phytochemicals are known to have numerous anti-obesity effects including upregulation of lipolysis and adipocyte apoptosis (breakdown) and downregulation of lipogenesis and adipogenesis. In addition, phytochemicals have antioxidant properties and decrease oxidative stress.
- Fruit influences the microbiome composition. The fiber in fruit is known to be able to shift the microbiome composition of an individual to a profile with increased prevalence of *Bacteroidetes* and *Actinobacteria* (dominant in lean individuals) and decreased prevalence of *Firmicutes* and *Proteobacteria* (dominant in obese individuals) (Sharma et al., 2016).

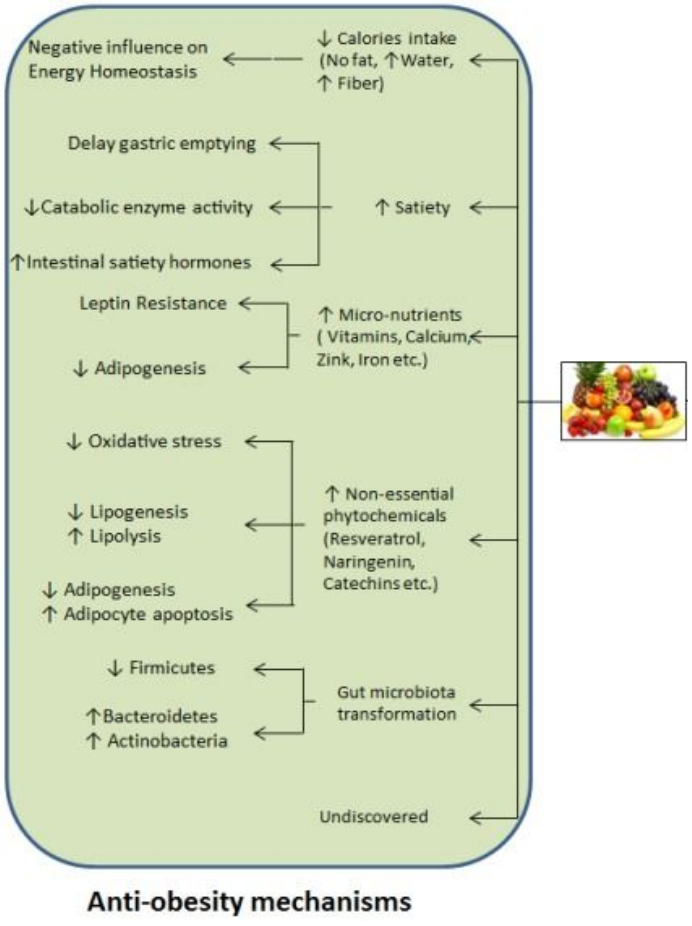
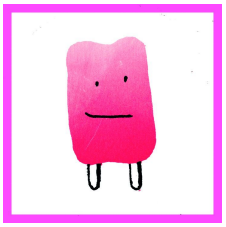


Fig. 21) Anti-obesity mechanisms of fruit. Source: Sharma et al., 2016

Different types of fruits can have very different compositions, so each fruit might influence weight via different mechanisms. Although vegetables are very similar to fruits, their role in weight regulation might differ from that of fruit because of complex interactions between metabolic mechanisms. Also, many more unidentified mechanisms might be involved in the relationship between diet and weight regulation (Sharma et al., 2016).

Just like in vegetables, the link between fruit and DM2 has been found by some (Cooper et al., 2012), but not all (Kurotani et al., 2013) studies. The previously mentioned large meta-analysis by Want et al. concluded that fruit intake is inversely associated with DM2 risk. This association is particularly strong for berries and fruit fiber (Wang et al., 2016).

There is sufficient evidence that fruit consumption is effective in the prevention of overweight and DM2. Therefore, this FitGaaf! sticker is expected to be an effective component of the program.



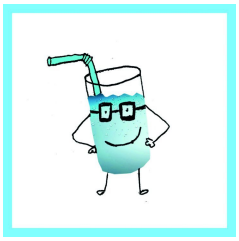
3.3.5 The joker

The joker sticker is different from the other stickers because it is not desired that children use this sticker much. The reason that it is included in the calendar is because it is meant to teach children that it is alright to eat something unhealthy every once in a while, as long as it is not excessive. The sticker is meant to stimulate awareness of the unhealthy behavior and therefore, prevent subconscious snacking. Also, if the joker sticker is already used that day, the child might think twice before eating another snack. The joker sticker is mainly a psychological tool, not a direct health-promoting tool.

An important limitation of the joker sticker is the broad interpretability of this sticker compared to most other stickers. One person might use the joker sticker for a muesli bar where the other uses it for an entire chocolate cake. The difference in fat, sugar and calorie content of these “joker-products” is so big, that it is hard to compare them. Also, each person has a different interpretation of what an unhealthy food item is. One piece of dark chocolate is less healthy than a slice of cucumber but more healthy than a candy bar. Whether you believe it is a joker-worthy snack, depends on your normal diet.

Knowledge of what is healthy and what not is a very important factor in the use of the joker sticker. If a person has sufficient health literacy, this person can use the joker sticker in the way that it is supposed to be used. However, if a person has no idea about what is unhealthy, this person could think that he is eating properly while eating many more “joker-products” than he thinks he does. Also, the sticker might give someone the feeling that it is good to eat unhealthy foods. Therefore, a broadly interpretable sticker like the joker is not very suitable if the FitGaaf! program is used in a population with low health literacy like low SES groups (Furuya et al., 2015). To suit these people, the sticker should be more altered or left out.

Because of the above, is difficult to determine the effect of the joker sticker on DM2. If the sticker prevents subconscious snacking, it will likely have a positive effect on metabolic parameters, including insulin resistance. However, if the sticker is interpreted as a “wildcard” to eat something extremely unhealthy, the damage might be bigger than the benefit. Therefore, the effect of this sticker is uncertain and using it might be risky.



3.3.6 Water

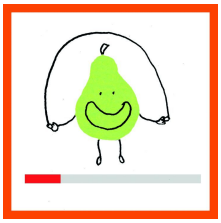
The sticker for water in this lifestyle intervention doesn't have the goal of increasing the fluid intake of children. The body is good at regulating its fluid levels via thirst signals and urinating. If sufficient drinkable liquid is available, dehydration is unlikely to occur. The water sticker has a different goal; replacing unhealthy beverages with water. Therefore this sticker indirectly aims to reduce sugar intake. Of course, this system can only work if drinking more water will also lead to decreased intake of sugary drinks. And to take it one step further, decreased intake of sugary drinks should not be compensated by increased intake of sugary foods.

In a study by DellaValle et al., non-dieting adults were given ad libitum access to food plus a caloric drink or water before the meal. The group that received a caloric drink didn't compensate for the calories of the beverage by eating less (Della Valle et al., 2005). Comparable results were found in a study on preschool children. Drinking milk instead of water during lunch led to increased total calorie intake (Hagg et al., 1998). In other words, drinking water with a meal leads to a lower EI compared to drinking a caloric drink with the meal. This makes the water sticker promising, but in a normal setting, it is uncertain if the water sticker will lead to replacement of caloric drinks for water or adding extra water to the diet. Also, several comparable studies found no effect of water drinking on EI (Birch et al, 1989; Akhavan et al., 2011).

The effects of water intake on EI are not completely clear, but water might also influence the energy balance by having an effect on energy expenditure (EE). Stookey et al. found a higher EE after drinking a caloric beverage (orange juice) compared to the EE after drinking water. However, this increase in EE was smaller than the energy content of the beverage. Netto, a caloric beverage has a positive energy balance, whereas that of water is neutral (Stookey et al., 2012). On the other hand, a different study found an increase in EE in obese boys during exercise after consumption of flavored water compared to 6% glucose solution (Chu et al., 2011). The same results were found by a study of Boschmann et al., who compared water and saline consumption at rest. The authors proposed an explanation for this finding; the low osmolarity of water allows it to enter the cells via osmotic gradients, which causes swelling of the cells and activates the organs (Boschmann et al., 2007). Studies on the influence of water on EE are inconsistent as well, so again, based on literature, the effect of the water sticker on this aspect is difficult to determine.

The effects of water intake on overweight are unclear, but water intake might influence DM2 markers via a different mechanism than weight and energy balance. A study in adults looked at the influence of physical activity and consumption of fruits, vegetables, and beverages on DM2 risk. The authors found a significant negative correlation between water intake and DM2 risk score. However, they did not correct for physical activity and fruit and vegetable consumptions, so to attribute the reduction of DM2 risk to water consumption seems rash (Carroll et al., 2015). A large study by Pan et al. did correct for lifestyle, as well as age and BMI, and didn't find an association between plain-water intake and DM2 risk. However, they did find that replacement of 1 serving of a sugar-sweetened beverage or fruit juice by 1 cup of plain water reduced the risk for DM2 by 7-8% (Pan et al., 2012). This can, however, most likely be attributed to a decrease in sugar intake, not to a direct effect of water on DM2 markers.

Altogether, the literature about the effects of water consumption on DM2 is too inconsistent to either confirm or decline the hypothesis that water consumption decreases DM2 risk. As mentioned before, decreased sugar intake does decrease DM2 risk, but it is uncertain if stimulating water intake via a FitGaaf! sticker will lead to decreased sugar-sweetened beverages intake or if the sticker will only stimulate people to drink extra water on top of their normal beverage consumption. Therefore, the effectiveness of the water sticker remains uncertain at this point.



3.3.7 Moderate intensity exercise

Moderate intensity exercise is defined by FitGaaf! as "exercise that doesn't make you very tired". As examples, cycling, walking and playing outside are mentioned. These activities require about 40-60% of the heart rate reserve. Children are advised to perform moderate intensity exercise for 30 minutes per day. This type of exercise costs energy and is, therefore, part of the total EE. However, physical exercise is only a small part of the total daily energy expenditure (TDEE). About 70% of all energy is used for the basal metabolic rate (BMR). This is the energy that is needed to maintain essential physiological functions, including organ functions and growth. 10% of the energy is used for the thermic effects of feeding (TEF). TEF is the thermogenesis necessary for digestion and metabolic utilization of nutrients. 15% of the energy is used for non-exercise activity thermogenesis (NEAT). NEAT is the energy that is needed for low intensity exercise like standing and sitting up straight. Only 5% of the TDEE is exercise activity thermogenesis (EAT), including moderate intensity exercise and vigorous intensity exercise, which is discussed in the next paragraph (figure 22) (Trexler et al., 2014).

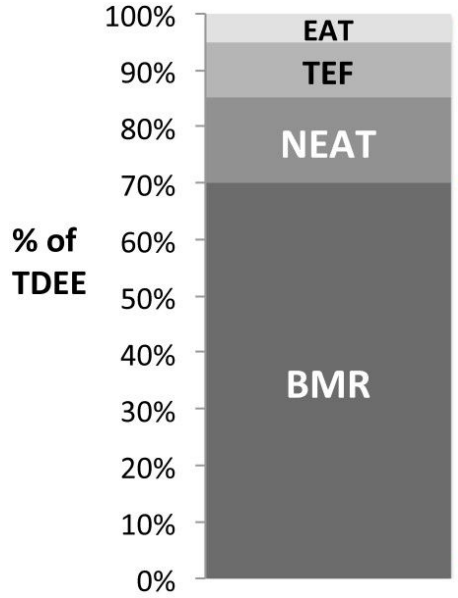


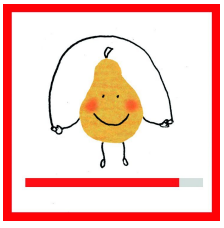
Fig. 22) Division of the total daily energy expenditure (TDEE). Source: Trexler et al., 2014

Although EAT, and therefore moderate intensity exercise, accounts for a small part of the TDEE, it is the part of TDEE that is the easiest to influence. Exercising more leads to an increase in EE and will tilt the energy balance to the side of a negative balance. Therefore, exercising can lead to weight loss or can inhibit weight gain. However, the energy balance can only shift if the increased EE is not compensated with increased EI. A link between moderate intensity exercise and EI has been shown in different studies.

Bouts of moderate intensity exercise caused an increase in the EE, but they didn't lead to an increase in the EI in non-obese children (Thivel et al., 2013; Fearnbach et al., 2016). In adolescents, a decreased EI was observed after moderate intensity exercise (Varley-Campbell et al., 2017). This suggests that there is an interaction between exercise and one of the factors that regulate EI. A study by Masterson et al. looked at the effects of an acute bout of moderate intensity exercise on neural responses to visual food stimuli in children. They found increased activity in the hippocampus and the right temporal medial lobe after presenting a high-calorie food item and decreased activity after presenting a low-calorie food item. This is an indication that there is a close interaction between visual stimuli, reward, and moderate intensity activity. However, based on this study, one would expect an increase in EI after exercise, which is contradictory to the studies mentioned before. To unravel the interaction between moderate intensity exercise and neural processes behind EI, more research is needed (Masterson et al., 2017).

Moderate intensity exercise also has an effect on physical fitness. In adult men with DM2, a 6-month moderate intensity exercise intervention led to a decrease in visceral fat, while the subcutaneous fat volume stayed the same (Jonker et al., 2013). Like mentioned before, less visceral fat is associated with less peripheral insulin resistance (Garg, 2004). Also, a recent study has shown enhanced glycemic control in patients with DM2 after eight weeks of moderate intensity exercise (Dixit et al., 2017). A combination of different types of moderate intensity exercise (aerobic and resistance training) was most effective in improving physical fitness (Taylor et al., 2014).

There is sufficient evidence that moderate intensity exercise can improve physical fitness in healthy individuals and glycemic control in patients with DM2, but no literature could be found about the effects of moderate intensity exercise in non-obese children as prevention of DM2. For overweight children (at risk of DM2) however, stimulating moderate intensity exercise is expected to be an effective method of DM2 prevention.



3.3.8 Vigorous intensity exercise

Just like moderate intensity exercise, vigorous intensity exercise is part of the EAT of the TDEE. The difference is that vigorous intensity exercise requires a larger percentage of the heart rate reserve, usually described as >75%, compared to moderate intensity exercise. Examples of vigorous intensity exercise are running, playing soccer, swimming and jumping rope. In the case of children, physical education (PE) at school is the most important vigorous intensity activity. The FitGaaf! program recommends three moments of one hour of vigorous intensity exercise per week. Therefore, PE class alone is (at most schools) not enough. The main goal of this sticker is to stimulate children to do sports in their free time.

The effects of vigorous intensity exercise are more extensively studied than the effects of moderate intensity exercise. However, the effects on physical fitness seem to be quite similar. In a randomized clinical trial study, both moderate and vigorous intensity exercise improved physical fitness and physical function in patients with DM2. A significant difference was found between the vigorous and moderate intensity groups on the short term (2 months), but not on the long term (6 months) (Taylor et al., 2014). Since lifestyle interventions aim for a long-term change in behavior, both moderate and vigorous intensity exercise can potentially improve physical fitness.

Vigorous intensity exercise has been studied for its effects in the prevention of DM2 to a larger extent than moderate intensity exercise. In adults at risk of DM2, vigorous intensity exercise improved skeletal muscle metabolic control and cardiovascular function more than low intensity exercise and moderate intensity exercise (Rynders & Weltman, 2014). These effects were sustained in the long-term. A follow-up study of a vigorous intensity exercise intervention for adults with impaired glucose tolerance demonstrated a reduction of both cardiovascular and all-cause mortality 23 years after the intervention (Li et al., 2014).

The recommendations for how much vigorous exercise is best for children change quite often. At the moment, the recommendation is to exercise at least one hour a day, either moderate or vigorous (Voedingscentrum, 2017). This is a little different from the advice of FitGaaf!, which distinguishes between moderate and vigorous intensity exercise. However, based on the finding that moderate and vigorous intensity activity have similar long-term effects, the lack of a distinction in the national guidelines is understandable. The national guidelines also claim that more exercise is better (Voedingscentrum, 2017). This is a rather bold statement because several studies have shown excessive ROS production after excessive exercise, which is related to cardiovascular risk and DM2 risk. Although the threshold for too much exercise is quite high, it is important to keep in mind that overactivity might involve the same risks as underactivity (figure 23) (Durand & Gutterman, 2014).

