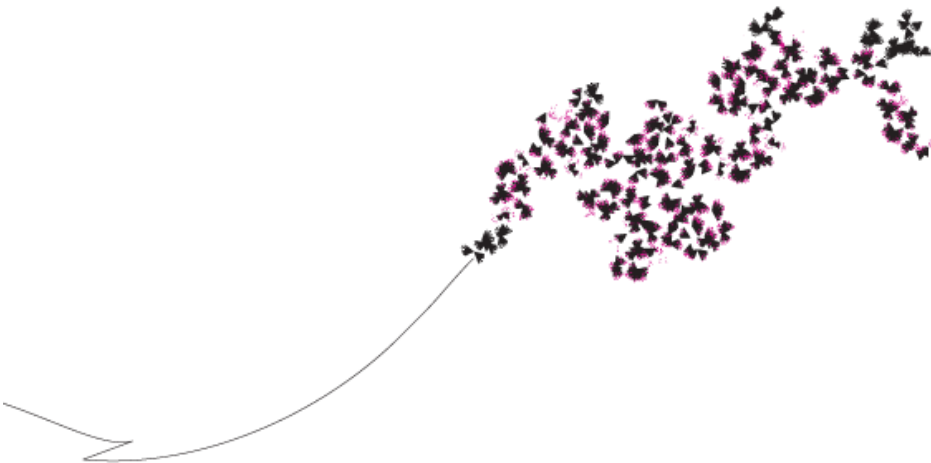Universiteit Twente
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Master Thesis
Gamified wearables in obesity therapy for youth - Successful Fundamental app design guidelines

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1 Abstract

Introduction:

Overweight and obesity have become a global phenomenon. Existing obesity programs for children and adolescents have only limited effectiveness because more than 50% of the times the weight is regained after treatment ends. Obesity treatment requires a multi-professional therapy that is time consuming and expensive. In recent years' science has started to examine the possibility of therapy enhancement through the use of technology.

The aim of this study was to examine which guidelines for gamified wearables can be developed into an effective tool for weight loss and trigger long-term behavior change within children.

Methods:

The thesis comprises an extensive literature analysis and a qualitative research design. Open-ended questionnaires were distributed to 3 clinicians and 18 children and later analyzed with the software MaxQDA. Within the realms of the thesis the three independent variables 1. Age 2. Gender and 3. BMI were considered and evaluated for biases.

Results:

The research has identified fundamental guidelines for gamified wearables that have potential to compliment traditional obesity enhancing weight loss. The second question investigated the impact for gamified wearable to trigger long-term behavior change cannot be reliably answered. Conclusions were drawn for the independent variables age and gender. The independent variable BMI, due to a too small sample size, was inconclusive. Based on the identified fundamental guidelines a prototype *'Body Balance'* was developed composed of 1. Game-approach 2. Rewards 3. Obesity management tools and 4. Education.

2 Background

In recent years increase in body weight and obesity have become a widespread, prevalent societal problem. It is now recognized as an official chronic disease by the A.M.A and WHO.[1] One particular novel concept that helps to promote healthy lifestyles and can fight obesity is gamification, where the treatment of obese clients is supported through the use of video and online games or apps with game elements. Another promising concept is the use of wearables. Tracked health related data can promote and enhance a healthy lifestyle (Spil et al., 2017). Currently there is very little research available regarding the effectiveness of gamified wearables to reduce obesity in children, although several studies (Spil et al. 2017, Tong et al. 2015, Zhao et al. 2016a, Zhao et al. 2016b) suggest that the two concepts combined can lead to positive outcomes.

Obesity leads to other chronic diseases such as diabetes or cardiovascular problems the major cause of morbidity worldwide.[2] Obesity is a financial burden to the economy of the healthcare system as well as the clients. It results in delayed skill acquisition in educational and cognitive abilities of children as young as three years old (Cawley, 2010).

The national center for health statistics in the USA has published results indicating that the worldwide prevalence of obesity is rising steadily and has more than tripled since 1970, especially among children and adolescents (Ogden et al., 2006). Thus childhood obesity can be considered as one of the most serious public health challenges in the 21st century. Thorpe et al. (2004) stated that this fact explains 27% of the increase in health care expenditures between 1987 and 2001.

According to the estimates of the WHO (World Health Organization), from a global perspective, the number of overweight or obese children (0 – 5 years old) in 2015 was more than 42 million. WHO currently estimates the number of overweight or obese infants and young children globally to increase to 70 million by 2025.[3] As obesity in children is generally associated with a higher chance of premature death, disability in adulthood, and serious consequences regarding psychological health, there needs to be numerous effective intervention programs that aim at helping children, adolescents, and adults with obesity

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(Dietz, 1998; Kelishadi & Azizi-Soleiman, 2014). In spite of these intervention programs the number of obese children is increasing at a steady rate. The question that remains is, how can existing obesity intervention programs be successfully augmented?

A recent field aimed at helping to reduce obesity is the field of digital health. In principle the concept of gamified wearables is a novel approach to motivate people to promote a change through the use of gaming elements which have been repurposed to engage the user playfully in a non-game context (Deterding et al., 2011).

Therefore, the purpose of this study is to understand the dynamics of gamified wearables to gain deeper knowledge into the field of obesity and its challenges, as well to provide guidelines for gamified wearables by answering the research question: **What are the basic and effective guidelines for gamified wearables in order to accomplish weight-loss and long-term behavior change in overweight and obese children and adolescents?** In order to answer this question this thesis will explore what obesity is, how it is currently being treated, to what extent technology in form of gamified wearable is already being used, and which guidelines need to be implemented in order enhance treatment.

3   Literature Review

To provide a rigorous literature review and a scientifically researched master thesis, a five-stage process based on the grounded theory approach as proposed by Wolfswinkel et al. (2013) was applied. This method ensures that a flexible roadmap finding the most influential documentation concerning the research question was followed and a transparent review was conducted.

According to Wolfswinkel et al. (2013) the criteria for inclusion and/ or exclusion for the research articles was made. Where thesis articles include a medical and IT part, a distinction between these two fields has been made. The scope of the time frame of the publication for medical articles was set between 1997 – 2017, and the scope for health – IT related publications 2007 – 2017. The purely medical related literature review was restricted to literature regarding obesity in children and not obesity in general. Due to very limited available literature on the use of technology and obesity in children, the distinction was not made for digital health literature.

Then appropriate 'fields' of research were identified in more detail as the topic of the thesis expands into different subfields within different disciplines. The subfields that were identified

are 1. Obesity, 2. Gamification 3. Wearables and 4. Digital Health. After having identified the scope and subfields the outlets and databases were selected. Based on the previously named restrictions the literature used was found in the database of Web of Science, Scopus, Picarta, Science Direct and NCBI.

Before the initial search progress through databases began, various possible search terms were determined as to ensure topicality and scientific relevance. The main search terms that were used were: obesity/overweight in children, childhood obesity, weight loss, Health Apps, gam*, which stands for serious gaming and gamification, wearables and smartphones, as these terms sufficiently reflect the scope of the chosen research area.

The initial search was carried out while navigating through the different databases duplicates were collected, which is why in stage three of Wolfswinkel et al. (2013) approach these doubles were filtered. Papers which were not applicable, identified by reading through abstracts and parts of the texts, were filtered and removed. During the selection process the preliminary criteria regarding the digital health and obesity subfield were adjusted. The search process was repeated several times until no new relevant articles appeared.

In stage 4 of Wolfswinkel et al. (2013) the selected texts were analyzed by first re-reading the abstract and highlighting the most interest findings and insights. During this process, certain concepts began to emerge. These concepts were grouped into categories. During the process the categories 1. Obesity in Children, 2. Digital Healthy Obesity, 3. Gamification, 4. Wearables 5. Gamified Wearables were constructed. Lastly, while preparing the analysis of the literature review, relations between the categories were found, which lead to the last stage of Wolfswinkel et al. (2013) approach, organizing the structure of the literature review chapter. In the following the processed and prepared data from the literature review will be presented.

3.1 Obesity in children

First and foremost, it is necessary to define the term obesity. According to WHO, "Obesity is abnormal or excessive fat accumulation that may impair health.". Obesity, regardless whether the patient is an adult or child is the result of a chronically high calorie intake where more calories are being consumed than expended daily (Pulgarón, 2013). It is also important to elaborate on the thresholds for overweight and obesity. The most important indicator for overweight and obesity is the body mass index (BMI), which is defined as the body weight of a person divided by the square of his height in (kg/m^2).

The internationally agreed thresholds of the body-mass index (BMI) indicate underweight, normal weight, overweight, and obesity in adults, but cannot easily be applied to children as age, gender, race, puberty and ethnicity have an impact on the classification (Han et al., 2010), which is why medical professionals apply BMI-SDS values and consider the age of child in order to determine whether a child is categorized as overweight or obese.[4]

Ebbeling et al. (2002) who reviewed many studies regarding obesity in children name insufficient physical activity and excessive calorie consumption as cause for childhood obesity. They argue that the parent-child interactions and home environment have changed over the past decades and this affects the lifestyle and behavior of children related to the risk of obesity. As an example, they name frequent family dinners in restaurants and greater access to television as a cause for higher calorie intake and less physical activity. An economic explanation was given by Cawley (2010) who argues that technological advances in food mass preparation and preservation have added to the phenomenon of eating more in less time. Budgetary restrictions of schools have led to the reduction and elimination of physical education classes. He goes on to elaborate that in the United States schools place vending machines with high calorie processed foods and beverages, instead of establishing nutritious lunch programs which further adds to the problem of childhood obesity. As a result, childhood obesity is a complex, multidisciplinary societal, and economic problem.