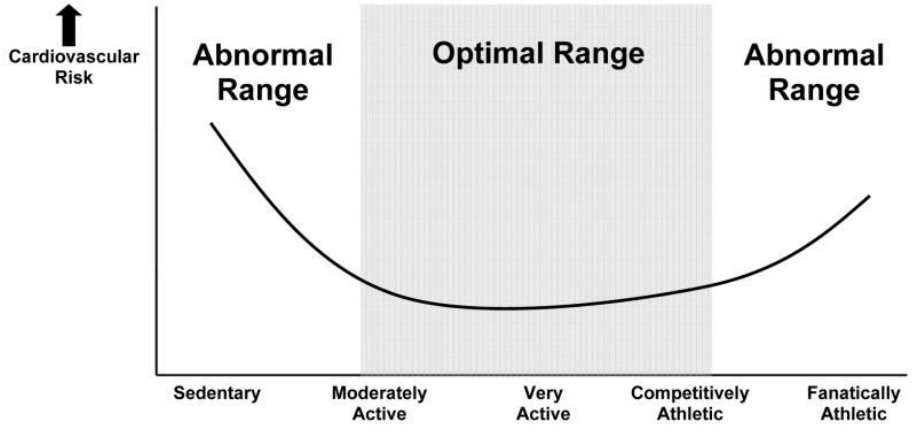
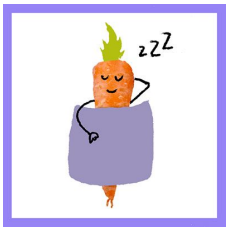


Fig. 23) The degree of vigorous exercise activity in relation to cardiovascular risk. Source: Durand & Gutterman, 2014

Although the direct interaction between exercise, both moderate and vigorous, and DM2 prevention in healthy children isn't studied, a protective effect can be expected. Not only does exercise improve physical fitness (Taylor et al., 2014), it also increases EE without increasing EI sufficiently, leading to weight loss or inhibition of weight gain (Thivel et al., 2013; Fearnbach et al., 2016). Creating the habit of exercising at a young age can also be beneficial later in life. Because of the earlier described link between overweight and DM2, it is reasonable to expect a protective effect of exercise on DM2. Therefore, exercise should be stimulated in a lifestyle intervention like FitGaaf!. For individuals at risk of DM2, exercise should get even more emphasis in the FitGaaf! program.



3.3.9 Sleep

Sleep is not often targeted in lifestyle interventions, even though it can have a large impact on health. Studies showed that sleep duration in children is associated with behavioral problems (both internalizing and externalizing). The association is U-shaped, meaning that there is an optimal sleep duration that causes the least behavioral problems. In this study, sleeping 9-11 hours was optimal for 9-year-old children and sleeping less or more was associated with more behavioral problems. The same pattern was found for self-reported physical wellbeing, also with the optimal situation in the 9-11 hours of sleep range (James & Hale, 2017).

A well-studied topic is the influence of sleep on obesity in children. A large body of evidence shows that shorter sleep duration is related to obesity in adults and children. Most of these studies also found that decreased sleep duration was associated with increased calorie and sugar intake (Wu et al., 2017). Although most studies find similar results, some don't find an association between sleep duration and calorie intake (Hoppe et al., 2013).

Most studies on sleep duration and obesity are observation studies, so causality is yet to be confirmed. Although causality is possible, several non-causal relationships can also be involved. For example, if a child is less active, it might require less sleep. The role of the parents can also have an influence. If parents are less strict in sending their children to bed on time, they might also be less strict when it comes to food and exercising.

One of the few studies that looked deeper into the relationship between sleep, obesity, and DM2 in children is a recent study by Rudnicka et al. In a large group of 9- and 10-year-olds, the authors found a negative correlation between sleep duration and risk-markers for DM2, even after adjustment for physical activity and adiposity (Rudnicka et al., 2017). This is an interesting counterargument for the hypothesis that the association between obesity and sleep can be fully attributed to lifestyle and parental vigilance.

The mechanisms that link sleep duration with DM2 are largely unknown. A study on adults found that 50% sleep deprivation led to increased lipolysis, which caused a decrease in peripheral sensitivity and modulation of hepatic metabolism. Also, cortisol and metanephrine levels were slightly elevated, which is an indication of stress. The authors suggest that increased stress after sleep deprivation is involved in the increase in lipolysis (Rao et al., 2015). This study takes some steps towards unraveling the mechanisms that link sleep to DM2, but much more future research is needed.

Based on these studies, especially the study of Rudnicka et al., one can say that sleep duration and DM2 are related. Other factors are possibly involved in this relationship as well, so causality cannot be concluded at this stage. However, based on the observed negative correlation between sleep duration and DM2 markers after correction for adiposity and physical activity, causality is likely. Therefore, supporting an optimal sleep duration is an important lifestyle intervention in the prevention of DM2 that deserves more attention than it is currently getting.

3.4 Potential addition to the program

The FitGaaf! program is a relatively broad program. Not only does it combine diet and exercise, the program also includes a sticker for sleep, which is uncommon among this kind of programs. Since the broad view of FitGaaf! is one of the factors that makes the program unique, it is useful to evaluate if there are any lifestyle aspects that the program doesn't cover yet. During my research, I noticed that the exercise-aspect of FitGaaf! only tackles EAT, which accounts for just 5% of the total daily energy expenditure. Another part of the total daily energy expenditure that can be influenced by lifestyle is NEAT (non-exercise activity thermogenesis). Therefore, the next part evaluates the potential of addressing NEAT in the FitGaaf! program.

3.4.1 NEAT

At the beginning of this chapter, the main causes of the obesity epidemic in the Netherlands were discussed. The most important cause appeared to be a decrease in physical activity over time, which can be attributed to the decreased necessity to be active in order to do daily activities (Hallal et al., 2012). Figure 22 in chapter 3.3.7. presents the different types of activity that make up the total daily energy expenditure. Most daily activities are part of non-exercise activity thermogenesis, or NEAT. Think of standing, walking, cleaning, cooking, and doing the dishes. Since technology has made daily activities less energy-costly, decreased NEAT is expected to be involved in the increase in the prevalence of obesity. Strangely, lifestyle interventions rarely focus on NEAT. Instead, they focus on EAT, which includes moderate and vigorous intensity exercise.

The role that NEAT can have in the management of obesity has been a topic of interest among researchers for a while now, but the actual translation of the findings into practice is a more recent topic. A mechanism involved in the link between NEAT and obesity was first observed in mice. Researchers found that the hypothalamus and extrahypothalamic nuclei in the brain are potentially involved in the regulation of NEAT, with orexin being the most well-established neuromodulator (Kotz et al., 2008). A study in rats found that blocking the activity of orexin with orexin antagonists led to decreased spontaneous activity and increased weight gain (Kiwaki et al., 2004). A study by Levine et al. demonstrated the link between fat mass and NEAT. Compared to lean individuals, obese individuals performed less spontaneous activity and were seated for a longer time. If they would adopt the same NEAT levels as lean individuals, they would burn an extra 350 calories per day (Levine et al., 2005).

NEAT seems to be an interesting target for obesity prevention and some promising findings indicate that it also plays a role in DM2. In Japanese patients with DM2, increased NEAT was correlated with increased insulin sensitivity, increased HDL levels and decreased blood

pressure (Hamasaki et al., 2013). One study compared the impact of EAT on metabolic parameters with the impact of NEAT on metabolic parameters. Healthy individuals were told to sit for a prolonged time, perform vigorous intensity exercise or perform minimal intensity activity (NEAT) for the entire duration of the experiment. The total energy expenditure was kept the same in all groups. The NEAT group had significantly improved triglyceride, LDL, and insulin plasma levels compared to the sitting group. Nonsignificant trends for improvement of these metabolic parameters were found compared to the vigorous intensity exercise group (Duvivier et al., 2013).

Since NEAT appears to be a very promising lifestyle target in the prevention of obesity and DM2, it could be a good addition to the FitGaaf! program. NEAT activities are very diverse, because they include all low-intensity activities. In case FitGaaf! wants to implement a NEAT sticker, care should be taken to be specific enough.

3.5 Conclusions

The increased prevalence of overweight has a lot to do with lifestyle. Food is readily available, the need for physical activity has diminished and cultural factors influence our behavior. Altogether, this leads to weight gain and related complications like DM2. Aiming to improve a person's lifestyle, especially at a young age, seems to be the way to prevent obesity and DM2. According to literature, most components of the lifestyle that FitGaaf! recommends are promising tools for the prevention of DM2. Especially the breakfast sticker and the sleep sticker are relatively uncommon lifestyle interventions that are expected to have a large impact on health. The effects of the water sticker are more difficult to predict because of the broad interpretability of the sticker and conflicting results in literature. The effects of the joker sticker are also uncertain because it is difficult to predict how people interpret it and if they understand it correctly. An interesting option for an additional sticker is one that targets NEAT. This new approach seems promising based on literature and can potentially further improve the effectiveness of the FitGaaf! program.

Chapter 4

Participation and parental involvement

This chapter discusses participation rates and how they can be improved. First, the role of reward and punishment in motivation is evaluated based on neurobiological literature, followed by actual data of the participation and motivation in the Hoogeveen project. Afterwards, the role of parental involvement and several factors that influence participation independent of motivation are evaluated. This chapter aims to find and answer to sub-question 3: *How can participation in the program be further improved?*

4.1 Motivation and participation

4.1.1 Effectiveness as a broader term

The effectiveness of the FitGaaf! program has previously been described as the degree to which the contents of the program can prevent obesity and diabetes mellitus type 2. Although this is a very important first step, it is not the complete story. Another crucial aspect of effectiveness is the degree to which participants comply with the program. Without sufficient participation, the aimed effect will not be reached, despite the fact that the program itself might be good. Therefore, participation is an important aspect to address as well.

4.1.2 What leads to participation?

There are a ton of different reasons for children and their parents to choose to actively participate in the FitGaaf! program or not. However, it can all be led back to one term; motivation. Someone can be motivated to participate or decide not to participate. Each person weighs the benefits and disadvantages of each choice, but eventually, the choice will go to the option that provides the most reward and the least punishment. Reward and punishments are well understood neurobiological processes, in which the neurotransmitter *dopamine* plays a key role.

4.1.3 Neurobiology of the reward system

As we all know from our own experience, being rewarded feels good an motivates to continue doing what you were rewarded for. Despite the seemingly simple link, there are several complex neural processes underlying reward. The parts of the brain that are involved in reward are called the *reward system*, of which the *mesocorticolimbic circuit* is the most important and well-studied part. The mesocorticolimbic circuit is an umbrella term for two interacting neural pathways; the *mesolimbic dopaminergic pathway* and the *mesocortical dopaminergic pathway*. These pathways are activated when a person experiences something rewarding (Bear et al., 2007a).

Activation of pathways in the brain is guided by *neurotransmitters*. Neurotransmitters are small molecules that can signal between neurons and activate or inhibit brain areas by binding to a receptor. When a neuron gets activated, an *action potential* will travel over the neuron. Action potentials are electrical charges that temporarily change the charge of parts of the neuron. When this action potential reaches the end of the neuron's axon, it can not directly evoke an action potential in nearby neurons. Instead, it will reach the presynaptic side of so-called *synapses*. Neurotransmitters which are stored in vesicles in the presynaptic neuron will get released as a response to the action potential. The neurotransmitters will travel through the synaptic cleft, which is the "gap" between the two neurons. Once the neurotransmitters reach the postsynaptic neuron, they will bind to receptors, which activates the neuron. This activated neuron can then activate other neurons in the same way (figure 24) (Bear et al., 2007b).

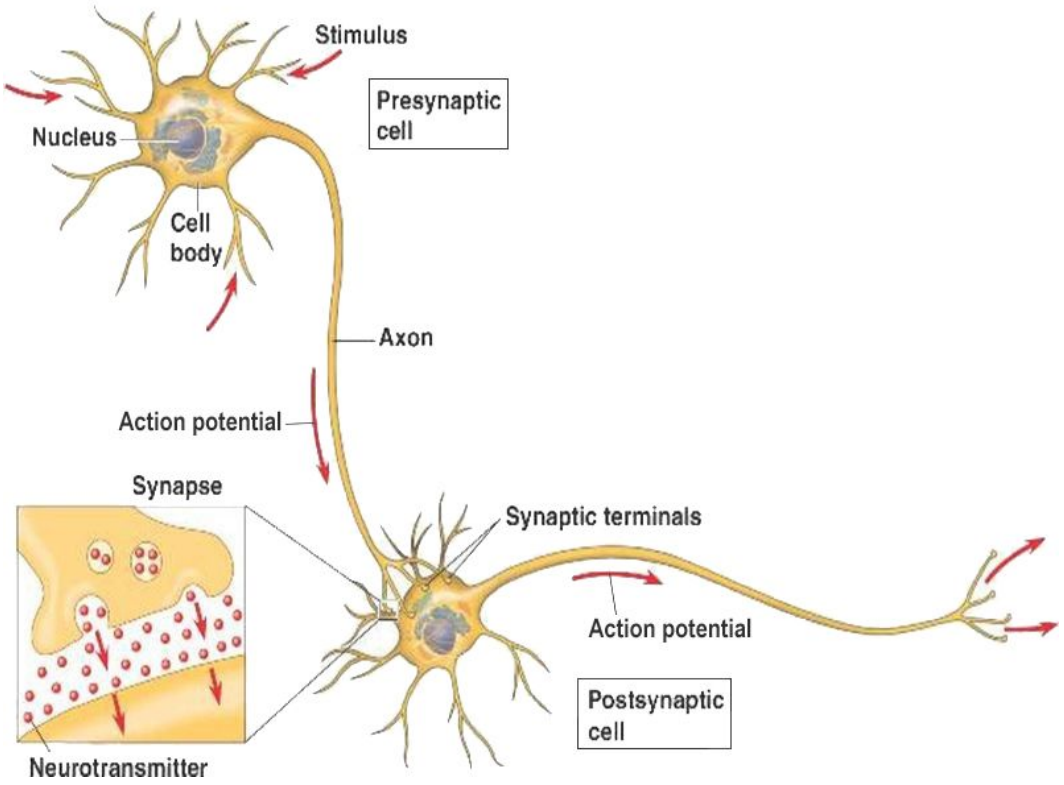
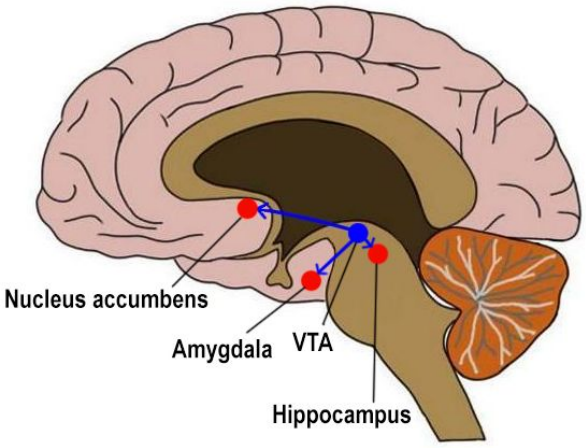


Fig. 24) Signal transduction from neuron to neuron. An action potential reaches the synapse and neurotransmitters are released. This evokes a new action potential in the postsynaptic neuron. Source: http://my-dementia.co.uk/What%20it%20is.html (modified)

In the mesolimbic dopaminergic system, signals travel from the *ventral tegmental area* (VTA) to the *nucleus accumbens*, *amygdala*, and *hippocampus*. When a person experiences reward, the VTA will produce the neurotransmitter dopamine en send it to these brain areas, causing the dopamine levels to rise. This leads to activation of the nucleus accumbens, the brain area involved in motor function, the amygdala, the brain area involved in emotions, and the hippocampus, the brain area involved in learning (figure 25). The mesocortical dopaminergic system works in a comparable way but involves different brain areas. In this system, reward stimulates the VTA and the VTA sends dopamine to the *prefrontal cortex*, the brain area involved in attention (figure 26) (Bear et al., 2007b).



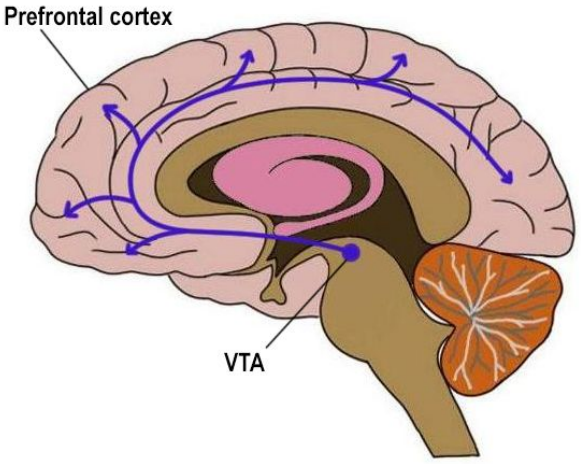


Fig. 25) The mesolimbic dopaminergic system. Source: https://www.neuroscientificallychallenged.com/glossary/mesolimbic-pathway/ (modified)	*Fig. 26) The mesocortical dopaminergic system. Source: https://www.neuroscientificallychallenged.com/glossary/mesocortical-pathway/ (modified)*

The role of dopamine in reward can be visualized in a classical experiment; the Skinner box. A rat is placed in a box with a lever. If the animal pushes the lever, its brain gets stimulated to release dopamine. Once the rat learns this association, it will repeatedly press the lever to receive brain stimulation. This shows the rewarding properties of dopamine (Bear et al., 2007b). It was believed for many years that dopamine release in the forebrain is related to pleasure, but this idea has been challenged in the last couple of years. When the dopaminergic neurons in the hypothalamus of rats are destroyed, the animals will still show signs of liking when they eat palatable food. However, they will stop actively seeking for palatable food. In other words, dopamine seems to be involved in *wanting* rather than *liking* (Kelley & Berridge, 2002).

Another neurotransmitter that is involved in the reward system is *serotonin*. Serotonin levels are strongly associated with mood; high levels cause feelings of joy, whereas low levels are associated with depression. When the reward system is activated, serotonin levels go up. In anticipation of reward, the serotonin level will start rising, but the level peaks during the actual reception of the reward. After this, serotonin will go down again. The brain is always trying to maintain a certain balance. Therefore, if the reward system gets activated constantly, the brain will eventually decrease its baseline serotonin level. The individual will crave for reward in order to improve his mood. This is the basis of drug addiction, but it is also the reason why you crave unhealthy food if you are used to eating a lot of it. Therefore, the role of serotonin in reward should not be underestimated (Kelley & Berridge, 2002).

More recent studies have also shown the involvement of the *neostriatum* in reward, specifically in overeating. Eating leads to a release of the natural opioid *enkephalin* in the neostriatum, which increases the motivation to eat, despite the discomfort of a full stomach (DiFeliceantonio et al., 2012).

The reward system is connected to memory and behavior. If a certain behavior gives you a positive feeling, you will be more likely to repeat this behavior in the future. For example, if you have eaten a hamburger and you liked it, you are more likely to choose a hamburger in the future. Anticipation to this hamburger can already activate the reward system. As a consequence, it can be difficult to say no to a hamburger once you've thought about eating one (Bear et al., 2007b). Sugar and fat in food lead to a strong activation of the reward system (Davis et al., 2008; Delaere et al., 2013). This explains why the foods that you can crave are usually unhealthy products. Food is not the only factor that can activate the reward system. Feelings of joy, pride, and appreciation can also be rewarding, which will enforce the behavior that caused this joy in the first place.

In the case of FitGaaf! there is a battle between different rewarding behaviors. Each individual has to choose, for example, between the joy of eating candy versus the joy of pasting a sticker for eating vegetables. A child is more likely to choose the healthy option if this option provides the biggest reward. Therefore, it is interesting to determine how the reward of participation in the FitGaaf! program can be increased. Some examples of added reward are compliments of the parents and teachers, making the child aware of its good behavior and rewarding long-term participation with an extra reward. Parents generally know best what works for their children, so to reach optimal participation rates, parents should be informed about the influence of reward and their roles in this.

4.1.4 Neurobiology of punishment

Reward is a very important factor of motivation, but punishment can also have a big impact on motivation. Punishing has an opposite effect of reward; behavior that causes negative feelings is less likely to be repeated in the future. Just like in reward, the neurotransmitter dopamine is involved in punishment. The mesocorticolimbic system has two different pathways, a *direct* and an *indirect pathway*. These contain different types of dopamine receptors, D1 and D2 respectively. When dopamine binds to a D1 receptor, a *long-term potentiation* (LTP) is induced, which activates the circuit and leads to reward seeking. However, activation of the D2 receptors causes a *long-term depression* (LTD), causing immobility and depressive-like behavior (figure 27). This is what happens when you experience something unpleasant (Seymour et al., 2007). So dopamine can induce both reward and punishment, depending on which receptor it binds to.

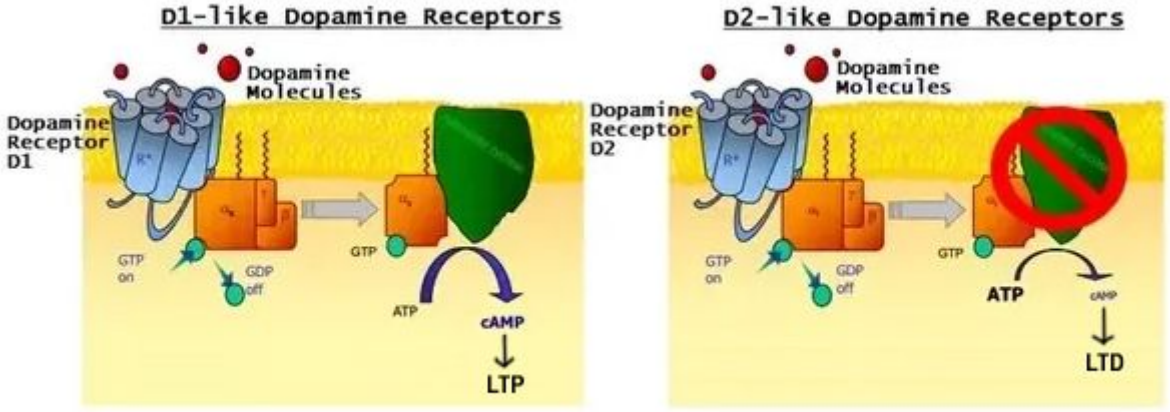


Fig. 27) Different mechanisms of dopamine binding to D1 and D2 receptors. Activation of the D1 receptor leads to a long-term potentiation, activation of the D2 receptor leads to a long-term depression. Source: https://www.quora.com/How-are-D1-dopamine-receptors-different-from-D2-receptors

Punishment can come in different shapes and sizes, varying from being physically punished by another to feeling bad about yourself because of something you did. Often, an individual will associate a certain behavior, person or environment with the aversive outcomes, which will lead to avoidance. This type of associative learning is guided by an amygdala-based brain circuit. The aversive outcomes may input to the amygdala directly from different brain areas (Seymour et al., 2007). The neurobiology behind punishment is less well-understood than the reward system, but it is clear that the same type of learning is involved in both systems.

In the FitGaaf! program, the emphasis is on reward, not punishment. However, feelings of punishment might still be experienced in participation and in non-compliance. If a child actively participates in the program, he or she will probably eat less unhealthy (rewarding) food. Being depleted of a reward is unpleasant and might be perceived as punishment. Also, trying new food might feel as punishment if the child doesn't like the taste. Although these feelings of punishment can decrease participation, there are also feelings of punishment involved that stimulate participation. Being too heavy to be able to play along with others can feel as punishment, as well as not being allowed to paste as many stickers as classmates because of less active participation. If a child feels punished for its unhealthy lifestyle, it might develop a negative association with it and look for alternatives, like what is offered by FitGaaf!.

4.1.5 Reward versus punishment

It is an age-old discussion; should children be punished for what they do wrong or should they be rewarded for what they do right? Parent think differently about this subject and choose the parenting style that they believe in. However, when you compare current parenting methods in the Netherlands with those of 50 years ago, there appears to be a shift from punishment-based teaching to reward-based teaching (Theunnissen et al., 2015). Is this new parenting style a consequence of the assumption that parents are getting softer or is there actually a benefit to reward-based teaching?

Several animal studies have looked at the difference between reward-based learning and punishment-based learning. In a study by Kravitz et al., mice were reinforced or punished via a technique called *optogenetics*. In this technique, the neurons of the direct and indirect dopamine pathways are activated with light. This way, activation is independent of dopamine. In an operant task (box with a lever) and a place preference task, mice were either rewarded or punished for a certain behavior. The mice that were rewarded learned quicker and showed a stronger response to a stimulus compared to the punished mice. Also, when the reward or punishment was taken away, the rewarded mice continued the learned behavior for a much longer time than the punished mice. This study showed that stimulation of the reward pathway facilitated better learning than stimulation of the punishment pathway (Kravtiz et al., 2012).

In young children, reward also seems to be more effective than punishment. In a study by van Duijvenvoorde et al., 8-to-9-year-old children were exposed to punishment and reward in a computer game while in an MRI scanner. Their brains responded strongly to reward but barely responded to punishment. Interestingly, the opposite was true for 18-to-25-year-old adults; they had a strong response to punishment and a weak response to reward. The study also evaluated a third group of 11-to-13-year-old children. At this age, the response to punishment was slightly bigger than the response to reward, but the difference wasn't as strong as in adults, suggesting that the transition occurs around this age. What exactly causes this switch in brain activity during development remains unclear (van Duijvenvoorde et al., 2008). Several studies have looked at reward and punishment in learning from a psychological perspective. Kelishadroky et al. argue that punishment should be avoided because it is a less effective learning method. Reinforcement leads to repetition of the behavior, leading to more reinforcement. This positive feedback loop can facilitate strong learning. Punishment, on the other hand, causes a person to stop a certain behavior to avoid further punishment. If this punishment is taken away, the behavior will likely recur, because there are no negative consequences anymore. A person will not have learned that a certain behavior is bad, but rather, will have learned how to avoid the punishment (Kelishadroky et al., 2016).

Altogether, reward seems to be the better option when it comes to teaching children. FitGaaf! fits this approach well since the calendar is mainly based on reward. The joker sticker is a little ambiguous because the FitGaaf! program says to use this sticker as little as possible. Using it supposed to feel as punishment, although it is uncertain if children will interpret it like this. Like previously mentioned, young children don't learn much from punishment, so the effectiveness of the joker sticker as punishment is questionable. Also, there is a chance that children are reinforced by pasting the sticker, which will reinforce snacking. To prevent undesirable consequences and confusion, it might be better to skip or alter the joker sticker and focus solely on reward in the FitGaaf! program. Besides this, it is important to teach parents about the positive effects of reward, especially in low SES areas, where punishment-based learning is more common than in high SES areas (Theunnissen et al., 2015).

4.1.6 Intrinsic and extrinsic motivation

So far, this chapter has discussed the role of reward and punishment in participation and learning, but when it comes to motivation to participate in the program, there is an important additional aspect to discuss. A child can be motivated to participate for different reasons. If

the child participates to receive an external reward or avoid an external punishment, this is called *extrinsic motivation*. The most obvious example is the reward that children get for pasting a sticker (appraisal, compliments, rewards). However, the goal of FitGaaf! is to make children *intrinsically motivated* to live a more healthy lifestyle. This provides a more personal reward, like being more fit, having more energy and feeling more confident (figure 28). Intrinsic motivation to live a healthy lifestyle can provide a long-term personal reward, unlike the external reward for pasting stickers for four weeks. Therefore, a key question in determining the effectiveness of FitGaaf! is whether or not the step from extrinsic to intrinsic motivation can be made.

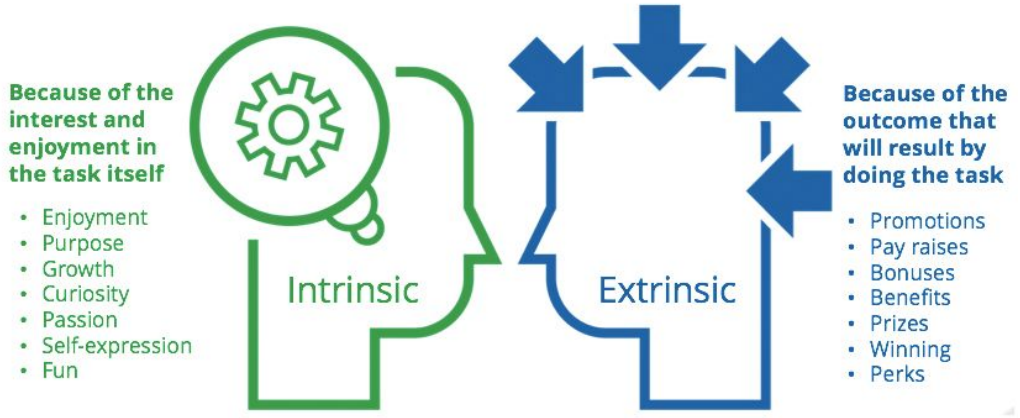


Fig. 28) The outcomes of intrinsic versus extrinsic motivation. Source: https://www.limeade.com/2017/10/watch-webinar-on-demand-the-power-of-intrinsic-motivation

Intrinsic motivation is usually harder to evoke than extrinsic motivation. In order to become intrinsically motivated to perform a certain behavior, a person needs to 1) realize that there is a personal reward to gain and 2) realize that the behavior can provide this personal reward. A young child will likely only experience issues related to an unhealthy lifestyle if the lifestyle has caused severe overweight. If not, the child will likely not see the need to live more healthily and won't be intrinsically motivated to participate in the FitGaaf! program. In practice, this means that directly invoking intrinsic motivation in primary and secondary prevention is very difficult. For this reason, FitGaaf! uses external rewards to stimulate extrinsic motivation first. If the children participate because they like the external reward for pasting stickers, they might also experience the effects that a healthy lifestyle has on their mood, energy, and confidence. By letting children experience first-hand that there is room for improvement in their lifestyles, they might become intrinsically motivated to maintain this lifestyle. This way, extrinsic motivation is used as a tool to evoke intrinsic motivation.

There has been a lot of debate about whether extrinsic motivation is aiding or eroding intrinsic motivation. Cerasoli et al. did a meta-analysis of 40 years of research regarding the link between intrinsic motivation, external incentives, and performance. Intrinsic motivation was found to be a medium-to-strong predictor for performance, independent of the presence of extrinsic motivation caused by external incentives. However, the predictive value of intrinsic motivation on performance was stronger if the external incentives were indirectly tied to performance compared to when they were directly tied to performance. This means

that the external reward and the intrinsic reward should not be obtained from the exact same behavior (Cerasoli et al., 2014). Based on this study, FitGaaf! seems to use external reward the right way. The extrinsic motivation to participate is sparked by being rewarded for pasting stickers. The intrinsic motivation to participate is promoted by feeling more fit and healthy, which is the indirect consequence of participation. Therefore, the extrinsic motivation should not obstruct the effects of intrinsic motivation in the FitGaaf! program. Continued use of the sticker system to promote intrinsic motivation is therefore recommended.

On a critical note, it is uncertain if children will develop intrinsic motivation to live more healthily after getting extrinsically motivated to participate in the FitGaaf! program. The induction of intrinsic motivation is based on feeling more healthy and having more energy. Whether these effects will already be noticeable after four weeks is unclear and will differ from person to person. Because of the broad interpretability of the stickers, the individual differences in baseline health/lifestyle, and the degree of active participation, no child will experience the same effects. Besides this, there is also the possibility of a placebo effect, which will be present for some, but not all, children. Because of this, it will remain uncertain if FitGaaf! can spark intrinsic motivation. However, based on literature, it should be possible.

4.1.7 Improving motivation for more effect

It is clear that motivation is a key element in participation and reaching the ultimate goal; improving the health of children. Reward and punishment are important tools that can increase or decrease motivation. Theoretically, the approach of FitGaaf! (reward-based and indirectly tied to the effects of the program) seems to be very suitable to evoke extrinsic and intrinsic motivation. However, if the participation rates in practice are low, there is a need for additional effort to improve motivation. In order to determine the participation rates, a research was conducted during one of the FitGaaf! projects in Hoogeveen. The results are discussed in the next paragraph.

4.2 The Hoogeveen project

4.2.1 Methods

From January 29th to February 23rd, a total of 301 children from three elementary schools in the Dutch city Hoogeveen were offered a chance to participate in a four-week FitGaaf! project. FitGaaf! visited the schools, de Sprong, Juliana van Stolbergschool and het Palet at the start of the project to introduce the calendars and kick off the projects with a small event. The children started pasting the stickers on Monday the 29th of January and continued doing so until the 23rd of February, which is a total duration of little under four weeks. For this internship, I was allowed to conduct a small research during the Hoogeveen project. The goal was to get an idea about participation rates and the effect of FitGaaf! on self-proclaimed fitness. Some limitations had to be taken into account: The research could not make the program less fun, biometric data could not be obtained and the opening and closing days were the only days during which data could be gathered. Due to these limitations, a simple method was chosen that could give some indications about the effectiveness and participation without sacrificing the fun.