Childhood obesity comes with considerable consequences for both the (1) individual and the (2) economy. From the perspective of the patient, childhood obesity can have substantial physical, psychological, and psychosocial consequences in the near and distant future (Ebbeling et al., 2002; Han et al., 2010). Bjørge et al. (2008) and (Must et al., 1992) among many others have studied the relation between childhood and adolescent obesity, and increased adult morbidity and mortality. Both have found evidence that there is a positive association between childhood obesity and premature death. Society has a very negative view of overweight and obese children and stereotype them as unhealthy, academically inferior, socially inept, unhygienic, and lazy. Thus, these children develop a negative self-image very early on, and grow up with a very low self-esteem, which is associated with loneliness, sorrow, nervousness, and unhealthy high-risk behaviors that can eventually lead to severe eating disorders (Ebbeling et al., 2002; Hill & Silver, 1995). These studies show the need for a stable,

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4 http://www.who.int/mediacentre/factsheets/fs311/en/

safe environment that provides the help and support to minimize the drastic consequences of this issue.

Singh et al. (2008) reviewed and examined publications and found the likelihood for obese children to grow into overweight and obese adults is moderate for overweight and obese youth. This indicates that obesity is a chronic disorder which is in need of persistent management and efficient treatment (Han et al., 2010).

Such intervention programs are both time consuming and costly for the client and the healthcare system (Cawley, 2010; Thorpe et al., 2004) . The significance of these implications point to the need to solve this societal problem with effective and efficient intervention programs. A German intervention program called MobyKids, owner Nina Holtz published a paper that explained that one year of frequent participation in the program 67% of the children are successful in increasing their self-esteem and improving their state of health (Holtz et al., 2015). Ebbeling et al. (2002) cites that the U.S. National Institute of Health(NIH) consensus shows that currently only 10% of actual weight loss can be expected from the participation in conventional programs. Commonly half of any weight loss is regained within 1-1/2 to 5 years.

Sarah E Barlow and Dietz (1998) recommend persistent support from the family after participation in the initial intervention program to maintain, strengthen, and improve the newly acquired behaviors. Immaturity of children compared to adults is the major obstacle in the successful treatment of childhood obesity. There are several other longitudinal studies that have demonstrated the crucial importance of parental participation in the obesity treatment of children because parents provide the emotional stability children often need (Sarah E. Barlow, 2007; Epstein et al., 1994; Golan & Crow, 2004; Golan et al., 1998). Sarah E. Barlow (2007) published a study in which they identified the primary goal of obesity therapy and its treatment to be a change in the patient's long-term physical and emotional health through an improved healthy lifestyle, accompanied by weight loss, increased physical activity, rise in psychological well-being and self-esteem. A 4-stage approach for child obesity treatment was developed. In summary, the stages say that children need to be taught basic healthy lifestyle eating and activity habits by minimizing inferior food choices, increasing healthy food consumption, physical activity, and learning to understand the client and their values. This implies that education plays an important factor for these children. Doctors and clinicians need to target the bad and good behaviors and provide more structured obesity

weight management support in order to achieve healthy goals. As can be seen in a study from Kelishadi and Azizi-Soleiman (2014), who reviewed several clinical-based obesity programs, the above mentioned components are incorporated in the behavioral therapies as the examined programs comprise components such as motivational interviewing, goal setting, positive reinforcement, monitoring, and cognitive restructuring. All these programs contained nutrition and exercise education which together with counseling had significant effect on the children's body weight. In the Sarah E. Barlow (2007) study it has been made clear that the treatment of obesity requires lifelong attention and commitment and that it is also necessary to alter and adapt the home environment for healthy habits, as weight loss alone will not achieve the long-term goal of a healthy lifestyle and the treatment of children needs a multi-faceted solution. The Epstein et al. (1994) longitudinal study suggested that not only positive parental behavior, but long-term changes in their environment, reinforcement of physical activity, and a healthy lifestyle are important for therapy to be successful. Again reinforcing the importance of sufficient education and support.

It becomes clear from corresponding academic and scientific literature that smartphones and wearables pose as two burgeoning device categories that yield the power to promote healthy lifestyles and enhance treatment (Spil et al., 2017), which is the goal that clinicians would like to achieve after the initial intervention program.

Therefore, the following chapter 3.2 will focus on reviewing literature regarding technology, in particular gamified wearables. The review will highlight guidelines and to what extent such gamified wearables can be leveraged when integrated into various interventions that might be useful in long-term behavioral change of obese children.

3.2 Technology

In the past decades, increasingly more and more technological inventions have been designed that breathed new life into many industries. Since persuasive technologies can positively influence and stimulate health related behavior, the interest in such digital innovations has grown in recent years (Zuckerman & Gal-Oz, 2014). Especially for the healthcare industries such technologies yield the power to not only improve life quality, but also reduce healthcare related costs and therefore pose as a possible financial relief (Spil et al., 2017).

Two very promising technological concepts for the healthcare industries are gamified apps, and the usage of wearables. Literature on wearables and gamification are increasingly being published in highly ranked journals and conference proceedings (Spil et al., 2017).

The following three subchapters will provide more detailed information on aspects on these topics.

3.2.1 Gamification

As mentioned above, gamification is a major field of research and interest for the healthcare sector and has received worldwide attention in recent years due to pervasiveness of smartphones and computers (McGonigal, 2011; Richards et al., 2014; Zhao, Etemad, & Arya, 2016; Zichermann & Cunningham, 2011). In principle, the concept of gamification poses as novel approach to motivate people and promote a change in them through the usage of game elements which have been repurposed to engage the user playfully in a non-game context. The game elements trigger a sense of joy and thus enhance the users experience, ultimately training or teaching the user new knowledge trough the game elements (Deterding et al., 2011). Deterding et al. (2011) defined gamification as *"the use of game design elements in non-game contexts*."

With the increasing prevalence of smartphones, by 2021 72% of the global population, meaning 5.6 billion people, are said to be mobile users[5]. Companies are developing gamified apps that are aimed at favoring certain behavioral traits through motivating the user with game elements, positive feedback and rewards (McKeown et al., 2016). McKeown et al. (2016) state in their article that the possible game elements which can be applied, reach from overall game mechanics and dynamics over very specific components, to aesthetics for such potential apps. In a broader sense one can distinguish between two components which are part of every gamification app: 1. game mechanics and 2. game dynamics (Zichermann & Cunningham, 2011). According to Zichermann and Cunningham (2011) game mechanics are functional components which one can also find in traditional video games, like pattern recognition (memory-game interaction), gifting (easy transferable virtual items), collecting, gaining status (trophies, badges), fame (leaderboards) or flirtation (e.g. poking, easy-to-ignore interactions). While game dynamics represent the reactions of engaged users as response to the used game mechanics like self-expression, altruism or competition to name a few (Thiebes et al., 2014;

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5 http://www.cisco.com/c/m/en_us/solutions/service-provider/vni-complete-forecast/infographic.html

Zichermann & Cunningham, 2011). If game mechanics are implemented the right way, game dynamics can be exploited to inherently align the companies interest with the intrinsic motivation of the user (Zichermann & Cunningham, 2011).

Cugelman (2013) elaborates that within behavior change it is important to know which persuasive principles work for which application and that it needs to be assessed whether gamification itself is a suitable application for an intervention and therefore assessed 7 criteria that help identify the suitability (Appendix 1). Cugelman's (2013) thought of process matches to some extent Cialdini (2001) who described 6 influential principles and distinct psychological means that can be used by designers of persuasive technologies to create an effective persuasive system. Cialdini (2001) outlined that the appropriateness of a principle varies with cultural and personal preferences due to underlying psychological processes. According to Cugelman (2013) the framework of gamification needs to have, among other things, the ability to foster motivation within the user and for them to overcome their challenges. This compares the persuasive architecture of gamification with the principle of coaching. Moreover he calls upon the theory of "flow" by Csikszentmihalyi (2014) that is frequently used in video game design. It describes how people become bound up and engaged in certain activities given that their skill level perfectly matches the challenge level suggesting that a game should increase its degree of difficulty and excitement with the users' experience so the user becomes absorbed in the game. He states that gamification should comprise a game that is not only fun but also supports the user to set goals, provide increasing challenges, and motivation in form of reinforcement, show progress and feedback and give rewards (like status or badges for achievements) and should contain a fun factor with social connectivity. Zichermann and Cunningham (2011) defined the enjoyment and fun component as the "Fun Quotient".

It becomes evident that there are numerous scientific publications (Baranowski & Frankel, 2012; Cugelman, 2013; Hswen et al., 2013; Hu et al., 2014; Jones et al., 2014; Spil et al., 2017) that solely examine the usability of gamification in healthcare and specifically in relation to reducing childhood obesity. Several gamified apps which are available in the stores of iOS, Android, and Windows under the category of health and fitness are proof. (Deterding et al., 2011).

It can be concluded from the literature review that gamification can be used in the healthcare industry to motivate clients and stimulate their long-term behavior, effort and difficult challenges for the clients can be turned into more engaging and enjoyable activities

provided the situation is assessed correctly and adequate game mechanics and game dynamics, like rewards and skill matching games-approaches are carefully combined and applied (Cugelman, 2013; Deterding et al., 2011; Spil et al., 2017; Zichermann & Cunningham, 2011).

3.2.2 Wearables

Wearables exist in various devices such as smart watches, smart glasses, bracelets, gesture controllers or belts, and are believed to change our lives (Zhao, Etemad, & Arya, 2016). Prominent examples are the Apple watch, the FitBit bracelet, the controller belt and google glasses (Spil et al., 2017).[6] The number of wearables is expected to grow from 9.7 million devices in 2013 to 135 million devices in 2018.[7] As society has recently started moving towards a healthier lifestyle an increase in the adoption of such wearables has occurred (Nelson et al., 2016). *"The terms "wearable technology", "wearable devices", and "wearables" all refer to electronic technologies or computers that are incorporated into items of clothing and accessories which can comfortably be worn on the body."* (Tehrani & Michael, 2014). Healthcare and fitness specific wearable devices can be identified as technological gadgets and activity trackers to monitor and record a person's physical fitness activity which are worn by the person (Fritz et al., 2014). The most common functionalities of wearables are step counting, speed and distance tracking, heart rate tracking, and quality of sleep monitoring. The transfer of the data to other devices takes place through Bluetooth or Wi-FI. Tehrani and Michael (2014) pointed out in their publication that although wearables can perform many of the core tasks of mobile phones and computers, the focus of wearables lies in the provision of sensory, monitoring, and scanning features of health-related data which are typically not seen in mobile and computers, therefore outperforming them in this area.

Table 2 which is based on Butte et al. (2012); (Spil et al., 2017); Yoganathan and Kajanan (2013) displays a summary of the identified wearable categories, their functions, and the data that is being collected.

Table 1: Wearable Technology, Function / Measurement & Data based on Butte et al. (2012); (Spil et al., 2017); Yoganathan and Kajanan (2013)

Wearable Technology	Function / Measurement	Data
Pedometer	Can accurately measure step count, also estimates distance	Distance & speed tracking, calorie counting

	and energy expenditure but less accurate	
GPS	A Global Positioning System, provides information on a person's location, mode of transportation, and speed	Distance & speed tracking, recording achievement
Accelerometer	Recording movement and speed. Thus provides indication of frequency, duration, and intensity of physical activity	Speed tracking
Heart Rate Monitor (HR)	Lightweight and (small) monitoring devices for heart rate that indicate of energy expenditure	Heartbeat measuring and calorie counting
Bluetooth	Connects multiple devices with each other	Sharing capability and expandability
Wi-FI	A wireless computer networking technology with which networking capabilities over various radio bandwidth is possible	Sharing capability and expandability

Wearables can easily and comfortably be worn the entire day, personal physical information can be collected throughout the day (Spil et al., 2017). Dontje et al. (2015) stated in his study that the self-monitoring of such physical activity on a daily basis potentially increases one's awareness to such an extent that it can pose as a pre-requisite for behavioral change. This implies that wearable devices can serve as a client management tool and have enormous potential in field of health and medicine. Nelson et al. (2016) conducted a survey that has shown that individuals wearing wristbands like FitBit, or Apple Watch, are positively influenced because an individual's feelings of empowerment are increased.

As can be seen in existing literature wearable devices yield enormous potential for the health sector. The combination of gamification and wearables, gamified wearables, seems to yield enormous potential. Therefore, the following literature review subchapter 3.2.3 will investigate in detail gamified wearables.

3.2.3 Gamified Wearables
At the theoretical level this thesis, similar to Zhao, Etemad, and Arya (2016) investigates to what extent the three general fields (1) Serious Gaming & Gamification, (2) Wearable Technologies and (3) Health and Fitness combined can help to enhance traditional obesity intervention. The investigated target field is thus the overlap of these three fields, named

gamified wearables. Therefore, it is important to determine, similar (Zhao, Etemad, & Arya, 2016)al. (2017), Wortley (2015), Zhao, Etemad, and Arya (2016) and Zhao, Etemad, Whitehead, et al. (2016) to what extent wearable technologies can be utilized for interaction with gamification and whether that idea is feasible, motivating, and engaging. Spil et al. (2017) assessed in their publication that people have a positive attitude towards wearables and gamified health apps in general, but the adoption and usage rates of wearables are still relatively low especially in comparison to the adoption and usage rate of gamified health apps. Nonetheless, people show an increasing interest in wearables and their usefulness. Gamified apps are already a widely-accepted concept but the Spil et al. (2017) results have shown that users show increasing doubts over the physical data quality. As has been already established by Spil et al. (2017) through the use of gamified wearables these doubts could be eliminated, thus the quality of the gathered data would increase. Tong et al. (2015) also suggested that game-based approaches can be utilized to encourage and promote physical activity and lifestyle improvement. Within the serious gaming and gamification an incentive approach is being applied where virtual and physical rewards are set to decrease obesity and increase quality of life. Tong et al. (2015) stated that the effectiveness of research prototypes which use 'gamified wearables' are rarely investigated. Zhao, Etemad, and Arya (2016) developed based on their own findings a pilot prototype. A player vs-player and a single-player goal-based game as a case-study for their concept and found that based on their results it can be said that existing technologies do match the current user needs. Indicating that the idea of deploying gamified wearables for exercise and fitness is feasible, motivating, and engaging.

Another case study regarding gamified wearables was carried out by Wortley (2015) over a time period of 2 years. He investigated the use of the wearable bracelet, Jawbone UP, which measured and collected data regarding physical activity, ones' sleep cycle, and calorie consumption (manual entering of nutrition data) and displayed the data within a free mobile application that gave feedback and visual support. The main conclusion Wortley (2015) drew from his own study was that disruptive technologies like gamified wearables, which provide accurate data measurement, feedback and smart coaching, e.g. in form of games, can create an engaging experience that yield the power to influence behavioral change. It has to be noted that the study was applied to adults. Therefore, it would be interesting to see whether same results could be achieved with children. Since the original draft of his publication Wortley (2015) was involved in several gamified wearable projects. Among others the PEGASO

project'[8] which investigated the use of wearables and gamified apps to encourage and enable healthy lifestyles amongst teenagers.

When reviewing existing literature, it becomes evident that there have been several attempts to develop and implement gamified wearables to achieve weight loss, to raise realistic awareness of physical activity and calorie consumption (Ahtinen et al., 2010; Kniestedt & Maureira, 2016; Tong et al., 2015; Xu et al., 2012; Zhao, Etemad, & Arya, 2016).

3.3 Summary

In the following I will summarize five main guidelines gleaned by the authors in literature analysis regarding potential weight-loss and long-term behavior change through wearables and gamified apps. The literature analysis has investigated critical guidelines for gamified wearables for enhancing obesity therapy individually and jointly, and indicates that the below named points combined should be examined more closely within the qualitative study as to ascertain whether they can lead to weight-loss and long-term behavior change within obesity therapy.

1. Obesity management tool:

   Visually edited data helps to support self-improvement due to a learning curve

2. Game-Approach:

   Gamified Apps encourages physical activity and trigger lifestyle improvement.

3. Rewards:

   Virtual and physical rewards decrease obesity and increase life quality

4. Emotional support:

   Virtual motivational reminders create engaging experiences and provide support that eventually trigger behavioral change.

5. Education:

   Nutrition and exercise education have a positive effect on body weight

4   Empirical Analysis

4.1 State of the Art

In the first subchapter of the empirical analysis a detailed overview of state-of-the-art projects regarding gamification, wearables, and obesity in youth will be given.

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8 http://www.pegaso4f4.eu/

When searching through the App Store or Google Play Store several gamification apps can be found. In Appendix 2 a table is attached which shows current gamification apps and gamified wearables for children on the market that are aimed at increasing physical activity and improving nutrition.