Group 1 and 2 were not included in this research, because these children were too young to be able to understand the questions properly.
Group 3 and 4 were evaluated by means of a game after the FitGaaf! program. We put 4 gym mats on the floor, each representing an answer. Nine questions were asked (appendix 4). For each question, the child was supposed to skip to the gym mat of their choice. The number of children at each mat was counted for each question. Children that chose not to go to a mat were not included in the results.
Group 5, 6, 7, and 8 were evaluated differently. At the start of the FitGaaf! project, the children were told a scenario story about having to run to school to be able to get there on time. The children were asked to imagine that this happened to them and were asked how tired they would feel afterward. The child could choose from 5 options; not tired at all, a little tired, tired, very tired and severely tired. At the end of the FitGaaf! project, the same question was asked again. The difference between the scores before and after the FitGaaf! project was used as an indication of self-proclaimed fitness. Besides that, the children were also asked to rate the program, note how many weeks they participated, and note how many weeks their parents participated (appendix 5).

After the Hoogeveen project, the data were digitized and analyzed. A student T-test was used to evaluate the difference in the self-proclaimed fitness before and after (α=0,05).

4.2.2 Results

The data from group 5, 6, 7, and 8 were often incomplete because children forgot to fill in questions or because they were absent at either the opening or the closing day. The number of usable data points for group 5, 6, 7, and 8 of each school in each category is presented in table 6.

Table 6) Number of data points from group 5, 6, 7, and 8 of de Sprong, Juliana van Stolbergschool, and het Palet during the FitGaaf! Hoogeveen project

	De Sprong	Juliana van Stolbergschool	Het Palet	All schools
Participation duration (child)	n=155	n=59	n=33	n=247
Participation duration (parent)	n=155	n=59	n=33	n=247
Difference in self-proclaimed fitness	n=147	n=59	n=32	n=238
Rating of FitGaaf!	n=154	n=71	n=33	n=258

Participation

Out of the 247 children who answered the question about their participation duration, 179 participated in the FitGaaf! program by pasting stickers for one or more weeks. This is a participation rate of 75%. 99 parents participated along with their children, giving a parental participation rate of 43%. When a distinction is made between the different durations of participating, 44% of the children participated for 3-4 weeks, 31% participated for 1-2 weeks and the remaining 25% didn't participate. The participation rates of the children didn't differ much between the groups, but the participation rates of the parents decreased with the age of their children (figure 29). The participation results of the individual schools can be found in appendix 6.

Self-proclaimed fitness

50% of the children claimed to feel more fit after the FitGaaf! program. The change in fitness was determined by subtracting the self-proclaimed fitness score before the project from the score after the project. A positive value represents an improvement in fitness and a negative value represents a decrease in fitness. Overall, the average self-proclaimed fitness score decreased significantly from 2,15 to 1,93 (p=0,010), indicating an improvement in fitness. In the group that participated in the FitGaaf! program, a decrease from 2,31 to 1,88 was found, although this was not significant (p=0,187). The score of the group that didn't participate increased from 1,83 to 2,04 (p=0,870), suggesting a decrease in fitness, but these results were also not significant.

Age didn't influence the observed change in self-proclaimed fitness much (figure 29). The self-proclaimed fitness results of the individual schools can be found in appendix 6.

Rating

The children rated the FitGaaf! program a 2,7 out of 4. The rating doesn't differ much between the groups (figure 29). The ratings of the individual schools can be found in appendix 6.

Hoogeveen project 2018	Group 3/4	Group 5	Group 6	Group 7	Group 8	Average
Participation percentage children	79%	85%	70%	73%	61%	**75%**
Participation percentage parents	47%	54%	45%	27%	29%	**43%**
3-4 weeks participated	54%	49%	36%	42%	22%	**44%**
1-2 weeks participated	25%	36%	34%	31%	39%	**31%**
0 weeks participated	21%	15%	30%	27%	39%	**25%**
Percentage of children stating to feel more fit after FitGaaf!	62%	43%	41%	37%	49%	**50%**
Percentage of children stating to feel as fit after FitGaaf!	21%	39%	39%	51%	41%	**33%**
Percentage of children stating to feel less fit after FitGaaf!	17%	18%	20%	12%	10%	**17%**
Avg. difference in self-proclaimed fitness, 3-4 weeks participated*	-	0,2	0,7	0,2	0,4	**0,4**
Avg. difference in self-proclaimed fitness, 1-2 weeks participated*	-	0,5	0,4	0,3	0,7	**0,5**
Avg. difference in self-proclaimed fitness, 0 weeks participated*	-	-0,9	-0,4	0,5	-0,2	**-0,3**
Avg. rating FitGaaf!**	2,7	2,9	2,8	2,8	2,5	**2,7**

*Fig. 29) Overview of the results of the Hoogeveen project at the Sprong (n=181), Juliana van Stolbergschool (n=75) & het Palet (n=45). Complete datasets are available upon request. *: 1=not tired at all, 2=a little tired, 3=tired, 4=very tired, 5= severely tired. A positive value means an improvement, a negative value means a decline in self-proclaimed fitness after FitGaaf!. **: 1=not fun at all, 2=not fun, 3=fun, 4=a lot of fun.*

4.2.3 Conclusions

Altogether, the participation rates of the children and parents are quite high at 75% and 43% respectively. Some children didn't fill in the question about participation on the form, which could mean that they didn't participate or didn't understand the question correctly. Therefore, the actual percentages might differ slightly from the ones presented here.
The self-proclaimed fitness level is a very subjective measurement of fitness. Not only can each child interpret the question slightly differently, they might also choose answers that they think are the right answers or that their friends chose. Therefore, the improved self-proclaimed fitness in the entire group can merely be seen as an indication of effectiveness. Biometric data is needed to examine whether the actual fineness of these children is affected by the FitGaaf! program.
The average rating indicates that the children liked working with the FitGaaf! program. The program is meant to be fun, but children are also supposed to learn something. Based on this rating, FitGaaf! seems to balance fun and education properly, but again, it is uncertain if children gave their true opinion or were influenced by others.

To summarize, it is difficult to draw strong conclusions from the Hoogeveen data, but the results indicate a positive effect of the FitGaaf! program on self-proclaimed fitness, high participation rates and a decent rating.

4.3 Parental involvement

4.3.1 The "second target group"

Despite the fact that the participation rates of the FitGaaf! program are already relatively high, there is always room for further improvement. So far, this chapter has mainly focussed on children. Of course, this is the main target group, but children at this age are still very dependent on their parents. Besides this, the parents are their main role models. Therefore, the parents play a key role in participation and effectiveness and are an important second target group for FitGaaf!.

4.3.2 The role of the parents in lifestyle interventions

Like the name says, lifestyle interventions target the day-to-day activities of a child. Especially in young children, these day-to-day activities are strongly regulated by the parents via rules and supervision. Besides this, the parent is the one who buys food and toys and who ultimately decides if a child can, for example, join a sports club. If a child is motivated to participate in a lifestyle intervention but the parent isn't, it will be nearly impossible for the child to participate. Therefore, it is of importance to motivate the parents to support participation.

Besides the fact that the parents have a strong influence on what the child is allowed and able to do, they also play an important role in motivating the child. Preschool children tend to copy the behavior and opinions of their parents. If a parent tells the child that a lifestyle intervention is boring, useless or too difficult, the child will likely copy the opinion of the parent and decide not to participate. If, on the other hand, the parent is enthusiastic, the child is more likely to be so as well (Nauert, 2015). Several studies looked at the relation between parental involvement and the degree of participation in a lifestyle intervention. Jørgensen et al. did a study on 13-year-old children in a intervention program that provides free fruits and

vegetables at school. Children whose parents were medium-involved consumed 47,5 grams more fruits and vegetables at follow-up compared to children whose parents were low-involved. High parental involvement led to an increase in fruit and vegetable intake of 95,2 grams at follow-up. This supports the role of parents in the motivation to participate (Jørgensen et al., 2016). Although a lot of studies find a positive correlation between parental involvement and participation of the child, there are also some studies that don't find a correlation. Many papers don't describe the dose, strategy and content of parental involvement, which makes it difficult to draw conclusions and compare studies. Also, there are few studies that compare interventions with and without a parental component (Van Lippevelde et al., 2012). There is a need for more high quality research regarding this topic. The Dutch RIVM published a report in 2014 that contained recommendations about parental involvement in lifestyle interventions. This report also states that there is limited scientific support for the claim that interventions with a parental component are better than those without a parental component. However, the report concludes that interventions with parental involvement are effective in improving lifestyle. The knowledge, attitude and upbringing skills of the parents are mentioned as important elements that influence the behavior of a child. The RIVM advices policymakers and intervention developers to incorporate a parental component in lifestyle interventions for children (RIVM, 2014).

4.3.3 Parental involvement in Dutch interventions

According to the 2014 RIVM report, about half of the lifestyle interventions in the Netherlands that focus on primary school children involve the parents. The degree and type of involvement differ between them. The most common type of parental involvement is parent meetings and activities. 70% of all interventions that have some type of parental involvement organize these kinds of meetings. Other common types of parental involvement are being informed about the intervention (27%), actively participating in the intervention (24%) and making child-parent homework assignments (18%). Some other, less common, types of involvement are personal meetings with the parents, online parent platforms and contracts with the parents about (home) rules. The programs use different types of media to involve parents, both online and offline. The most common media are flyers, books, and websites. About half of the interventions that involve parents are executed in a collaboration between schools and third parties (RIVM, 2014).

Despite the fact that half of the interventions acknowledge the advice of the RIVM and incorporate an element of parental involvement, the other half of the interventions doesn't. It seems odd to ignore the people who play such a big role in the life and choices of a child. However, not all prevention programs incorporate elements of motivation and change. Interventions that solely focus on knowledge, for example, probably don't benefit as much from parental involvement as lifestyle interventions. However, there is still room for improvement via parental involvement. Sharing knowledge with not only the child but also the parent can allow for better kitchen table conversations and can make certain topics discussable. For this reason, the RIVM stimulates all kinds of interventions to evaluate the options for incorporation or expansion of parental involvement in the program (RIVM, 2014).

4.3.4 FitGaaf!'s approach to reaching parents

FitGaaf! is an example of an intervention that aims to strongly involve the parents of the children. In fact, parental involvement is a key element of the FitGaaf! program. The calendars are meant for children, but there is also an area on the calendar on which parents

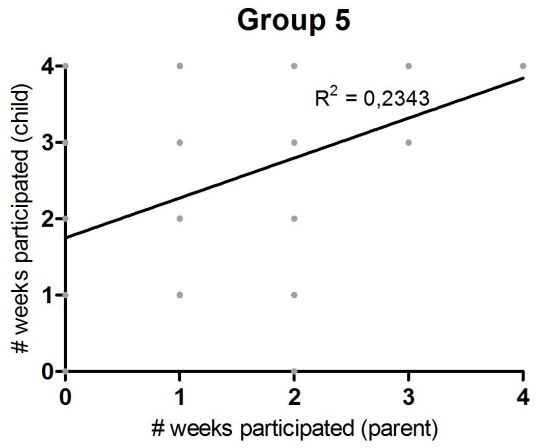
can paste stickers. Therefore, parents can participate together with their children. Besides active participation, parents are also involved via letters, newsletters and parent-child exercises on the calendar. Optionally, parents can find more information about the program and stickers on the website and Facebook page of FitGaaf!.

This method, which is mainly applied in school projects, is not the only method FitGaaf! uses to reach parents. In the current small collaboration with Team050, FitGaaf! organizes parent meetings to inform parents about a healthy lifestyle. In this collaboration, FitGaaf! only provides information. Afterward, parents can decide to participate in the FitGaaf! program with their children if they are interested. In the program itself, there are no parent meetings incorporated. This is striking since parent meetings are the most common type of parent involvement in prevention programs according to the RIVM (RIVM, 2014). In school projects, parent meetings can be a valuable addition to the FitGaaf! program, because it can spark enthusiasm in the parents and provide tips that will make participation easier for the parents. These parent meetings can be a variation on the parent meetings that are currently being held at Team050.

4.3.5 Parental involvement during the Hoogeveen project

During the Hoogeveen project, data was gathered about the participation of the children. Besides this, the participation rates of the parents were determined. The goal of this part of the study was two-sided; to determine the degree of parental involvement and to determine if participation of the parent is related to participation of the child. A Pearson correlation test was used to find a correlation between the participation duration of the parent and the child (α=0,05).

The results in chapter 4.2.2 showed a parental participation rate of 43% (figure 29), which is high in comparison to other voluntary lifestyle projects according to professor G.J. Navis (personal communication, 2018). If, based on literature, parental involvement improves participation rates in children, it is expected that the children whose parents participate in the FitGaaf! program participate more. Therefore, a correlation was sought between the number of weeks that the parents participated and the number of weeks that the children participated during the Hoogeveen project in group 5 to 8. The results are presented in figure 30, 31, 32, and 33.



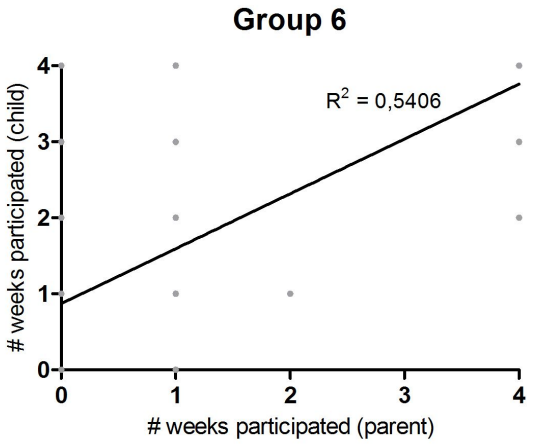
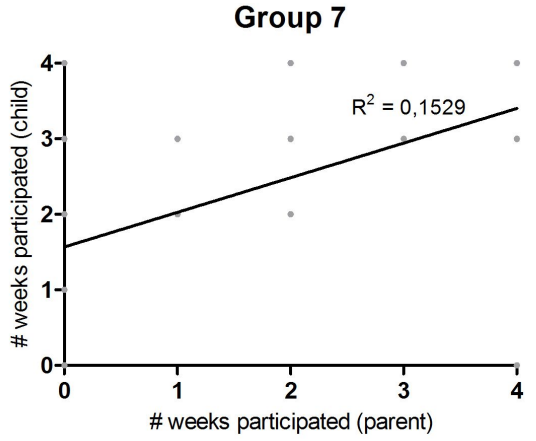


Fig. 30) Correlation between the number of weeks of participation of the child and the number of weeks of participation of the parent in group 5. Pearson correlation=0,484, P<0,001, n=67.	*Fig. 31) Correlation between the number of weeks of participation of the child and the number of weeks of participation of the parent in group 6. Pearson correlation=0,735, P<0,001, n=73.*



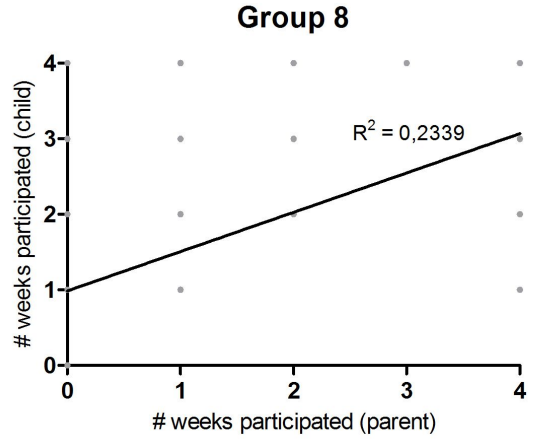


Fig. 32) Correlation between the number of weeks of participation of the child and the number of weeks of participation of the parent in group 7. Pearson correlation=0,391, P=0,005, n=51.	*Fig. 33) Correlation between the number of weeks of participation of the child and the number of weeks of participation of the parent in group 8. Pearson correlation=0,484, P<0,001, n=56.*

In all groups, a significant positive correlation was found between parental participation and child participation (group 5: P<0,001, group 6: P<0,001, group 7: P=0,005, group 8: P<0,001). This means that a longer duration of participation of the parent is associated with a longer duration of participation of the child. These results don't say anything about whether parental participation influences child participation or the other way around, but it is clear that FitGaaf! should not only focus on the children when it comes to stimulating participation.