Tong et al. (2015) has published a paper in which he states that game-based approaches, meaning utilizing a gamification strategy for an app together with a wearable, can promote physical activity and substantially improve quality of life. In the paper a created research prototype named "FitPet" was presented to introduce the design of such a potential mobile game. A follow-up study could expose important issues such as how such games and systems can be effectively implemented into the everyday life and cast some light onto the user's reaction towards interactive games. Tong et al. (2015) research prototype, which is elaborated in more detail in Appendix 3, is intended to motivate and encourage people to implement more walking into their daily life through a reward system because regular physical activity is crucial for the physical health of an individual. The game can be related to Tamagotchi's. More importantly Tong et al. (2015) have applied the mentioned game mechanics and dynamics from Zichermann and Cunningham (2011). Through its accelerometer, the smartphone records steps one takes in real-time. The step data can be converted into coins, so with each step coins can be accumulated which can help to maintain a healthy pet. Similar, Kniestedt and Maureria (2016) proposed a concrete game, the Little Fitness Dragon (LFD), which is a game for smartphones and smart-watches. It can work as a self-standing app or in combination with a smart-watch to track and motivate the players to be physically active. Kniestedt and Maureria (2016) were not yet able to test the validity of the LFD but could evaluate the interest in the game design from their target audience. Byrne et al. (2012) showed within his randomized field experiment with 39 adolescents in the U.S. that virtual pets can influence changes in behavior. Within the Byrne et al. (2012) study adolescents took photos through the app of their breakfast which was then used to take care of their virtual pet resulting, through positive and negative feedback from the pet, in improved breakfast habits of children. Tong et al. (2015) refers within their study to other game-based projects like the "American Horse Power Challenge (AHPC)", a research project by Xu et al. (2012) or "Intro" a project by Ahtinen et al. (2010). Xu et al. (2012) project AHPC is a competition game to increase physical activity for adolescents and consists of a wearable pedometer, web-based game, and personal feedback. The game challenge was intended to change physical activity

behavior. Consequently, the results of the study focused only on increasing adolescent physical activity, not direct weight loss. The challenge was a multi-month school-based competition in form of a virtual race against other participating schools within the United States. The pupils had wearables which counted their steps and the earned points into an online platform. Each student contributed to their school's rank and were notified via a virtual achievement reward about their progress and points. Xu et al. (2012) results indicated that the AHPC in fact did increase physical activity of students but that the effectiveness reduced over time especially in students who participated for a long period of time. The authors believe the justification lies within the design scope of the gamified wearable, as interest cannot be sustained over a long-time period. To maintain long-term interest in such apps is a widely-discussed factor in research (Hswen et al., 2013; King et al., 2013; Richards et al., 2014). Richards et al. (2014) states *"Systems can grow stale if they are not readily changed or if content remains static. There should be a plan in place to handle the addition of extra content to keep players engaged with the system." King et al. (2013)* discussed, similar to Hswen et al. (2013) that gamified wearables will need to hook users in the same way entertainment and fun games currently do, as the success and adoption of such apps will stand in relation with the motivation and engagement of the users.

As has become evident, gamified wearables are a major field of research and discussion within the realms of the healthcare system. Current research has already revealed several issues, especially to maintain the users interest over a longer period of time. In chapter 3 the empirical analysis will analyze open ended questionnaires that were used with children aged 11 – 16 years of age, and is intended to cast some light onto critical guidelines gamified wearables should follow in order to be effectively used within interventions for weight-loss and long-term behavior change.

4.2 Aims and Objectives

While the extensive literature review gathered the most important insights on the topic, now a qualitative analysis will be presented which will complete and amplify the previous statements. The empirical findings of this study were gathered from qualitative interviews with 18 overweight and obese children and adolescents, and 3 clinicians that work within the realms of interventions to achieve weight loss and long-term behavior change for the clients. The advantage of the applied qualitative method is that detailed backgrounds of the interview

subjects can be disclosed to enrich the information and the results. The results have been obtained by means of a computer-based qualitative data analysis software, MAXQDA.

The purpose of the qualitative study is to elaborate on potential critical guidelines a gamified wearable should have in order to be considered of value for overweight and obese clients and obesity therapy. The interviews for both target groups were conducted following an interview guide that was structured to be transparent. This allowed the clients the liberty to talk openly about their experiences. For reason of privacy the answered surveys will not be provided. The questionnaires are presented in Appendix 4.

4.3 Methodology

The qualitative analysis method follows the grounded theory approach as first proposed by Glaser and then Strauss in the 20th century, and the framework Matrix of Miles and Huberman (1994) for qualitative analyses. In grounded theory one starts with a very concrete and contextual vision and then, based on interviews and emerging answers, underlying explanations can be revealed. The underlying explanations are revealed by obtaining and analyzing in-depth data. Eventually an evolving theory will develop from the corpus of used data. The data analysis is being done through a two-step set of coding processes. Substantive and theoretical coding. In substantive open axial and selective coding is applied. The ultimate goal is to produce categories and their properties. Theoretical coding weaves the substantive codes together into a hypothesis and theory (Glasser & Strauss, 1967; Strauss, 1987; Walker & Myrick, 2006). Further information, in particular about the Matrix can be found in chapter 3.4 Data Analysis.

4.4 Design & Data Collection

The patient, from now on termed client, questionnaires were distributed in Germany and the Netherlands. The personal conversation lasted between 10-15 minutes. Medical professionals, from now on termed clinicians, questionnaires were distributed in Germany and the Netherlands. These personal conversations lasted between 45 – 60 minutes. Questionnaires were also answered by mail. The questionnaires for the clinicians were kept very general, as the clinicians were asked to elaborate on their own experience and difficulties within obesity therapy. The questionnaires were built upon the identified critical guidelines of the literature analysis.

In the first part the clinicians were asked describe the intervention program they work with. This introduction directly led to the central and crucial discussion of the interview and the main question of the paper. What are the issues that arise within therapy? What are the best tactics and tools to handle these issues? And which parts of the therapy need improvement?

Here clinicians gave in-depth opinions and experiences that revealed various problems. The interview guide for the overweight and obese children and adolescents covered a sports, nutrition, and technology section which was intended to detect the attitude of clients towards the use of gamification and wearables within obesity treatment. This included input from both the interviews with the clinicians, as well as extended literature review.

In order to generate valid results 18 overweight and obese children between the age of 11 and 16 with a BMI between 25 and 52 were interviewed. The characteristics can be found in the Matrix below.

		BMI		Gender	
				Boys	Girls
Age	11 - 13	Overweight	25-30	3	4
		Obesity Grade 1 (slight obesity)	30--35	1	2
		Obesity Grade 2 (obesity)	35-40	2	
		Obesity Grade 3 (strong obesity)	> 40		
	14 - 16	Overweight	25-30	1	
		Obesity Grade 1 (slight obesity)	30--35	1	1
		Obesity Grade 2 (obesity)	35-40	2	
		Obesity Grade 3 (strong obesity)	> 40	1	
			Total	11	7
				18	

Table 2: Interview Matrix

After having been informed about the nature, method, and target load of the investigation all clients or their guardians, and clinicians signed an informed consent. They agreed and acknowledged that the data and results of the study will be published anonymously and confidentially to third parties.

The distinction of age was made based on programs that have been reviewed. Organization 1 offered two distinct intervention programs for children aged 4 – 8 and 8 – 13. The clinician confirmed that within the obesity group 8 – 13, one can further differ between 8 – 10 and 11 – 13 year olds. The other organization works with 6 – 12 contemporary children in a group. Clinicians 1 and 2 were 2 group leaders from groups within Germany that worked mainly with clients of age 11 – 16.

According to my research children aged 11 – 13 are the ideal subjects because they are old enough to understand and work with within the realms of such a study and my personal capabilities. This is because they become increasingly independent and begin to think abstractly and as well start planning ahead for several weeks. They develop a sense for morals and gain a better understanding of themselves thus, making the age range the perfect fit for a potential serious gaming app with which they can work themselves. Children 14 – 16 pose a second interesting target group as they become incrementally more independent of their parents.

On the basis of these factors and information the Matrix distinction 11 – 13 and 14 – 16 year olds was made, therefore the age poses as the first independent variable. The decision to interview boys and girls was made to see whether any gender specific differences exist in preferences to a gamified wearable, becoming the second independent variable. Lastly, it is also interesting to see from a research point of view, whether the degree of obesity or overweight has an impact on the responsiveness for such an app. Thus, BMI is the third and last independent variable.

The data was collected from questionnaires. Interviews were conducted and the data was gleaned from the answers. The interview questions were presented on the basis of a standardized open-ended questionnaire. This approach was chosen to gain an understanding of the motivation, mindset, and opinions. The questions were formulated to generate insight into certain behaviors, opinions, and values, as well the client's feelings towards the topic of obesity therapy. Having distributed the questionnaires with the chosen method provided a valuable profile of potential customer perceptions on gamified wearables for obesity therapy from the client and clinicians.

4.5 Data Analysis

In order to make sense of the collected qualitative data it will be explained how the data was understood and interpreted using the framework of Miles und Huberman (1994). To produce findings for scientific purposes, first the volume of the collected data was reduced so as to extract and identify the most important information and patterns. Based on these findings a framework, in this case the practical guidelines, were established and the essence of the findings unraveled.

While having analyzed the questionnaires of both the clinicians and clients, data has been continuously reduced through re-segmenting and re-summarizing the main categories of the

answer given by the interviewees. The interviews were analyzed by using the coding software MaxQDA. The interviews were completely transcribed. In reference to the elaborated questioning, the essential statements were coded openly and through an in-vivo method, the direct takeover of a quotation. All in all, the 18 client interviews yielded 500 codes which were assigned to categories. In the beginning, there were six main categories. During the coding process new subcategories were created and quotations assigned. Although this method of qualitative data analysis constrains generalizability, it allows developing theoretical constructs to confirm or reject existing theories. The same procedure was used for the medical professional interviews. Three interviews yielded 74 codes and were originally assigned to 5 main categories and 2 subcategories. During the coding process with the in-vivo method new categories evolved and issues within the obesity therapy were revealed.

Codesystem	500
Apps	199
Sport & Games	121
Nutition	126
BMI	18
Gender	18
AGE	18
Sets	0

Codesystem	74
Gamification Wearables	0
Experience with Wearables_ No	6
Potential Goals of Gamification/Wearables	9
Therapy Tactics	17
App functions	17
Challenges	16
Therapy	9

Abbildung 1: Codesystem MaxQDA

Clusters and guideline patterns have been found by coding and interpreting the entire interview, implying that not only the answers but also the mimic and gestures was being interpreted to extract working guidelines. According to the principle of Miles and Huberman (1994) 'You know what you display?' the data was summarized and visually processed with the code-relation-browser, configuration tables and iterated excel table through Max QDA. During the analysis process the graphs and as well tables have been iterated and adjusted to the evolving patterns. Conclusions were drawn in the very end, after having reduced the data to such a minimum that only relevant information that assisted the research question was displayed. Based on the qualitative data analysis sourcebook of Miles and Huberman (1994) a content-analytic summary table was created which brings together all data from the interviews into a single form where all 4 target groups (based on the independent variable age and gender) are examined for their attitude towards the theoretical guidelines. The table will be presented in chapter 5. The content-analytical summary table clarifies the understanding for the critical guidelines.

4.5.1 Implications from the interviews with medical professionals

4.5.1.1 Traditional Therapy

The clinicians were asked to describe the program they are working with within the realms of the obesity therapy. After having analyzed all programs closely, it can be said that they all have similar characteristics.

Children and adolescents that fall within a same age range are gathered on a regular basis for behavioral and nutritional training and to play sports together. The workout sessions consist of cardiovascular training, toning exercise, and persistence training within a playful setting to increase the physical fitness of the clients. The nutritional sessions include theoretical instruction on dietetics, learning to prepare healthy meals, and the realistic perception of food consumption. Further obesity therapy programs often include one-on-one sessions for the psychological treatment of the overweight and obese children and the inclusion of parents. Meaning there are child/parents afternoons and parents also receive one-on-one sessions. Programs are often limited to a certain time frame of 1 to 2 years and the hours of therapy reduce over the length of the program. This is to convey to the children and adolescents a sense of autonomy and independence which they will experience after the obesity therapy. Another important part of obesity therapy is homework for self-reflection. Clinicians all confirmed that obesity therapy makes essential use of game elements, reward systems, and psychological stimulation so as to trigger a long-term behavior change within the children and raise awareness of their habits.

All three clinicians have confirmed that although obesity therapy can be successfully done with children of all age ranges, the best target group are children and adolescents aged 12 or older because they are more autonomous in their everyday life. Further all clinicians explained that the willingness to participate in obesity therapy does not vary with BMI or gender. Also, there is no significant evidence that the success of therapy varies with gender. One clinician expressed that the success of long-term behavior change can be harder in children and adolescents with a very high BMI because the path to a healthy body takes longer and can seem unreachable for them at times. The clinicians were asked to elaborate on the biggest challenges they face when treating overweight and obese children. The analysis revealed that the challenges can be assigned to three categories 1. nutrition challenges, 2. sport challenges,

and 3. behavior change challenges. It becomes evident from the graph below that all programs seem to experience the same issues.
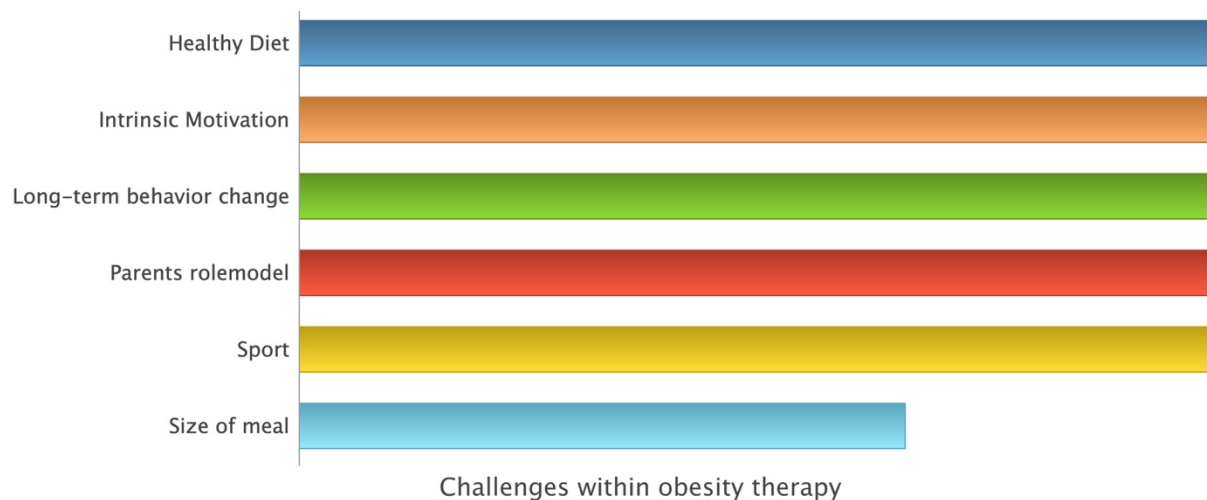

Figure 2: Challenges within obesity therapy

Within the nutritional category clinicians explain that there are two main issues they struggle within therapy. The first issue is that many children lack a basic knowledge of nutrition leading to the circumstance that clients are unaware that their diet is harmful. Within treatment nutritionists work with the client so that they can identify poor food choices so that this issue is resolved by the end of the therapy. The second issue that lies within this category is a lack of discipline*. "At some point children know exactly what is good for them and what is not, but they are missing the discipline and motivation to commit to healthy eating. Many children eat not out of hungriness but pure appetite. The appetite is fueled by different reasons such as socialization, boredom or frustration.[9]"* Clinicians also mentioned meal size, which works closely together with the program content of 'realistic perception of food consumption'. One clinician explained that patients are often excessive when it comes to food and drinks and that their stomach is so used to the exorbitant meal sizes that it takes a longer period of time to adjust the body to normal sizes again. Another clinician reported that the habit of excessive food consumption is not only a problem of the child but also of the family, making it even more difficult to adjust the child to a new perception of food consumption. This leads to another concern, the function of parents to role model. On clinician explained: *"For dinner the family of 4 consumes 2 kilos of potatoes, 2 kilos of pork sausages without any vegetables, with sugary soda and a high calorie desert. The child does not know any better because they have been raised with the false assumption that these excessive meal sizes are*

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9 Interview with clinicians

normal.[10]" It has been mentioned by the clinicians that parents are a crucial factor within the obesity therapy program because the success of the treatment is dependent on the collaboration of parents in the home. The newly taught information has to be incorporated into the family home in order to be adapted by the children and adolescents. If parents fail to work with the medical professionals the chances of success are lower according to the interview clinicians. It has been explained: *"Children often struggle with a healthy diet and rely on their parents to buy the right groceries, prepare healthy meals and snacks for them and to act as a role model when it comes to discipline.[11]"* Clinicians indicated that a bridge between parents acting as role models, and long-term behavior change can be built. According to the clinicians one of the main success factors next to the necessary knowledge for long-term behavior change is intrinsic motivation. But if the family home neither shows support nor adapts the healthy habits themselves, the chances of successful long-term-behavior change are adversely affected. Further all clinicians agreed that the behavior change can only be successfully accomplished if parents support their children. The most significant impact on children is their parent's behavior. One example of the impact parents can have, are the groceries brought into the household. It is the parent's responsibility to provide healthy groceries, snacks, and meals. This is the reason many interventions include parents in the therapy. The clinicians explained that overweight and obese children often do not care how much food they consume. The "I do not care" attitude leads to disproportionate meal sizes and excessive eating habits. All clinicians confirmed that it is more difficult to change the child's behavior towards their diet than getting them involved in regular physical activity. *"It is very hard to control whether children eat appropriately or not. Not being able to give them coaching, as with a membership in a sports association, makes this behavior change very challenging.[12]"* Although regular physical activity is a problem of many overweight and obese children and adolescents, the clinicians stated that with the 'fun factor' committing to this healthy habit is easier. The interviews indicated that physical activity is easy to control and a more accepted concept than a healthy diet.

The third challenge category is behavior change. Within this category lie 3 sub challenges: triggering intrinsic motivation, long-term behavior change within patients, and adjusting the

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10 Interview with clinicians

11 Interview with clinicians

12 Interview with clinicians

parent's role within the client's life. It has been explained by one clinician that the results of an obesity intervention can only be retained in case of long-term commitment, which is only possible with intrinsic motivation, the right control and role model function of the parents. One clinician explained that the most challenging part of the therapy is not only to prepare the clients well enough for the time post therapy, but to trigger the intrinsic motivation within them to change their behavior towards a healthy lifestyle. The goal being to integrate activity and healthy eating into their everyday life. Clients are often willing to participate in therapy, but experience up and downs especially when it comes to discipline with food and activity. Children and adolescents have to intrinsically be motivated to adjust to a healthy lifestyle. All clinicians have confirmed that the assimilation of intrinsic motivation is especially difficult. As stated before, all three parties confirmed that it was harder to change the mindset of overweight and obese children and adolescents towards healthy nutrition than to move and workout. Clinicians have explained that the joy and love for physical activity, which many discover during therapy, they actually view as the most effective tool in changing a child's long-term behavior towards a healthier lifestyle. Possible explanations that were given for this were that clients learn to enjoy sports and have fun during the workout. They associate positivity and fun with sports, which changes their inner mindset towards sport which leads them to adapt this healthy behavior easier into their everyday life. The statement made sums up the implications of this category quite well. *"The disease obesity and its treatment is accompanied by a major psychological component. The feeling towards food, sport, society and their own body plays a major role for successful treatment. Only if the therapy triggers the client willingness to change can relapses be avoided. This is why it is important, that obesity interventions integrate psychologists into treatment and help patients to reveal unhealthy habits and patterns.*[13]*"*

    In summary, all clinicians have confirmed that although many of the clients successfully leave the program because they are healthier according to their BMI, frequently the results are not long lasting considering long-term behavior change is not achieved. Possible explanations that were given are inadequate support which results in a reduction of motivation, ultimately relapsing into unhealthy habits.