During the Hoogveen project, all parents were asked to answer some questions about their attitude towards lifestyle and FitGaaf! in a Google Forms questionnaire, before and after the project. If they did this, they received a bag with some free healthy groceries from the local Albert Heijn. Unfortunately, only four parents filled in the questions before and after the project. Due to the low response rate, the results of this questionnaire could not be used for this report. In a next FitGaaf! project, a parent focus group meeting should be considered as a more effective method for evaluation.

4.3.6 Implications for FitGaaf!

The RIVM recommends incorporation of parental involvement in prevention projects for children, based on promising research findings. FitGaaf! is already actively targeting the parents by allowing them to actively participate in the program alongside their children and by providing information about a healthy lifestyle. In the Hoogeveen project, parental involvement was high and a positive correlation between parental involvement and participation rates of the children was found. This indicates that the FitGaaf! is currently effective in reaching the parents and that parent involvement might improve child participation rates, although causality is difficult to prove. For this reason, the parental element in the FitGaaf! program should not be altered too much. However, in order to involve the parents even more, parent meetings could be considered. FitGaaf! already has experience in providing these meetings, so translating it to a project-format should be a relatively quick and low-cost task. However, providing parent meeting during school projects will make the program more expensive. The added benefit of parental involvement should be weight against the increased costs. Another option is to have parent meetings as an optional addition to the program. In this case, customers can decide for themselves whether this is desired for the target group.

4.4 Additional options for increased participation

4.4.1 The capability approach

So far, this chapter has mainly focussed on improving the participation rates by improving the motivation to participate. However, participation is not only dependent on motivation. There are several reasons why someone might not participate, despite being motivated. Looking at these additional reasons is called the *capability approach*, originally described by Sen (2003) as an economic tool and later translated to a healthcare context by Haisma et al. (2018). This approach describes what is needed to enable people to make use of resources. Reasons why people don't make use of a resource can be put in two categories; "not being able" and "not knowing how". To overcome these hurdles, there is a need to identify the needed conversion factors that can enable the use of the resources (Haisma et al., 2018). This capability approach is also applied to FitGaaf! in order to find out how the participation rates can be further improved. The FitGaaf! program is seen as the resource in this evaluation.

4.4.2 Not being able to participate

Imagine that you are the parent of a child who comes home one day with a FitGaaf! calendar. He/she is very motivated to participate, but you know that this will be very difficult. You live too far away from sports clubs and you don't have enough money to buy fruits and vegetables. This is an example of when motivation to participate is not enough.

The major limiting factor to make use of the FitGaaf! program is money. Fruits and vegetables are more expensive than fries and hamburgers. If life is tough, for example when money is scarce, people are likely to choose short-term benefit (saving money on food) over long-term benefit (being healthy) (Bruine et al., 2007). In addition, membership to a sports club can be too expensive for families with a low income. If FitGaaf! wants to focus on secondary prevention and focus on low SES areas, money is an important factor to take into account. There are two options to decrease the degree of limitation of the costs of a healthy lifestyle.

The first option is to provide people with a very low income with free healthy food and sports club memberships. These kinds of projects are usually funded by the government and implemented by policymakers, so FitGaaf! has very little influence on it. However, if FitGaaf! can participate in a large collaboration project, like the aforementioned "Kans voor de Veenkoloniën" project, this will allow for communication between FitGaaf! and policymakers. This way, governmental funded foods and sports can be provided simultaneously with FitGaaf!. Not only will this be good for the participation and effectiveness of FitGaaf!, but it will also stimulate people to make use of the provided options for a healthy lifestyle. Communication between policymakers and FitGaaf! is key. Without it, FitGaaf! will not be able to overcome the hurdle of high costs via this route.

A second option is to educate parents about living healthy on a budget. Although a lot of healthy food items are expensive, there are also plenty of cheap options. Think of oats, frozen spinach, and beans. Providing cheap and healthy recipes can help people to realize that healthy food can also be cheap. Also, emphasizing that you can also save money with a healthy lifestyle, for example when you choose water instead of soda, can diminish the feeling that living healthy is expensive. Sports don't have to be expensive either. There are plenty of sports that you can do without being a member of a sports club. Think of skating, running, and playing soccer with friends. Also, there are big differences between the membership fees for different sports. Providing information like this is easily within reach for FitGaaf!. Parent meetings, newsletters, social media and the website are good platforms to teach parents about enabling their children to participate in FitGaaf! while sticking to a budget. Optionally, FitGaaf! could collaborate with a budget coach to give optimal advice.

4.4.3 Not knowing how to participate

Let's get back to the previous example of being a parent whose child comes home with a FitGaaf! calendar. You are motivated to participate in the program, but when you go to the supermarket, you realize that you have no clue how to cook healthily. Does pizza *vegetariana* count as a vegetable? And what about diet coke as a healthy drink? Despite your good intentions, you might choose not to participate because you simply don't know how.

Health literacy is a key element in the FitGaaf! program. Not only does health literacy give a person the confidence to participate, the program is also more effective when the participants participate correctly. Knowledge of health is not something that can be assumed to be on point. Especially among people with a low SES, health literacy is quite low, which is related to the level of education and the culture and norms in low SES neighborhoods (Furuya et al., 2015). Teaching people about how they can live more healthy can be an important conversion factor to increase participation rates and intensity.

The most obvious method to improve health literacy is to provide information, for example via newsletters and parent meetings. It is, however, important to fit the way in which information is provided to the needs of the target group. For this reason, it is important to get an idea of what information is needed. Linda de Ruyter did a focus group study to determine the needs of low and high SES groups in prevention projects. high SES people indicated that they didn't want much information, because they don't like to be patronized. For this target group, it could be interesting to provide tips and tricks to make participation in the program more fun or easier. Basic information about cooking vegetables and exercising is, however, less desired. Low SES focus groups had very different desires in the study of Linda de Ruyter. They wanted more basic information and felt overwhelmed by tips and tricks that are far from basic information. Therefore, a low SES target group requires a completely opposite approach (de Ruyter, 2018). In case FitGaaf! want to engage in secondary prevention, the company should be very aware of the low SES target group and fit the type of provided information to this group.

To get a better idea of the exact topics that require attention, a questionnaire can be used at the next project to ask parents about what they want to learn. This feedback can be used to further improve the program. To support the parents even better, an online platform can be created on the website of FitGaaf!. Providing basic information on this platform and allowing parents to ask questions to FitGaaf! and each other will make the information easily accessible for those who need it.

4.4.4 Not being aware of the need to participate

Besides not being able to participate and not knowing how to participate, a third limiting factor exists; not being aware of the need to participate. This means that a person doesn't see the need for participation, because this person doesn't believe that there is something to improve in the lifestyle of his or her family. Especially in low SES areas, the gap between self-perceived health and actual health is large (G.J. Navis, personal communication, 2018). Conversion factors to overcome this hurdle are awareness-promoting activities and programs. The task of providing these conversion factors is mainly in the hands of governmental organizations that have the means to launch campaigns and medical specialists that communicate with people one-on-one. Although FitGaaf! is dependent on this conversion factor, it is difficult for the company to influence it. FitGaaf!'s role is to contribute to raising awareness by doing projects and promoting the program.

4.4.5 Implications for FitGaaf!

When it comes to improving the effectiveness of the FitGaaf! program, the capability approach is a valuable tool to identify the needs of the target group. By taking this approach, a lack of money and low health literacy can be identified as major hurdles when it comes to making use of the resource FitGaaf!. The major conversion factors are funds and knowledge about living healthy (on a budget). These are important topics that FitGaaf! should not ignore in the process of improving its participation rates.

4.5 Conclusions

In order to be an effective program in the prevention of obesity and DM2, participation is key. Without sufficient participation rates, the program will not have (enough) effect. As identified in this chapter, there are several aspects that can influence whether or not a child will participate. Firstly, the child needs to be motivated to participate because there is a reward linked to participation. In order to achieve long-term participation, this external reward should evoke intrinsic motivation to participate. The involvement of parents can highly influence the willingness to participate and can facilitate proper participation. Besides motivation to participate, it is also of importance that the child and its family are able to participate, know how to participate, and see the need to participate (figure 34). In the Hoogeveen project, the participation rates in the FitGaaf! program were already quite high. However, to improve the participation further, FitGaaf! needs to address the aforementioned requirements for participation. Especially by providing more information about living healthy (on a budget), for example via parent meetings, FitGaaf! can potentially obtain even better rates, and therefore, improve the effectiveness.

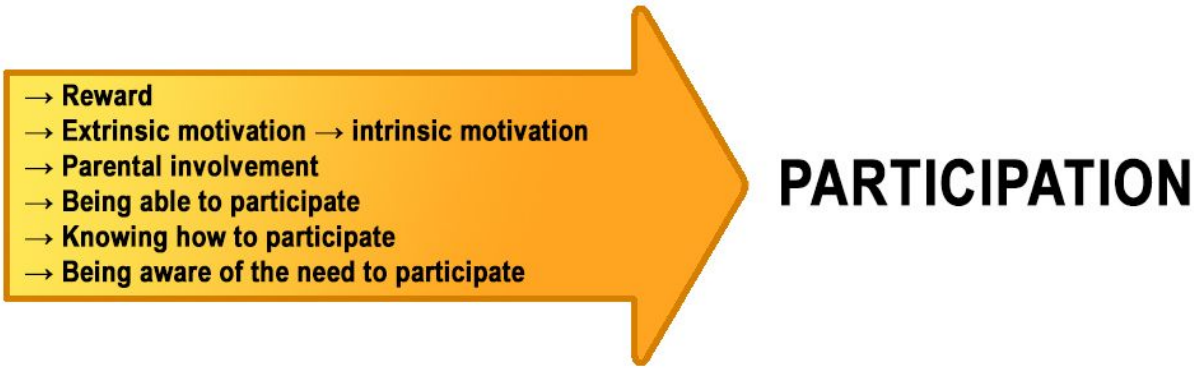


Fig. 34) Overview of what is needed to make children and their parents participate in the FitGaaf! program.

Chapter 5

Improving the effectiveness of FitGaaf!

This chapter integrates the findings of chapter 2 to 4 and evaluates options for improvement of the program and strategy. The main question of this report will be answered: *How can the effectiveness of the FitGaaf! program be improved?*

5.1 Integrating the results

This report has extensively discussed the strategy of FitGaaf!, the biomedical core of the program and participation in the FitGaaf! program in order to find out how the effectiveness of the program can be improved. Some strengths, weaknesses, opportunities, and threats have been identified, as well as some additional options for improvement of the program. When it comes to choosing the right strategy, FitGaaf! needs to realize what specific aspects to address. Optimally, FitGaaf! should emphasize its strengths and diminish its weaknesses while keeping the threats in mind and seizing opportunities. This chapter integrates the results of the previous chapters and steers towards a concrete advice.

5.2 Effectiveness of the market strategy

5.2.1 The optimal market choice

FitGaaf! has been active in the field of obesity prevention for a while now, but still, the company hasn't been able to obtain a strong market position or a steady income. Clearly, there is a need for a change in the strategy. In chapter 2, the three markets of obesity prevention have been extensively described and evaluated. Currently, FitGaaf! mainly operates in the primary prevention market. The lack of success in this market can be attributed to the overwhelming competition and the lack of available money due to the low urgency for prevention at this level. FitGaaf! also hasn't been able to establish itself in the tertiary prevention market, mainly because FitGaaf! doesn't meet the requirements for funding and partnerships. FitGaaf! isn't able to alter its strategy to overcome these hurdles, since the threats are external. FitGaaf! is too small to compete in the primary prevention market and to underqualified to compete in the tertiary prevention market. Because of this, the company doesn't get opportunities to grow and is, therefore, stuck in a vicious cycle. These markets both appear to be dead ends for FitGaaf!.

The market that seems to fit FitGaaf! much better is the secondary prevention market. In this market, there are fewer competitors and more opportunities for funding. Also, the requirements for funding and partnerships aren't out of reach like in the tertiary prevention market. The main requirement is that the program needs to suit low SES people. FitGaaf! has had several successful projects in low SES schools, including the schools in Hoogeveen that were discussed in this report. FitGaaf! could apply for the low SES mark in the Loket gezond leven database to officially get recognized by the government as a program that can operate in the secondary prevention market. Therefore, FitGaaf! is advised to apply for a low SES mark in the Loket Gezond database as soon as possible.

Besides entering the secondary prevention market, FitGaaf! should also leave the tertiary prevention market. The current partnership with Team050 is an entry into this market, but as mentioned before, FitGaaf! cannot obtain a strong enough position in this market. Since the team is very small and time is limited, it is not wise to invest time in something that is not going to take FitGaaf! any further.

The primary prevention market, however, should not be left immediately. It takes time to establish yourself in a new market, so it cannot be expected that FitGaaf! will generate sufficient income right after entering the secondary prevention market. Since the school projects are the biggest source of income, they should not be dropped before having a new source of income. The projects in the primary prevention market can also be very similar to those in the secondary prevention market. Therefore, it is wise to continue primary prevention projects, preferably in low SES schools, to get more experience and to fine-tune the program. Once FitGaaf! has established itself in the secondary prevention market, a choice has to be made about leaving or staying in the primary prevention market. It is advised to consider the size of the team while making this decision. If the team hasn't grown since entering the secondary market, it is wise to focus on 1 market only since there is a need for complete focus in this difficult field of obesity prevention. If the team has grown, focussing on more than one market becomes an option.

5.2.2 Market strategy

The SWOT analysis from chapter 2 can be used to determine what market strategy would fit FitGaaf! best in the secondary prevention market (figure 12).

Strengths	Weaknesses
S1: Suitable for low SES S2: First indications of effectivity S3: High participation rates S4: Agile nature that allows for adjustments S5: Flexible and personizable product S6: Unique approach	W1: Small team W2: Lack of financial means W3: Lack of focus in business strategy W4: Low ranking in the Loket Gezond Leven intervention database W5: Inability to obtain biometric data to determine effectivity
Opportunities	**Threats**
O1: High urgency for tackling overweight, obesity and DM2 O2: Large target group O3: Strict political regulations O4: Low threat of substitutes O5: Buyer loyalty can decrease the bargaining power of the buyers O6: Emergence of HIBs	T1: Intense competition for funding T2: Negative impact of obesogenic environmental factors T3: Lack of health promoting/protecting laws T4: Strong rivalry between competitors T5: High threat of new entrants T6: High bargaining power of buyers T7: Decreased political interest in prevention due to the Jeugdwet

Fig. 12) SWOT-analysis of FitGaaf! in the secondary prevention market. Strengths and weaknesses are derived from the internal analysis of FitGaaf!. Opportunities and threats are derived from the external analysis (PESTEL and Porter's five forces) and the policy analysis.

Diminishing the weaknesses

Several weaknesses have been identified; some that FitGaaf! can solve in the short term and some that should get solved as a result of obtaining a strong market position.

A relatively easy weakness to solve is the low ranking in the Loket gezond leven database. FitGaaf! is currently listed as "well-described" (level 0). The application for this rank has taken place in 2015, which is already quite a long time ago. Since 2015, FitGaaf! has had several school projects with positive results that indicate effectiveness, also in low SES schools. Therefore, it is strongly advised to re-apply to aim for a higher rank and a low SES mark. Based on the requirements of Loket Gezond Leven, FitGaaf! appears to fit in level II, "first indication of effectivity". Figure 35 lists these requirements (in Dutch). Programs need to provide results from two Dutch or one Dutch and one international study with light evidential value (C. de Jager, personal communication, 2018). Studies with light evidential value should meet the following requirements:

- The measured effect is related to the goal and target group of the intervention.
- Verified methods were used for the measurements.
- There are measurements from before or during the intervention and after the intervention, without controls. In case of self-proclaimed effectivity an after-measurement is sufficient.
- The study is well documented and can be replicated.
- In case of quantitative research, results need to be analysed with suitable statistics, need to be examined for significance and need to be presented in an acceptable measure (C. de Jager, personal communication, 2018).