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13 Interview with clinicians

4.5.1.2   Gamification, Wearable & Apps

When asked whether mobile applications and wearables could be a tool to prevent such setbacks, medical professionals seemed to be very optimistic. All clinicians have confirmed that the combination of mobile apps, based on the concept of gamification, and wearables could enhance traditional therapy. All clinicians expressed the necessity of an app that varies with the age range of children, which is also executed within traditional obesity therapy. One clinician stated: *"The younger the child, the less we work with text and serious tasks and the more we make use of games and pictures.*[14]*"* In order to see which potential features a future serious gaming app should have one question was directed towards potential features of the technology. Interestingly all clinicians gave the same answer. Only one clinician had a differing opinion on the matter.
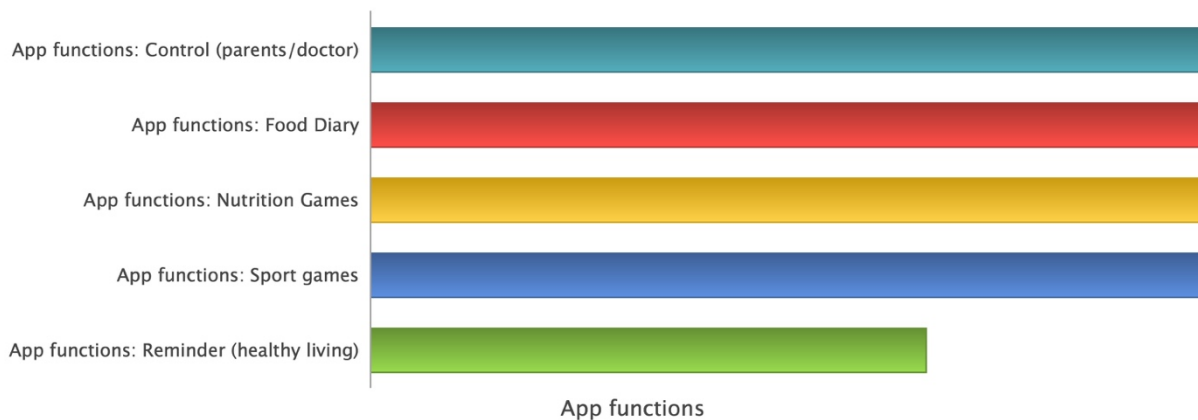
Figure 3: Potential app functions according to medical professionals

Not surprisingly, the proposed mobile app features coincided with the answers from the question regarding the therapy challenges. All three parties stressed the need for a control function. A feature that allows a third party to have access to the client's profile in order to independently gain insight into the child's daily routine. As previously mentioned, the clinicians have explained that due to a lack of control in times of absence of the client, or after the therapy has terminated, many times the success of the obesity therapy is not retained. It was revealed by the clinicians that a control feature that could potentially give parents and medical professionals insight into the daily routine of the user would support the process of understanding the clients experience and habits, and uncover certain patterns that would otherwise be left concealed. One clinicians remarked, *"There exist apps for obesity management but I have to admit that I have not yet come across one that meets all of my and*

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14 Interview with clinicians

my clients' expectations – with a control and login feature for medical professionals is crucial in my eyes. Despite these shortcomings, I still believe in the power of technology and I'm already recommending parents to use sport apps. I'm sure many parents and as well medical institutions would be willing to pay for a technology that combines all features.[15]" It was made clear during the interviews that the sharing of information with doctors and the automatic transfer of data into the health record can be very beneficial and reduce time and effort on the medical side. Clinicians elaborated that the integration of motion data from a wearable device to a health app with the possibility to logon as a third party, be it the doctor or the parent, yields tremendous potential. Clinicians can make sense of a client's progress as their nutrition intake, exercise, and health data can be viewed accurately at any point in time. Following this proposition all clinicians proposed the implementation of a food diary app. Clinicians have also expressed interest in this feature as it would result in less paperwork and could potentially provide more privacy for the children because the logging of food and exercise is more discrete on an app than on paper. Further the main category 'games' was named and can be split into nutrition and sport games, which should be based on both the gamification principle, according to the interviewed clinicians. Two clinicians explicitly mentioned that they are already making use of games and competition principle within current therapy format. Children are not only being encouraged to engage in physical activity on their own and in teams, but also urged to compete against themselves. For example, one of the programs encourages kids to beat their own homework score each month by promising a reward. The reward varies with the score and can reach from a small reward given by the parents to the children, up to a reward provided by the intervention program. The clinician stated that the reward element work really well for groups and her belief is that rewards are among other things, the key factor when it comes to motivating children. It was also emphasized that provided children have fun and experience joy while doing sports, the commitment seems to increase. The clinicians hope that gamification in both areas could trigger a committed improvement due to the fun factor. Two clinicians also mentioned a reminder feature. They thought a meal time reminder would ensure that patients eat when they should, and a motivation reminder could yield the potential to prevent binge-eating. One of the clinicians said, *"I personally think that a visual reminder of healthy habits can be*

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15 Interview with clinicians

tremendously helpful to stay on track and reinforce the thought processes we try to work on during therapy.[16]*"* The third clinician has neither agreed nor disagreed with a reminder feature.

In conclusion, it can be said that the qualitative analysis reveals that all clinicians confirm the need for the critical guidelines mentioned in chapter 3.3. They expressed a benefit from a gamified wearable that supports the clients with an obesity management tool which allows them to have more control and insight into the child's everyday life. Also, games that motivate them to be healthier e.g. through rewards, gives them emotional support and educates them further.

4.5.2 Implications from the interviews with the children

The analysis of questionnaires which were distributed to the children will follow. Based on the critical guidelines that emerged from literature analysis a questionnaire for the children was developed. This is intended to reveal the main working guidelines for potential gamified wearable. The questionnaire was divided into 3 sections, which display chapter 4.5.2.1 – 4.5.2.3 and can be found below. All children had to fill-out a standard pre-section including their age, nationality, height, weight, and mobile phone status. Twenty-one questionnaires were collected, but only 18 were used for the analysis due to age and BMI limitations.

4.5.2.1 Physical Activity

As previously explained in chapter 3.1. physical activity plays an important role in the process of losing weight and becoming healthy within obesity therapy. In order to understand the thought process of the clients better they were asked several questions regarding their preferences towards physical activity.

One key question of chapter 5.4.2.1 is whether rewards can pose as an extrinsic motivator to increase the willingness in overweight and obese children to move and commit to regular exercise. Some of the children were unable to imagine rewards. They were given possible ideas that were based on talks with one of the clinicians and the practical recommendation of the book "Business Gamification for Dummies." The possible reward ideas were spending a day with your parents at a place of your choice, going to bed at a later hour, having a sleepover

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with friends, or receive a small present. As can be seen these are loosely bound to the three business gamification categories 1. Recognition 2. Privileges and 3. Monetary rewards.[17]

The analysis has shown that female respondents in general are not as receptive to rewards as male respondents. The majority of female children are not swayed by extrinsic motivators because they believe the motivation needs to come from within, as their parents always say. Some said that they are already committed to a sport they love doing e.g. dance and that further physical activity cannot be triggered by gifts. The following negative quote was given both by female and male clients: *"If I do not want to work out, I do not work out.[18]"* However, some clients have shown great interest in the idea of rewards as compensation for their physical commitment. The analysis has also indicated that the female clients that had a positive attitude towards rewards, and were most likely convinced by the combination of virtual and personal. It was noticeable that these children were not looking for approval of their parents when asking further questions. One client asked whether they could co-determine the reward, seeming fairly excited. One client expressed particular interest in personal rewards and disinterested in virtual rewards. It became clear from her answer that she perceived virtual rewards similar to badges and a took level status for granted saying: *"I really want more Panini cards. Can I get a more cards if I do not get this badge or whatever? I can get badges in other games.[19]"* Male children in contrast looked for less approval of their parents and showed greater interest by requesting more information on possible rewards. It also became evident that male respondents took that question more seriously. One respondent started arguing with himself while answering: *"It is a difficult question. I mean, I like sports and sport games but sometimes my motivation would be pushed through this, but I also do not think I need a reward every day, because I love soccer.[20]"* Similar to female clients, males also seemed to prefer a combination of virtual and personal reward rather than a stand-alone virtual or personal reward. Several clients wondered about the scope of possible rewards and asked whether money was a possibility as reimbursement for their physical commitment. Nevertheless, some expressed their lack of interest saying*: "If I want my best*

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17 http://www.dummies.com/business/marketing/types-of-rewards-useful-in-business-gamification/

18 Interview with children

19 Interviwe with children

20 Interview with children

friend to sleepover my parents never say no. Why would I have to work out more to get that then? That is stupid.[21]"

The analysis did show that the independent variable gender together with age has impact on the reply of the question, but no such statement can be made for the independent variable BMI. Across all BMI ranges answers differed, reaching from very positive to very negative reaction towards the idea of compensating increased physical activity with rewards. When taking age range into consideration it becomes clear that especially young female clients are not motivated by rewards because they have expressed that extrinsic motivators do not work for them. The analysis evokes sufficient doubts as to whether the questions were answered truthfully. It was observed, that in particular younger female clients were mentally weighing the 'correctness' of their answer. Believing the correct answer to whether rewards would help them to live healthier was 'No', they were seeking the approval of their parents through eye contact. One client verbally stated: *"My mom always says I have to want it myself.[22]"* Strongly implying that the perceived opinion of the mother played a key role in answering this question.