FitGaaf! has results from projects in Appingedam, Delfzijl and Hoogeveen that all appear to meet the requirements for light evidential evidence. The only aspect that is not certain to meet the requirements is the use of verified methods, since the questionnaires that were used to evaluate were not officially verified by a psychologist. Therefore, in its application FitGaaf! should underscore that the questionnaire was purposely chosen to be fun and easy to understand because of the nature and vision of the program. A committee has to decide whether or not FitGaaf! can rise to rank II. Rank III is not within reach yet, because causal evidence should be provided for this rank, which FitGaaf! doesn't have.

Eerste aanwijzingen voor effectiviteit

- ➢ De opzet van het empirisch onderzoek voorziet in een minstens lichte bewijskracht. Er zijn resultaten beschikbaar voorafgaand, bij de start of tijdens de interventie en na afloop van de interventie (zgn. voor- en nameting), zonder controle-conditie. Bij onderzoek naar de ervaren effectiviteit volstaan de resultaten van een nameting.
- ➢ Voor het aantal studies geldt dat:
  - Er zijn minstens twee Nederlandse studies naar de voorliggende interventie met een lichte bewijskracht of één Nederlandse studie naar de voorliggende interventie in combinatie met minstens één (inter-)nationale studie naar deze of een vergelijkbare interventie met minstens lichte bewijskracht. In het laatste geval is aannemelijk gemaakt dat het doel, de doelgroep, de aanpak en het theoretisch model van de vergelijkbare interventie voldoende van toepassing is op de Nederlandse situatie en/of de voorliggende interventie. De erkenningscommissie oordeelt uiteindelijk over de vergelijkbaarheid.

Fig. 35) Requirements for rank II (first indication for effectivity) in Loket Gezond Leven in Dutch (C. de Jager, personal communication, 2018)

Another weakness that can be solved on the short term is the lack of focus. Like mentioned before, FitGaaf! should keep the small size of the team in mind and not bite off more than it can chew. Focusing on one market, the secondary prevention market, can help the company to grow. In a competitive field like obesity prevention, it is much more strategic to do one thing and be very good at it than to do ten things at the same time and be mediocre at all of them. The company needs to establish itself in order to expand the team and get a steady source of income. Once these weaknesses are solved, re-entering another market can be considered.

Emphasizing the strengths

Besides solving its weaknesses, FitGaaf! should also emphasize its strengths. One of FitGaaf!'s major strengths is its promising results in school projects, especially at the difficult low SES target group. Not many programs are able to reach low SES people properly, but the way that the FitGaaf! program is set up seems to be a good fit. By focussing on the secondary prevention market and applying for a higher rank in the Loket gezond leven database, FitGaaf! can highlight this strength.

The FitGaaf! program has been very versatile, which is the result of a lack of focus. Although this lack of focus hasn't been positive for FitGaaf!, the resulting flexibility of the program can be used to FitGaaf!'s advantage. The FitGaaf! program can be offered in several different ways, for example in the classical school project form, but also as a tool for healthcare specialists. In a low SES target group, flexibility is one of the major requirements for a prevention program according to the study of Gera Nagelhout (Nagelhout et al, 2018). To prevent losing focus, it is wise to create one standard program for low SES projects and to provide options for expansion of this program. For example, additional parent meetings, newsletters, or exercises. This way, flexibility can be maintained while being able to focus on improvement of the basic program.

Because there is is a wide range of obesity prevention projects, even in the secondary prevention market, FitGaaf!'s strength of having a unique approach should be emphasized. What makes FitGaaf! different from many other programs is the fact that the project takes place at home with the parents. The relatively small burden on teachers can be a reason to choose for FitGaaf!. However, budgets for prevention are usually small, so being unique is not enough. The FitGaaf! program is relatively cheap because of the at-home approach. This should be emphasized as well. In the light of Porter's generic strategies, FitGaaf! has to aim for both cost leadership and differentiation, not choose one of them (Porter, 1980).

Avoiding the threats

Threats are external factors, so these are very hard to control. For example, the obesogenic environment, the lack of health-promoting laws, high threat of new entrants and decreased political interest in prevention cannot be changed by FitGaaf! Still, it is very important for FitGaaf! to be aware of external threats.

The intense competition for funding, strong rivalry, and high threat of new entrants imply that FitGaaf! needs to step up its game. Being mediocre isn't enough to outcompete the competition. The market threats further underscore the need for a focused strategy.

The high bargaining power of buyers is an indication that buyers need to be made loyal to give FitGaaf! some more bargaining power. To improve buyer loyalty, FitGaaf! should pay more attention to aftersales. So far, no school has done the FitGaaf! project more than once, which is an indication of poor aftersales. Currently, FitGaaf! sends schools the results of the project, based on the gathered data, but doesn't keep in contact. If FitGaaf! would keep

customers up to date about developments and would suggest new projects, customers would be more likely to think of FitGaaf! once they are looking to do another lifestyle project. Since FitGaaf! has already proven itself, there will be more room for bargaining in this second project.

Seizing the opportunities

The opportunities in the secondary prevention market are reasons to choose for this market. The high urgency for tackling overweight, obesity, and DM2 and the large target group are some of the advantages of this market that attract companies like FitGaaf!.

There are also some opportunities within the market. The most interesting one for FitGaaf! is the emergence of HIBs. If FitGaaf! is able to participate in a HIB, this is a way to circumvent threats related to the low availability of governmental money for prevention. More and more HIBs arise, especially for low SES target groups. These HIB projects pay a lot of attention to lifestyle and health literacy because these are major issues in low SES areas. Because of the seemingly good fit with FitGaaf!, the Kans voor de Veenkoloniën project appears to be the best HIB project to start a partnership with. Previous promising results in Hoogeveen, a city that is targeted by KVDVK, make FitGaaf! an interesting partner. Therefore, it is advised to explore the option for a partnership as an entry into the secondary prevention market. The first steps of exploration are already taken and can be found in supplemental appendix 7.

On the long-term it might be interesting for FitGaaf! to start a new, small scale HIB. FitGaaf! has a good relationship with Univé and VGS and has some connections in the municipality of Groningen. Once the company has established itself in secondary prevention, FitGaaf! should take the initiative and organize a meeting with potentially interested parties about the possibilities for a HIB.

5.2.3 Additional strategic choices

In addition to the SWOT-based strategy recommendations, some additional strategic recommendations can be given for a stronger market position. Firstly, it is very important for FitGaaf! to be as visible as possible. Tom is already promoting FitGaaf!, but the visibility could be significantly improved by visiting more networking events. Networking is very important for a company like FitGaaf! that is highly dependent on partnerships and funding. A network can also be useful when there is a need for a certain skill that is lacking in the small team of FitGaaf!. And in addition, being visible is necessary when FitGaaf! wants to be invited to compete in competitions for funding.

It is advised to reconsider the style of FitGaaf! to work on a more professional image. The style of the calendar is very colorful and fun, which is perfect for making the calendar fun for children. However, FitGaaf! uses almost the same colorful layout and informal language towards parents, customers, funding bodies and policymakers. In order to be taken seriously, it can help FitGaaf! to work on its professional image. Being aware of the target group is key. Parents might like to be approached in an informal way, but funding bodies might not. FitGaaf! should ask itself who will read what content. The language on the website, for example, is very informal and sometimes almost childlike, but (potential) customers probably visit the website much more than children. It is advised to choose slightly more professional layouts and language for all platforms that are not directly aimed at children. Also, the way that FitGaaf! is presented could be a little more professional. Calling FitGaaf! a “growing young company” instead of a “cute little company” can already make a big difference in being taken more seriously without sacrificing Tom’s vision and personal style.

5.3 Effectiveness of the biomedical core-concepts

5.3.1 The current program

Choosing the right market strategy is one thing, but when the program isn't having an effect, it will still be very difficult to obtain a strong market position. Before entering the secondary prevention market, FitGaaf! should have an idea about its effectiveness. Like mentioned before, it is very difficult to determine the effects of prevention, especially if gathering biometric data is out of reach. However, past scientific research can also help to give an indication about the effectiveness. Chapter 3 aimed to shed a light on the effectiveness of the elements of the FitGaaf! program. Each individual sticker was examined.

The most promising stickers were the breakfast sticker and the sleep sticker. A large body of epidemiological evidence supports the link between breakfast/sleep and overweight, as well as DM2 (Szajewska & Ruszczynski, 2010; Rudnicka et al., 2017). Despite the strong scientific support for these two stickers, there are not many lifestyle interventions that incorporate sleep and breakfast elements. This is one of the unique features that FitGaaf! should emphasize in order to differentiate more from the competition. Currently, the emphasis is more on the food and exercise components, as can be illustrated by FitGaaf!'s slogan "gezond eten, drinken en bewegen" (healthy eating, drinking and exercising). A slogan along the lines of "een gezonde invulling van de dag" (a healthy lifestyle throughout the day) covers the contents of the program better.

The positive effects of fruits and vegetables on health were mostly supported by literature. Several studies identified the negative correlation between fruit and vegetable intake and DM2 markers (Cooper et al., 2012; Wang et al., 2016), but causality remains difficult to find. Still, fruits and vegetables are important components of a healthy lifestyle that should be addressed in a lifestyle intervention like FitGaaf!. Interestingly, different types of fruits and vegetables seems to have different effects on health. For example, cruciferous vegetables, berries and fruit fibre were more strongly correlated to health benefits than other types of fruits and vegetables (Wang et al., 2016). Whether this should be addressed in the FitGaaf! program, is a difficult question. In low SES neighborhoods, intake of fruits and vegetables is low (Hulshof et al., 2003). If a child starts eating more fruit because of the FitGaaf! program, this is already an improvement. Specifying which exact fruits to eat seems too much of a stretch. Also, berries are quite expensive and the term cruciferous vegetables might be too difficult for low SES people. In an easy-to-understand lifestyle intervention like FitGaaf! it is advised to keep things simple and aim for small steps of improvement. Therefore, the fruit and vegetable stickers should not be further specified. A way to still incorporate cruciferous vegetables and berries in the program is by using these ingredients in recipes. These recipes can be provided by FitGaaf! via social media, newsletters or parent meetings.

Moderate and vigorous intensity exercise increase the energy expenditure (Thivel et al., 2013; Fearnbach et al., 2016) and improve physical fitness (Taylor et al., 2014). Therefore, they are crucial in the treatment and prevention of overweight. The protective effects of exercise on DM2 are not sufficiently studied to be able to say if there is an effect or not. However, the link between exercise and weight regulation and the link between weight and DM2 suggest a role of exercise in DM2 prevention (Garg, 2004). Also, in overweight individuals, exercise can improve glycemic control (Dixit et al., 2017). Since overweight is common in low SES areas, also among children, it is very important to stimulate exercise in

this target group. The fact that FitGaaf! uses two different stickers for exercise is fitting. Not only does it illustrate the different types of exercise, it also puts more emphasis on exercise. It is advised to keep the exercise stickers as they are.

The effect of the water sticker is difficult to determine based on literature, mainly because it has a broad interpretability. It is uncertain whether children will replace soda with water or whether they will drink extra water on top of their normal drinks. In the first case, water consumption will decrease sugar intake, and therefore, protect against DM2 (Bosy-Westphal & Müller, 2015). In the second case, there is probably no effect on DM2 risk. The description of the water sticker needs to be made more specific. For example, the sticker can represent replacing all the soda of a day for water. This way, the water sticker is more likely to have an effect on DM2 risk.

Finally, there is the joker sticker. It is advised to stop the use of this sticker as it is in case FitGaaf! wants to enter the secondary prevention market. Although the goal of this sticker is to prevent subconscious snacking, it can also be interpreted as a "wildcard" to eat something unhealthy every day. Besides that, each person will think differently about what can be considered to be a joker product and what not. For people with low health literacy, the joker can potentially do more harm than good. The joker sticker might also be confusing for them because this sticker should be used as little as possible, whereas the others should be used as often as possible. One of the aspects that makes FitGaaf! suitable for a low SES target group is the fact that the program is very easy to understand. A sticker like the joker sticker, which requires high health literacy, is contradictory to the vision. Therefore, it is not advised to keep this sticker in the calendar when using it for a low SES target group.
Although the joker sticker in its current form doesn't seem to fit a secondary prevention program, there is still value in teaching children that limiting the amount on unhealthy foods is also necessary in a healthy lifestyle. Therefore, this lesson should be maintained, but in a different form. A potential different implementation of a joker-element will be discussed in chapter 5.4.2.

In general, it will always be difficult to prove effectiveness with a literature study alone. Theoretical support for something can only have a sufficient predicting value when the circumstances of the FitGaaf! project are exactly the same as in literature. This is never the case. Therefore, the goal of this literature study is not to prove the effectiveness of the FitGaaf! program, but to give an indication of the potential effectiveness. The results suggest a protective effect of the FitGaaf! program on overweight and DM2. This is good motivation to invest in biometric data acquisition in the future, for example in collaboration with a healthcare professional.

5.3.2 Improving the backbone of the program

Besides the proposed alterations to the current program, it might also be interesting to further improve the backbone of the FitGaaf! program by adding a new sticker, for example as a replacement for the joker sticker. Chapter 3 introduced the promising lifestyle target non-exercise activity thermogenesis (NEAT), the energy used for most low-intensity daily activities. A NEAT intervention can be implemented in several different ways. Because NEAT isn't a very concrete type of activity, it may be difficult to translate it into a sticker, but for the sake of simplicity, NEAT could be implemented as a "household chores" sticker (figure 36). In this case, the child can paste a sticker if he or she does a little chore in the house, like

mowing the lawn, doing the dishes, helping with cooking, cleaning up the table or folding clothes. The type of chore isn't important, as long as it requires minimal activity. Parents can decide what chores are appropriate and fun for their children and they can help if needed. Besides a sticker, the benefits of NEAT can also be taught to the parents via information meetings or newsletters. Since NEAT is a relatively unknown lifestyle intervention target, parents need to know about it in order to use it. Implementation of more NEAT in the lifestyle of a child can be very easy. Parents can let their child do simple chores, can buy chairs without backrest and can stimulate standing in activities that are usually done sitting down, like baking, gaming and doing homework. Not only are these interventions simple, they also don't cost any money, unlike sports clubs. This low-effort high-result type of intervention is therefore also fitting for low SES groups. It is advised to implement the household chores sticker or a different sticker that targets NEAT in the FitGaaf! program before entering the secondary prevention market.

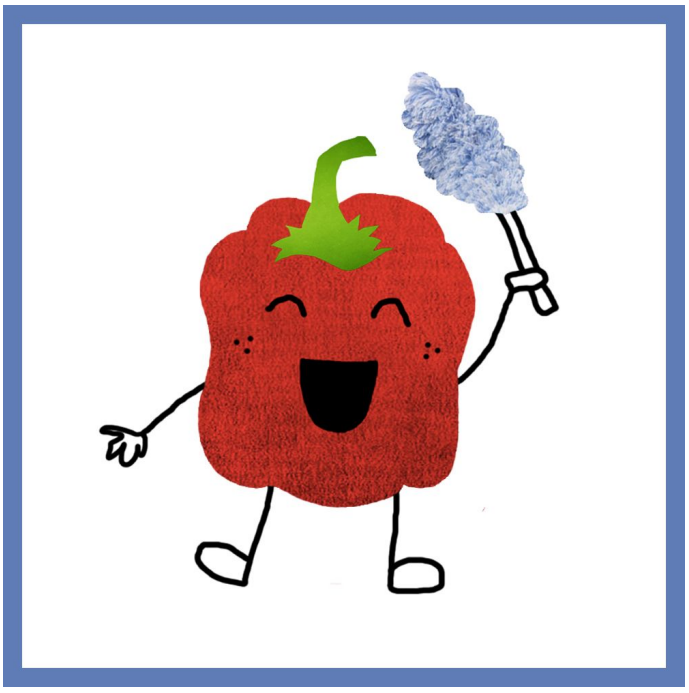


Fig. 36) The proposed "household chores" sticker (own design)

5.4 Participation

5.4.1 More participation for more effectiveness

An important component in the potential success of FitGaaf! in the secondary prevention market is participation. Many prevention programs struggle to get sufficient participation rates because prevention, especially primary and secondary prevention, can't be forced upon someone. A good balance between being fun and being effective should be sought. The previous paragraph discussed suggestions for improvement of the effectiveness of the core of the program. This paragraph focuses on improving the rate and intensity of participation to further improve the effectiveness.