Conclusively the results indicate that personal rewards work better than virtual rewards as extrinsic motivator. In combination, they work especially well. It seems as if rewards for physical activity work best for male overweight and obese children within the age range 11-13.

Clients were asked if they liked sport in form of games, to which all answered yes. The questionnaire dug a little bit deeper and asked the clients answer whether they prefer competitive sport games with friends and in teams, or if they preferred playing sport games by themselves. It became evident that children prefer playing games with friends rather than alone.

Interestingly females expressed the desire that they prefer playing games with a non-competitive background. More than half of the female clients stated they love playing games with their friends, but that the focus on competition builds up a lot of pressure which they are not too fond of. Some girls answered, or words to that effect, that they play together with their friends all time. One mentioned: *"My best friend and I meet almost every week and hang out. We either use my or her stuff.[23]"* It is widely known that girls simulate family and friendship

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21 Interview with children

22 Interview with children

23 Interview with children

situations with their dolls from a young age on, while boys race with their play cars, indicating early on that the female gender has a different attitude toward competitive games then boys. In other words, boys felt very confident about competitive-games. One client elaborated: *"Kinda cool. Can I also compete against strangers? This would be great, then I can practice with strangers and then later win against my friends.*[24]*"* Two boys aged 11 – 13 stated to prefer to play by themselves instead of with friends. The children did not elaborate much further on their answers, but one mentioned briefly that he plays a lot of games at home. The child also answered he likes to play WiiSport and other virtual games. So, it is possible the child plays a lot of Xbox, Nintendo, and Tablet Games, where one usually play by one's self. Further it also became evident that children aged 14-16 have a clear preference towards competition. This result can also be triggered by the effect that more male clients were present in the age range 14-16 than girls. Nonetheless, interviews of older clients have made it clear, that competition games are being viewed as killing two birds with one stone. One client replied: *"It is fun and I can hang out with my friends.*[25]*"* While younger children often expressed the fear of the competition becoming too much. One mentionable quote: *"A little competition is fun and really cool, but not all the time. It then becomes lame…like less fun.*[26]*"* For the variable BMI no interesting observations have been made.

Children were also interviewed regarding the use of gamified wearables like PokemonGo!, GeoCaching, Zombie Run and gamified sport games like Nintendo Wii Sports. Interestingly everyone knew PokemonGo! and Nintendo Wii, but only half of the respondents have answered that they still play PokemonGo!, implying that the gamification features were not entertaining enough to hook the user for a longer period of time. Both female and male clients have expressed enthusiasm about the game but it was noticeable that the enjoyment decreased as time went on. Clients were asked if they felt they were actively working out when playing such games, but a great majority reasoned that they do not feel like they are actively doing sports. *"You do not do sports in front of a screen.*[27]*"* Other children explained that they perceived these kinds of games as a simulation and not as sport. *"It is not really difficult. Sometimes I stand up or walk but I do not sweat.*[28]"* Other children expressed how

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24 Interview with children
25 Interview with children
26 Interview with children
27 Interview with children
28 Inerview with children

passionate they were about these games and how enthusiastic they were following the goal of the game. One female client explained that she does not like the sports because she is not good at it and it makes her feel weird, but she considers WiiSport to be fun because it is not as much pressure or work. It is evident that opinion on this matter divides in two different groups. One group perceives serious gaming as a form of sport they prefer over traditional sports, and the other groups perception is the exact opposite.

4.5.2.2   Nutrition

It was explained in chapter 3.1., that a healthy diet and good nutrition are a crucial factor in the process of losing weight and becoming healthy within obesity therapy. In order to understand the thought process of the children better the clients were asked several questions regarding their preferences towards healthy nutrition.

One of the key questions of chapter 4.5.2.2 is whether rewards can pose as an extrinsic motivator to simplify the commitment in overweight and obese children to a healthy and balanced diet or whether they do not view this as any help. Again, as some children were unable to imagine possible rewards, they were given the same possible reward ideas as in chapter 4.5.2.1.

Older girls thought nutrition rewards were a good idea, younger girls thought of this as an unnecessary tool making it seem like younger female clients are generally less receptive to extrinsic motivation when it comes to nutrition. Justification for this answer had various reasons. One client admitted the following, *"Sometimes you have cravings. Rewards do not matter then.[29]"* Again, another one elaborated that she feels like extrinsic motivation is cheating and rather she would want do it out of intrinsic motivation. However, it was observed that female clients were looking for approval of their parents which were present in the room during the interview. Several clients gave the impression that they were seeking their parents' consent and waited for their parent to subtly convey their response before making their final decision. Boys seemed to answer more independent of their parents. Yet also here one exception was observed. One of the boys, aged 11-13, made sure by verbally asking his father: *"Right Dad?[30]".* The father neither approved nor disapprove but encouraged his son to answer.

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29 Interview with children

30 Interview with children

Many parents have not encouraged their child to have an independent opinion, but rather suggested an answer to their child by nodding.

Male respondents in comparison seem to be more amenable to extrinsic influence and have answered that they favor a combination of virtual and personal rewards. The results further indicate that in cases of a positive answer most clients preferred personal rewards. Generally, it was observed that younger clients think of rewards as extrinsic motivator for support and are more receptive than older children.

In order to assess how well children are educated on nutrition, healthy meal sizes, and control, several questions regarding these topics were given. First, they were asked whether they make use of any visual help e.g. nutritional pyramid throughout the day in order to eat healthy and whether they thought a visual prompt could eventually help them to improve their diet. None of the clients stated they currently use visual help, which is an interesting observation since the clinicians presented to me the material they are using for therapy which undisputable make use of pictures, charts and objects, including the homework material they are given. It seems as if children were not aware of the visual help given. Only a small handful of male respondents think they can benefit from a visual help, while the rest oppose such idea. Female respondents seemed to be more open to this idea, but generally stated the clients were unsure about the effect of such visual help: *"Generally, I know what is healthy and unhealthy, but sometimes I cannot help myself. I suppose a nutrition pyramid could help me to choose better alternatives but sometimes visual help won't help me because when I crave sweets, I crave them, and no visual help in the world makes a difference then.*[31]*"* The age variable indicates that the guideline education, in form of visual material e.g. nutrition pyramid, is more applicable to younger clients. When examining this guideline for the variable BMI no interesting observation could be made.

Following this question, the clients were also asked to estimate whether they are mentally able to differ between healthy und unhealthy snacks to investigate the need for further education. The aim was to figure out whether children consume intentionally or unintentionally too many calories on a regular basis. Only one female respondent admitted to having severe issues estimating the degree of healthiness of her food. Everyone else stated that for the most part that they had a general knowledge about snacks but that they kept

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31 Interview with children

finding themselves in situations where they are unsure about the nutritional detail of the consumed food, so in times of uncertainty they tend to eat the food rather than re-checking or forgoing the snack. One client in doubt stated: *"I cannot differ between healthy and only healthy or really, really bad and just normal bad. I know chocolate is not good for me and tomatoes are, but when I'm at friend's birthday party I sometimes do not know what the healthier option is. But I also admit that I do not care then.[32]"* However there were also respondents that felt very confident about knowing what they consumed, one said: *"We only cook healthy meals at home, so I know that the food I consume is healthy.[33]"* When asked whether they can estimate the caloric intake of the food they consume all but two clients answered negatively. The two clients that have answered that they are able to count calories displayed two specific features. One of the clients revealed later they used a calorie counting app, and the other one added that she was not counting calories but macro and micro values (carbs, fats and proteins). When stating she was aware of the number of calories consumed, she really meant the intake macro and micros values that are counted in grams. Therefore, the general statement can be made that children seem to lack in-depth knowledge about their food consumption. Based on this, the questionnaire dug deeper an asked whether children would prefer to fill out a hand-written food diary or electronically to use an app on their smartphone. The preference obviously lies with an electronic food diary. This result is supported by a closely related question from the questionnaire that intended to figure out whether children would prefer to see the benefits of taking a picture of their food instead of logging their food manually into an app. The data demonstrated that more than three quarters of the children desire such a feature. One client that was unsure about the use of a picture to estimate the caloric intake has expressed the doubt of accuracy, *"Can my phone do that? I do not think it is that precise, and therefore not helpful.[34]"*

The last question asked within this chapter targeted the need of emotional support as a reminder as to stay committed to a healthy diet throughout the day in moments when neither their parent nor their intervention program can be of help e.g. in school breaks, when watching TV in the afternoon by themselves, or when bored. The majority of female and male respondents answered that they could use emotional support in moments of loneliness. One

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32 Interview with children

33 Interview with children

34 Interview with children

respondent acknowledged: *"Eating breakfast or dinner is fine. I mean, I eat whatever my mom cooks, but in the afternoon my mom and dad are working and I'm by myself so I eat whatever is available. Also, I get hungry before dinner and then I snack. If my mom would be home that would be different so I guess if she would prepare something or would come home earlier then I wouldn't snack as much….[35]"* The child went on to explain that she would welcome emotional support. It was noticed that a few clients became increasingly emotional when thinking about the question. Clients were encouraged to deal with the question more in-depth because they did not have a clear understanding of what was being asked. The encouragement lead to the result that theoretically speaking the guideline for more emotional support is wanted by the clients. Further it was observed that male clients 14-16 think of emotional support as redundant. One explained: *"I'm with my friends all the time so I'm never really alone.[36]"* The response makes sense, as adolescents are at more liberty to decide over how they spend their free time. Results give the indication that the negative answer of clients, the ones that do not wish for any further emotional support, has an age and gender bias. Again, no such conclusions can be drawn for the independent variable BMI.