5.4.2 Motivation and participation in the FitGaaf! program

It appears that FitGaaf! already has quite good participation rates. In the Hoogeveen project, the participation rates of both the children and their parents were very high, according to professor G.J. Navis (personal communication, 2018). The children in Hoogeveen gave the FitGaaf! project an average grade of 2,7 out of 4, which indicates that the children like to participate, despite the fact that the FitGaaf! project is meant to teach them something, not to entertain them. There seems to be a strong enough element of reward.

Being allowed to paste stickers is rewarding because it is fun to do and it will lead to compliments and appreciation from the parents, teachers, and fellow classmates. The FitGaaf! program focuses on reward, but also has one element of punishment; the joker sticker. Pasting the joker sticker is not desired, so if a child uses it, this should cause a feeling of punishment. However, research has shown that punishment doesn't facilitate learning in young children, the target group of FitGaaf! (van Duijvenvoorde et al., 2008). From this perspective, it is doubtful if the joker sticker will even have the desired effect. This is another reason for skipping the joker sticker, on top of the previously mentioned fact that the joker sticker might be interpreted the wrong way. A solution to these two problems could be to make the joker sticker reward-based. So instead of pasting the joker sticker when you eat something unhealthy, you should paste the paste the joker sticker if you decide *not to eat something unhealthy*. This way, children are rewarded for skipping snacks and replacing unhealthy items by healthy items. This solves most problems related to the joker sticker:

- Reward-based instead of punishment-based
- Easy to understand
- No risk of being interpreted as a "wildcard"
- Facilitates small steps of improvement, which suits the vision

Therefore, it is strongly advised to stop the use of the joker sticker in its current form and make the program entirely reward-based**.**

A big uncertainty in the FitGaaf! program is whether the extrinsic motivation to participate can facilitate intrinsic motivation to participate. Research has shown that the predictive value of intrinsic motivation on performance is stronger if the external incentive is not directly tied to this performance. Therefore, the external reward should not be obtained from the same behavior as the intrinsic reward (Cerasoli et al., 2014). This is the case in FitGaaf! because the external reward is obtained by pasting stickers and the internal reward is obtained from the healthy lifestyle itself. Although it is positive that the external and internal reward are not tied to the same behavior, it remains uncertain if FitGaaf! can facilitate intrinsic motivation. This chance can, however, be increased by adding different types of external rewards to promote different aspects of intrinsic motivation. For example; providing positive feedback on active participation might improve the confidence of a child, which can intrinsically motivate them in a different way. It is recommended for FitGaaf! to attend parents and teachers more on the positive effects of reward on learning.

FitGaaf! actively involves the parents in the program. This is important because children are very dependent on their parents when it comes to changing their lifestyle. For this reason, the Dutch RIVM advises adding a parental component to interventions for children (RIVM, 2014). Interestingly, FitGaaf! doesn't use the most common type of parental involvement; parent meetings. Since FitGaaf! already has some experience with parent meetings at Team050, it is possible to start providing optional parent meetings at school projects. This

way, parents can be informed about their role and they will feel more involved. Also, in these meetings FitGaaf! can address some of the additional hurdles that prevent people from participating; not being able to participate, not knowing how to participate and not being aware of the need to participate. In parent meetings, FitGaaf! can underscore the urgency for prevention, provide information about living healthy on a budget and answer the questions that parents have. In addition, FitGaaf! should create a parent platform on the website where parents can find basic information and ask each other questions. Paying more attention to parental involvement will improve the participation rates and will also further strengthen this important FitGaaf!'s component.

5.4.3 The FitGaver! app

FitGaaf! has been thinking about creating an app to support the calendar. This envisioned app can scan the calendar and use this data to provide games and challenges in the theme of the stickers that need some more attention (figure 37). For example, if you didn't paste enough sleep stickers, you will get mini-games that require focus and attention. This app should teach children in a very personalized way and the games should improve long-term participation. It could be a great additional external reward and it could improve the participation rates significantly. There are, however, also some downsides to this app.

Fig. 37) Impression of the look of the FitGaver! app

Although the idea of this app has been around for a while, FitGaaf! hasn't been able to obtain funding to create the app yet. It is a project that gets a lot of attention from the team, and therefore, takes up a lot of time. This app would be a nice addition to the FitGaaf! program, but it isn't crucial. At the moment, obtaining a stable source of income, building a reputation, and removing flaws from the program are much more important. It is strongly advised to focus on these topics first.

On the short term, the app shouldn't be the focal point of FitGaaf!. However, it might still be an interesting option for the future. Having an offline and an online element is upcoming in the field of prevention and the interest in e-health is growing. Therefore, such an addition to the program could further increase the value of FitGaaf!
An important thing to keep in mind before creating the app is the age of the target group. The app is meant to be used by the child, under the supervision of a parent. The age range of the children that can participate in FitGaaf! is very broad, so the app should have games that suit 4-year olds, as well as 12-year olds. It will be more costly to create games for different age categories, but this will be unavoidable if the app should fit the entire target group. Another option is to create the app for the older children only, for example, group 5 to 8. This group might need the extra reward more than the youngest children.
It is also important to take into account that costs are an important aspect for low SES people. In case FitGaaf! wants to use the app in secondary prevention, it should be a free app without hidden costs. If FitGaaf! can get sufficient funding, this should be possible. A more worrying issue is the fact that the app can only be used on a smartphone. These devices are expensive, so it cannot be assumed that each low SES parent has one. FitGaaf! stands for equality and a fair chance for everybody, so providing something like an app is conflicting with this motto. It is important to consider this, especially in secondary prevention. In primary prevention projects, an app would be more suitable. Therefore, it is advised not to spend time on the app before the decision has been made about whether or not to remain active in the primary prevention market.

5.5 Conclusions

Some suggestions for alterations in the strategy, biomedical core of the program, and participation approach have been identified by integrating the results of the previous chapters. FitGaaf! seems to a have a lot of potential, but there is a need for change in order to reach this potential. Several advices for FitGaaf! are given that aim to achieve this. The next chapter translates these advices to a plan of action for FitGaaf!.

Chapter 6

Advice

This chapter provides a concrete advice for FitGaaf! regarding improvement of the effectiveness of the program.

6.1 Concrete advice for FitGaaf!

Based on the findings in chapter 5, an advice can be given to FitGaaf!. A distinction is made between short-term and long-term advice, as well as between advice related to the program and advice related to the strategy. The aim of this chapter is to provide very concrete suggestions for alterations to help FitGaaf! in the improvement of its effectiveness. More details and argumentation can be found in chapter 5.

6.2 Short-term advice

6.2.1 Program

The FitGaaf! program has been evaluated on its effectiveness in the prevention of DM2 among children and its effectiveness in reaching sufficient participation rates. Before altering the strategy, the program should be altered to fit this new strategy. The following short-term advice is given:

1) **Specify the description of the water sticker.** In order to achieve the goal of decreasing the intake of sugary drinks, the water sticker should be defined as a sticker that can be pasted once a sugary drink is replaced by water.
2) **Alter the joker sticker by making it reward-based.** The current punishment-based joker sticker is not effective in teaching children and has a high risk of being interpreted wrongly. The use of the sticker should be altered: it should be pasted when skipping an unhealthy food item.
3) **Add a household chores sticker that addresses NEAT**. Target non-exercise activity thermogenesis, as it is proven to be effective in the prevention of overweight and DM2 and is easy to implement as a sticker.
4) **Provide parent meetings and an online parent platform.** This way, parents are more involved and can be taught about living healthy on a budget and facilitating proper participation for their children.

6.2.2 Strategy

To obtain a stronger market position, FitGaaf! is advised to alter its current market strategy.

5) **Apply for rank II and a low SES mark in Loket Gezond Leven**. FitGaaf! appears to meet the requirements for rank II. A higher rank can potentially improve FitGaaf!'s reputation and increase the chance of acquiring funds.
6) **Focus on the secondary prevention market.** This market fits better to FitGaaf!'s strengths and weaknesses and the threats are avoidable because of good opportunities. Due to the small size of the team, only one market should be targeted.
7) **Aim for participation in a health impact bond as an entry in the secondary prevention market.** HIB's provide new opportunities for funding and collaborations. Because of previous successes in Hoogeveen, the Kans Voor de Veenkoloniën projects is currently the most suitable HIB to participate in.
8) **Work on the professional image and network.** FitGaaf! should use a more professional style towards customers, emphasize its unique selling points, and network more to become more well-known in the industry.

6.3 Long-term advice

6.3.1 Program

After obtaining a stronger market position and being able to expand the team, new options may arise that can take FitGaaf! to the next level. These options, however, should be considered as options for later, as they don't have priority at this moment.

9) **Gather biometric data during projects.** This way, the actual effectiveness of the FitGaaf! program can be determined. FitGaaf! is advised to look at options for collaboration with healthcare specialist and/or universities.
10) **Develop a FitGaver! app, but only for primary prevention.** An app that requires expensive devices doesn't fit a low SES target group. However, when FitGaaf! takes a step towards primary prevention, this app could improve participation.

6.3.2 Strategy

Priority lies in establishing a strong market position in the secondary prevention market. Only if this is established, the next steps can be considered.

11) **Expand the team.** By hiring more employees, FitGaaf! can obtain missing skills like psychology and marketing and potentially target an additional market (if desired).
12) **Initiate a new health impact bond.** By assembling the right people from its network, FitGaaf! should take the initiative in starting up a new HIB.

The order of implementation and the timeframe for implementation are also important to consider. Therefore, these points of advice are put in a timeline (figure 38). It is estimated that establishment in the secondary prevention market will take 2 years. In the following years, the long-term advice can be implemented. Ultimately, this advice should answer the question that this internship started with 6 months ago; *How can the effectiveness of the FitGaaf! program be improved?*

*Fig. 38) Timeline for implementation of the provided points of advice. Short-term advice should be implemented in year one, establishment should take place in year two and, in case of successful establishment, long-term advice should be implemented in year three. Numbers correspond with the numbers of the points of advice as giving in this chapter. Horizontal lines represent long-term processes. Dotted lines represent optional continuation of processes. *: only in case the primary prevention market is targeted as well at this stage.*

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Appendices

Appendix 1 - Overview of contacted experts

Name	Organization	Function	Type of contact	Date
Frieda van der Jagt	Diabetes Fonds	Specialist knowledge and innovation	Telephone interview	15/02/2018
Susanne Täuber	University of Groningen, Faculty of Economics and Business	Associate professor	Meeting	21/02/2018
Linda de Ruyter	University of Groningen, Faculty of Economics and Business	MSc Human Resource Management graduate	Meeting	21/02/2018
Gerjan Navis	UMCG, Faculty of Medical Sciences	Professor	Meeting	20/03/2018
Carolien de Jager	RIVM	Advisor healthy lifestyle	E-mail	23/03/2018
Gera Nagelhout	Maastricht University, department of Health Promotion	Post-doctoral researcher	Telephone interview	26/03/2018
Iris Dijkstra	Municipality of Groningen	Policy advisor	Meeting	29/03/2018

Appendix 2 - Interview with Frieda van der Jagt, knowledge specialist of the *Diabetes Fonds*

Date: 15/02/2018
Type of interview: Telephone

Wat doet het Diabetes Fonds en wat is daarin uw rol?
Het Diabetes Fonds verzamelt geld voor onderzoek naar het genezen en behandelen van diabetes. We hebben daarnaast ook een rol in het geven van voorlichting en informatie over hoe je zo goed en gezond mogelijk kan leven met diabetes.
We hebben hier verschillende afdelingen en ik werk bij de afdeling kennis en innovatie. Onze afdeling onderhoudt aan de ene kant contact met de onderzoekers aan wie we geld geven en aan de andere kant houden we alle kennis op het gebied van diabetes bij; de kennis die we uit onderzoeken halen maar ook alle kennis die er al is. We zijn met 4 medewerkers en ieder heeft zijn eigen kennisgebied. Mijn kennisgebied is preventie van diabetes type 2, gezonder leven en voeding en diabetes. Wij houden alle kennis bij om in te zetten voor fondsenwerving en het up-to-date houden van de informatie op onze website.

Het viel me op dat de RIVM onderzoeken over diabetes type 2 bij kinderen al weer meer dan 10 jaar oud zijn. Heeft u een beeld van de trends in diabetes type 2 prevalentie onder Nederlandse kinderen in de afgelopen 10 jaar?
De cijfers van het RIVM zijn de meest recente cijfers. Als nieuwere cijfers niet op hun website staan, kun je ervan uit gaan dat ze er niet zijn of nog niet geregistreerd zijn. Ik weet zelf ook geen recente cijfers hiervan. Ik denk dat als je wil kijken naar trends in diabetes type 2 onder kinderen, je het beste kan kijken naar overgewichtcijfers. Deze zijn veel recenter en het is zo dat als kinderen diabetes type 2 krijgen op zo'n jonge leeftijd, ze altijd ernstig overgewicht hebben. Er zijn meerdere oorzaken voor diabetes type 2; leefstijl, erfelijkheid, maar ook ouderdom. Diabetes type 2 ontwikkelt zich in de loop van je leven, dus als mensen voor hun 45ste diabetes type 2 krijgen, heeft dat altijd te maken met leefstijl en met overgewicht. Zeker als je kijkt naar kinderen, dan heeft dat altijd te maken met overgewicht hebben, inactief zijn en ongezond eten. Erfelijkheid alleen kan niet bij kinderen tot diabetes type 2 leiden. Het is een van de factoren, maar er moeten meer factoren betrokken zijn als diabetes type 2 op zo'n jonge leeftijd tot uiting komt.

Denkt u dat de prevalentie van diabetes type 2 nog meer toe gaat nemen onder kinderen?
Dat vind ik lastig te zeggen. Ik denk dat als overgewicht bij kinderen toeneemt, voornamelijk ernstig overgewicht, diabetes type 2 ook toe zal gaan nemen. Diabetes is natuurlijk een heel proces, het bouwt zich op in jaren. Dus als overgewicht meer bij kinderen voorkomt, zegt mijn eerste gevoel dat dat later wel effecten gaat hebben. Het blijft altijd een individuele optelsom van factoren, dus ik vind het moeilijk om daar een goede uitspraak over te doen, maar bij kinderen heeft het wel echt veel met die trend in gewicht te maken. Dus ik denk dat als ernstig overgewicht onder kinderen zal toenemen, ook diabetes type 2 zal toenemen.

Denkt u dat een preventieprogramma zoals dat van FitGaaf! diabetes type 2 zou kunnen voorkomen? En heeft dat dan al effect op jonge leeftijd of pas later?
Het gewicht dat je hebt als kind voorspelt vaak het gewicht dat je als volwassene zal hebben. Daarnaast gaat het ook om gewoontes die je aanleert als je kind bent. Gewoontes leer je op jonge leeftijd, dus als je kinderen op jonge leeftijd aanleert om gezonder te leven, is

de kans groter dat ze dat op volwassen leeftijd ook zullen doen. En dat heeft invloed op de ontwikkeling van diabetes. Zo'n preventieprogramma zal wel effect hebben op de kans dat kinderen met ernstig overgewicht jong diabetes type 2 ontwikkelen, maar daarnaast, omdat je diabetes ontwikkelt in de loop van je leven, heeft het ook effect op veel latere leeftijd. Als je op jonge leeftijd aanleert om gezond te eten en veel te bewegen en je dat op volwassen leeftijd blijft doen, heeft dat ook dan nog effect.

Wat zijn naar uw mening belangrijke voorwaarden waar zo'n preventieprogramma aan zou moeten voldoen?
Uit onderzoek blijkt dat je je kennis wel kan vermeerderen en dat dat je intentie om iets te doen soms wel verandert, maar dat dat niet altijd leidt tot gedragsveranderingen. Daarnaast is het ook belangrijk om iemand langdurig te begeleiden om zo'n langdurige gedragsverandering te veroorzaken. Dat kan ook online zijn of via een app, maar in ieder geval is een langdurige stimulatie tot gedragsverandering belangrijk.
Het geven van een beloning werkt ook wel, maar het geeft extrinsieke motivatie, motivatie van buitenaf, in plaats van intrinsieke motivatie vanuit jezelf. Langzaam zal deze intrinsieke motivatie dus ook moeten komen, oftewel, mensen moeten gaan inzien dat een gezonde leefstijl belangrijk is. Ze moeten het niet voor de beloning blijven doen.
Wat ook steeds duidelijker wordt, is dat de inrichting van de omgeving belangrijk is; of kinderen veel verleidingen om zich heen hebben van ongezond eten en of kinderen de kans krijgen om buiten te spelen, dat soort dingen.
Gedragsverandering is moeilijk, je moet op meerdere dingen inspelen om dat voor elkaar te krijgen. Bij kinderen zijn ouders ook superbelangrijk, die zijn voorbeelden voor hun kind.

Weet u of er andere programma's zijn die zich focussen op leefstijl om diabetes te voorkomen?
Er zijn heel veel projecten die focussen op gezond leven. Een groot deel hiervan staat in de interventie database van het RIVM. Je hebt bij voorbeeld de Gezonde School, JUMP-in en JOGG. Deze focussen vooral op het voorkomen van overgewicht. Er zijn wel ook diëtisten die zich specialiseren in kinderen met overgewicht, de Lekker Pûh!!! diëtisten bijvoorbeeld.
Er zijn ook verschillende leefstijlprojecten voor volwassenen met een verhoogde kans op diabetes. Ze hebben verhoogde bloedsuiker levels, maar nog niet zo hoog dat ze diabetes hebben. De slimmer interventie is er bijvoorbeeld een. Daarnaast is er ook de Nationale Diabetes Challenge van Bas van de Goor. Hierbij gaan mensen met een verhoogd risico op diabetes in hun gemeente 1 keer in de week wandelen om zo wat beweging krijgen. Dit helpt hun bloedsuikerwaarden te verlagen.

Zijn er naar uw weten nog belangrijke recente ontwikkelingen in het onderzoek naar diabetespreventie en leefstijl? Of op het vlak van het beleid hier omheen?
We hebben recent een onderzoek gefinancierd waarbij mensen met diabetes een *very low-calorie diet* kregen voor een bepaalde periode. Hieruit kwam dat als mensen met diabetes in korte tijd veel gewicht verliezen, bijvoorbeeld door zo'n dieet of door een maagverkleining, diabetes volledig kan worden omgekeerd zonder enige vorm van medicatie. De "leefstijl als medicijn" beweging zet zich in voor het stimuleren van gezonde leefstijl om diabetes om te keren. Een voorbeeld is het project "keer diabetes2 om" van stichting Voeding Leeft.
Omdat leefstijlinterventies nu bijna nooit worden vergoed door de basisverzekering, wordt er met verzekeraars gepraat om te proberen om een standaardvorm van leefstijlinterventies in de basisbeurs te krijgen. Dit is een proces wat nog loopt en tot nu toe nog zonder resultaat.

Appendix 3 - Interview with Gera Nagelhout, post-doctoral researcher at Maastricht University, department of Health promotion

In response to the publication: Nagelhout, G. E., Verhagen, D., Loos, V., & De Vries, H. (2018). Belangrijke randvoorwaarden bij de ontwikkeling van leefstijlinterventies voor mensen met een lage sociaaleconomische status: Een Delphi-onderzoek. Tijdschrift voor Gezondheidswetenschappen. 96: 37-45.

Date: 26/03/2018
Type of interview: Telephone

Kunt u wat over uw onderzoek vertellen?
In het artikel staat inhoudelijk eigenlijk alles wat we hebben gedaan, daar is verder niet heel veel meer over te vertellen. We hebben het onderzoek uitgevoerd omdat we er zelf tegenaan liepen dat er niet echt een review was van factoren waar een lage SES interventie aan moet voldoen. Het is best lastig om dit te onderzoeken omdat je dan alle verschillende factoren experimenteel moet gaat toetsen waarbij je ook nog verschillende soorten interventies hebt, dat gaat gewoon niet. Dus wij dachten, er zal waarschijnlijk al heel veel kennis hierover moeten zijn. Daarom hebben we experts hun mening gevraagd. Hieruit kwam een lijstje van dingen waar je op moet letten bij interventies voor lage SES. Het is belangrijk wel in je achterhoofd te houden dat we alleen wetenschappers hiervoor hebben gevraagd. Dit zijn mensen die veel publiceren over het onderwerp, maar ook mensen die veel achter hun bureau zitten. Niet de mensen van de doelgroep zelf, dat zou wel een beter beeld geven.

Bij dit onderzoek is alleen de mening van experts gevraagd. In hoeverre zijn hun meningen gebaseerd op gesprekken met mensen met een lage SES score?
Dit weet je nooit zeker. Dat hebben we ook niet nagevraagd. Wel kun je aannemen dat ze, omdat ze er veel over publiceren, zelf ook soortgelijke interventies hebben ontwikkeld of in ieder geval hebben geëvalueerd. Het zou dus wel zo moeten zijn dat er hierbij kwalitatief onderzoek is gedaan of dat er gesprekken zijn geweest. De experts zullen dit keer op keer bij verschillende studies hebben meegemaakt en daarmee hun ervaring hebben opgedaan. Maar helemaal zeker weten doe je dat niet. Als je ziet wat eruit komt, klinkt het wel allemaal heel logisch. Het zijn bijna open deuren. Dit laat zien dat het misschien blijkbaar gewoon zo simpel is.

De eisen die het RIVM stelt aan interventies voor lage SES komen voor een groot deel overeen met de uitkomsten van uw onderzoek. In hoeverre zijn de meningen van de experts beïnvloed door deze eisen?
Het kan zijn dat enkele onderzoekers onbewust beïnvloed zijn door de eisen van het RIVM omdat ze denken dat dat is hoe het hoort. Maar dat lijkt me niet zo erg, omdat de overheid dit ook ergens op gebaseerd heeft. In het onderzoek hebben we de eisen van het RIVM in ieder geval niet meegenomen.

FitGaaf! wil kijken naar de optie om het programma toe te passen bij kinderen uit lage SES gezinnen. In hoeverre denkt u dat de resultaten van uw onderzoek te vertalen zijn naar kinderen (4-12)?
Wij hebben het onderzoek niet gespecificeerd naar volwassenen of kinderen, dus in principe zijn de resultaten even goed toepasbaar op zowel volwassenen als kinderen. Er hebben

onderzoekers aan het onderzoek meegedaan die zich specifiek richten op kinderen, dus het zou net zo goed op kinderen toepasbaar moeten zijn.

Wat zijn naar uw mening de belangrijkste factoren om op te letten bij een lage SES interventie bij kinderen?
Uit mijn eigen intuïtie zou ik zeggen dat het moet aansluiten op de belevingswereld. En als het kan, de aanpak richten op de onderliggende oorzaken. Kinderen zitten in een gezinssituatie waar ook vanalles gebeurt en vaak kun je daar in je interventie niks mee omdat het bijvoorbeeld alleen op de basisschool is, verder niet. Maar om echt impact te bereiken zou je verder moeten gaan en ook naar de ouders en leefsituatie moeten kijken en hier wat mee moeten doen.

Appendix 4 - Hoogeveen project; evaluation questions group 3 and 4

The following questions have been used for the evaluation at groups 3 and 4 in the Hoogeveen project. Each question was read out loud and children were supposed to give their answer by skipping to the sports mat of their choice. within 10 seconds.

1) Hoeveel weken heb je zelf (bijna) alle stickers geplakt?
   - mat A) 0 weken
   - mat B) 1-2 weken
   - mat C) 3 weken
   - mat D) 4 weken

2) Hoeveel weken heeft je papa of mama (bijna) alle stickers geplakt?
   - mat A) 0 weken
   - mat B) 1-2 weken
   - mat C) 3 weken
   - mat D) 4 weken

3) Hoe vond je het om met de FitGaaf! kalender en stickers te werken?
   - mat A) Heel erg leuk
   - mat B) Leuk
   - mat C) Niet leuk
   - mat D) Helemaal niet leuk

4) Heb je wat geleerd over gezond eten, drinken en bewegen?
   - mat A) Heel veel
   - mat B) Best veel
   - mat C) Bijna niks
   - mat D) Helemaal niks

5) Ben je gezonder gaan eten? Dus meer ontbijt, fruit en groente gaan eten?
   - mat A) Ja, veel meer
   - mat B) Ja, iets meer
   - mat C) Nee, hetzelfde
   - mat D) Nee, minder

6) Ben je meer water gaan drinken?
   - mat A) Ja, veel meer
   - mat B) Ja, iets meer
   - mat C) Nee, hetzelfde
   - mat D) Nee, minder

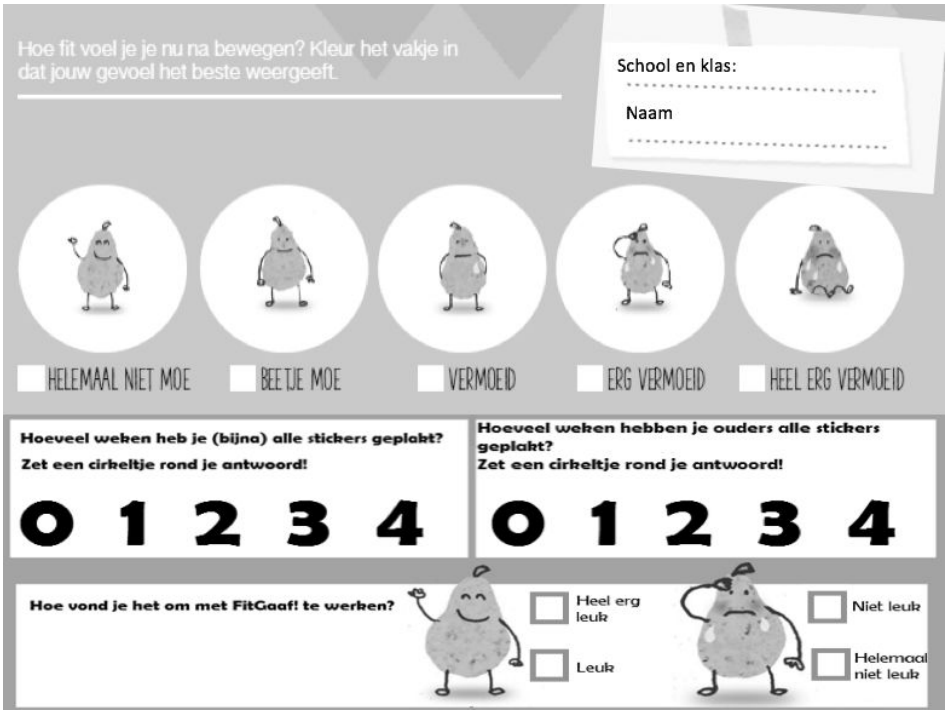
7) Ben je meer gaan bewegen?
   - mat A) Ja, veel meer
   - mat B) Ja, iets meer
   - mat C) Nee, hetzelfde
   - mat D) Nee, minder

8) Ben je minder gaan snoepen?
   mat A) Ja, veel minder
   mat B) Ja, iets minder
   mat C) Nee, hetzelfde
   mat D) Nee, meer

9) Voel je je nu fitter dan voor FitGaaf!?
   mat A) Ja, veel fitter
   mat B) Ja, iets fitter
   mat C) Nee, hetzelfde
   mat D) Nee, minder fit

Appendix 5 - Hoogeveen project; evaluation forms group 5, 6, 7 and 8

Pre-project evaluation form. After a situation story (below), Children choose one of the options; not tired at all (1), a little tired (2), tired (3), very tired (4) or severely tired (5).



After-project evaluation form. After a situation story (below), Children choose one of the options; not tired at all (1), a little tired (2), tired (3), very tired (4) or severely tired (5). They also have to circle the number of weeks of participation for themselves and their parents and rate the program as; a lot of fun (4), fun (3), not fun (2) or not fun at all (1).

<u>Situation story for question 1 of the evaluation forms.</u>

Stel je voor; je loopt door de straat van school en je kan de school al zien liggen. Ineens hoor je een geluid; de bel gaat! je wil niet te laat komen, dus je rent het laatste stukje zo snel al je kan school. je rent de deur door, rent de trap op en gaat snel op je stoel zitten. Net op tijd! Maar hoe voel je je nu?

Appendix 6 - Hoogeveen project; overview of the results of the individual schools (De Sprong, Juliana van Stolbergschool & het Palet)

Hoogeveen project 2018 - De Sprong	Group 3/4	Group 5	Group 6	Group 7	Group 8	Average
Participation percentage children	81%	86%	63%	73%	53%	**74%**
Participation percentage parents	45%	52%	43%	24%	25%	**41%**
3-4 weeks participated	51%	48%	23%	36%	19%	**39%**
1-2 weeks participated	30%	38%	40%	36%	34%	**35%**
0 weeks participated	19%	14%	38%	27%	47%	**26%**
Percentage of children stating to feel more fit after FitGaaf!	55%	29%	30%	45%	41%	**42%**
Percentage of children stating to feel as fit after FitGaaf!	23%	48%	46%	39%	45%	**37%**
Percentage of children stating to feel less fit after FitGaaf!	22%	23%	24%	15%	14%	**21%**
Avg. difference in self-proclaimed fitness, 3-4 weeks participated*	-	-0,1	0,4	0,3	0,2	**0,1**
Avg. difference in self-proclaimed fitness, 1-2 weeks participated*	-	0,4	-0,1	0,3	0,8	**0,3**
Avg. difference in self-proclaimed fitness, 0 weeks participated*	-	-0,3	-0,3	0,6	-0,5	**-0,2**
Avg. rating FitGaaf!**	2,5	2,7	2,4	2,6	2,4	**2,5**

Hoogeveen project 2018 - Juliana van Stolbergschool	Group 3/4	Group 5	Group 6	Group 7	Group 8	Average
Participation percentage children	74%	100%	74%	69%	63%	**75%**
Participation percentage parents	52%	75%	44%	39%	37%	**50%**
3-4 weeks participated	56%	75%	52%	54%	21%	**52%**
1-2 weeks participated	19%	25%	22%	15%	42%	**23%**
0 weeks participated	26%	0%	26%	31%	37%	**25%**
Percentage of children stating to feel more fit after FitGaaf!	67%	50%	48%	20%	67%	**56%**
Percentage of children stating to feel as fit after FitGaaf!	20%	31%	39%	80%	33%	**33%**
Percentage of children stating to feel less fit after FitGaaf!	13%	19%	13%	0%	0%	**10%**
Avg. difference in self-proclaimed fitness, 3-4 weeks participated*	-	0	1,0	0,0	1,0	**0,8**
Avg. difference in self-proclaimed fitness, 1-2 weeks participated*	-	-2	1,2	0,5	0,8	**0,7**
Avg. difference in self-proclaimed fitness, 0 weeks participated*	-	0	-0,8	0,0	0,4	**-0,1**
Avg. rating FitGaaf!**	2,7	3,3	3,2	3,0	2,5	**2,9**

Hoogeveen project 2018 - Het Palet	Group 3/4	Group 5	Group 6	Group 7	Group 8	Average
Participation percentage children	79%	77%	90%	80%	100%	**83%**
Participation percentage parents	42%	54%	60%	20%	20%	**44%**
3-4 weeks participated	58%	46%	50%	40%	40%	**51%**
1-2 weeks participated	20,8%	31%	40%	40%	60%	**32%**
0 weeks participated	20,8%	23%	10%	20%	0%	**18%**
Percentage of children stating to feel more fit after FitGaaf!	75%	69%	67%	0%	40%	**63%**
Percentage of children stating to feel as fit after FitGaaf!	17%	15%	0%	100%	40%	**23%**
Percentage of children stating to feel less fit after FitGaaf!	8%	15%	22%	0%	20%	**13%**
Avg. difference in self-proclaimed fitness, 3-4 weeks participated*		0,5	0,3	0,0	0,0	**0,3**
Avg. difference in self-proclaimed fitness, 1-2 weeks participated*		0,8	1,3	0,0	0,3	**0,7**
Avg. difference in self-proclaimed fitness, 0 weeks participated*		-2,3	-3,0	0,0	0,0	**-0,8**
Avg. rating FitGaaf!**	3,3	3,0	3,1	3,2	3,2	**3,2**

*Overview of the results of the Hoogeveen project at the Sprong (n=181), Juliana van Stolbergschool (n=75) & het Palet (n=45). Complete datasets are available upon request. *: 1=not tired at all, 2=a little tired, 3=tired, 4=very tired, 5= severely tired. A positive value means an improvement, a negative value a decline in self-proclaimed fitness after FitGaaf!. **: 1=not fun at all, 2=not fun, 3=fun, 4=a lot of fun.*