4.5.2.3   Gamification, Wearables & Apps

As previously explained in chapter 3.2.1 the concept of gamification and serious gaming for mobile applications can be used to motivate users and engage them into healthy competition with themselves and others. Thus, generating loyalty towards a certain goal by sparking interest and fun for the user. The goal of this thesis is not only to establish where gamified wearables can potentially enhance obesity therapy, accelerate and support the process of weight loss, but also to reveal working guidelines for such potential gamified wearables. Therefore one section of the questionnaire focused on these types of technology gadgets.

At first all participants were asked if they were in possession of a smartphone. All 18 participants answered yes. Further they were asked if they had any previous experience with smartphone apps regarding 1. Food apps (e.g. counting calories) 2. Exercise apps (e.g. runtastic) and 3. Educational Apps (e.g. math, healthy food). It becomes evident from the data that most of the participant have neither used nor are currently using a smartphone app to help them with their obesity. The ones that have made experience with such apps did not

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35 Interviewwith children

36 Interview with children

elaborate any further. They were then asked if they would be willing to use a wearable device e.g. a smart watch, if this could help them to gain control of their obesity to which most answered yes. Data shows that female clients seem to be slightly more receptive to the idea of wearing a device than male children. But generally, a wearable device was accepted by the majority of clients. When examining the independent variable age, it appears as if younger children are more open to the idea of wearing a device than adolescents. A female adolescent answered: *"Um, yes, but only if it looks good. If it is too ugly I do not want it.*[37]*"* This implies that the design of the wearable device plays a crucial role in the development of wearable device adoption, especially for adolescents.

Before the questionnaire went into the specifics, the children were asked whether they would like an app that helps them, in gaming format, to be physically more active. 13 out of 18 children thought this was something they would like and showed a great deal of enthusiasm. Unfortunately, there is no clear pattern visible for the remaining 5 questionnaire clients, as they split across all age, BMI and gender groups. Reasons for not wanting such gamified wearables were that they already do sports and do not think that there is any need to increase their physical activity, or descriptors like 'lame' and 'uncool' were given. Similar results were found when the questionnaire investigated the same leading question but directed towards a healthy diet. 12 out of 18 children thought of this as something they would like and show great amounts of enthusiasm. The clients that showed disinterest, were mainly the same clients that also showed a disinterest in rewards. Meaning that in particular girls of the age group 11-13 thought of the idea as 'uncool' or 'redundant'. Again, some clients deferred their responses by looking to their parents. One client stated: *"My mom signed me up for sport classes at the sport association club close by my home. It is fun and my mom says that this kind of sport does me good so I do not think an app would do the same.*[38]*"* It cannot accurately be said whether the answer given really indicates a bias by the perceived assumption of child, that the mother would have a negative attitude towards gamified wearables or not, but the gestures of the respondent led me to believe the answer was influenced to some extent. More than half of the participants had an BMI of 25-30. It can be said that generally speaking children appear to like the idea of game-based apps that improve their physical activity and nutrition. These two questions also included a question part b.) where the children had to

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37 Interview with children

38 Interview with children

answer once more what their thoughts were on rewards, which they receive for their achievements within an app. For some children, it appeared to be confusing how using a mobile application can produce a reward. This is why further explanation was necessary during the interview. It was explained to the child that rewards could be given in consultation with parents, doctors, or be displayed as virtual rewards. Data showed that male clients are more open to the idea of rewards than female respondents. Especially younger female clients who displayed a disinterest by implying that the guideline rewards in apps cannot be applied to them.

The children were presented a specific gamified wearable idea and they had to elaborate why or why not they would play the idea presented to them. Or if they would change anything about the presented gamified wearable. The children were given the following ideas:

1. **Monster App – a healthy living reminder**

    The presented picture and idea were based on the mySugr junior app which is directed at children who are diabetic. The diabetes management app belongs to the most successful app on the market with over 1.000.00 users as of May 2017.[39] Children were asked if they think it would be helpful to have a Little Monster companion on their smartphone that gives them advice and reminds them to live healthy at times, when such help is needed. The app would remind children using the wearable device based on the measurements the device and smartphone post throughout the day. The company xBird is proving that technology is extensive enough to recognize such patterns by extracting data points from smartphone sensors and wearable devices, and later combining environmental and digital biomarkers.[40]

1. **Fighter / Horse Game – increases physical activity and healthy diet**

    This game idea is based on the FitPet app, or to be precise the famous Tamagotchi from the year 1996 that came from Japan where children had to take care of a virtual pet by feeding, petting, and taking it for walks. This app in connection with a wearable device would work similarly. With the difference being that the player can only take care of its virtual counterpart through coins, which can be collected through working out and good nutrition. Indicating the more one personally works out and the healthier one eats, the

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39 https://mysugr.com/de/press/

40 http://www.xbird.io/

better the virtual counterpart becomes. Boys and girls were presented with two different game ideas:

Boys: You are creating a player with whom you can fight against other virtual players in an arena. The players your encountering are your friends. Your player is only as strong as yourself. If you are fit and healthy, your player will be strong. Further you are collecting coins through your regular workouts / healthy diet. The coins can be exchanged for protection equipment and boosters within the game. If you do not work out enough or eat unhealthy, your player will be weak. You can play the game with your friends by competing against them or play against random players. You can also form teams with your friends.

Girls: You are creating a virtual horseback rider and a horse. Together you and your horse can participate in competitions and beauty pageants. The other horseback riders you are encountering in the virtual game are your friends. Your horse back rider(player) is only as good as you are fit and healthy. Further, you are collecting coins through your regular workouts / healthy diet. The coins can be exchanged for horse treats and new equipment within the game. If you do not work out enough or you eat unhealthy, you will not be able to rise to new levels. You can play the game with your friends by competing against them or play against random players. You can also form teams with your friends.

2. **Hero App - nutrition education for children**

A very similar game already exists and is named "healthy heroes".[41] The child will create a virtual player (a hero) that tries to protect its hometown from hungry zombies that are trying to eat the brains of everyone in the city. The hungry zombies are not yet in the city, but they are preparing themselves by eating a lot of junk food. The only way, you the hero, can weaken the zombies will be to pick the right choice between various options. If the hero is not picking the right groceries, the zombies will destroy the city.

3. **Step Game - Reward for physical activity**

This game already exists and is called "iBitz", where an app for children is connected to the child's physical activity tracker called 'ibitz Kids Pedometer'. The counted steps can be exchanged into rewards and games.[42] The children within the questionnaire were

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41 https://itunes.apple.com/us/app/id608703978?mt=8&ign-mpt=uo%3D8

42 https://itunes.apple.com/us/app/ibitz-by-geopalz-kids/id588227932?mt=8

supposed to imagine that they collect points as they walk, or run with their friends around the block. Jump in the backyard, play soccer with their friends at home, in school or at their friend's house. All the points they collected they were told they could exchange for different rewards which they define with their parents beforehand.

The evaluation of the 4 games / apps will now be presented and conclusions will be drawn in the following chapter.

Monster App – a healthy living reminder

At first it should be noted that both positive and negative responses were expected. Children gave very descriptive answers whenever they disliked the idea. Negative answers were categorized in the following categories: 1. Childish 2. Annoying 3. Unnecessary and a combination of 2 and 3 together. Positive answers did not split into various categories but were simply defined as 'cool'. An unclear response was defined as 'sometimes'.

The data shows that all clients but two think of the app in a negative way. It became clear that in particular boys are averse to the proposed gamified wearable because the childish design does not appeal to them: *"I'm not a little child anymore.[43]"* Another client has expressed the app to be nonessential and described it as redundant. This answer came as a surprise, since the same client voiced interest in a more stable and safe environment through some form of emotional support. The rhetorical question: *"How is this supposed to help?![44]"* supports the assumption that the monster app was not perceived as a reminder that offered the help the client was looking for. Other clients remarked the app to be annoying time-consuming. It can be presumed that this particular client cannot see the intended added value of the app and therefore labeled it as annoying and redundant. The observation being made indicated that although emotional support, in form of a stable and safe environment where children do not have to handle their illness by themselves is wanted, gamified wearables cannot seem to provide this guideline. However, there were clients who remained indecisive and stated that they would use the app 'sometimes'. A few clients had a more positive attitude towards the monster app, mainly girls. These females responded that they would not want to receive multiple messages throughout the

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43 Interview with children

44 Interview with children

entire day as they would consider this annoying and pointless. But receiving them on a less frequent basis and in the right moment they could imagine it may make a difference.

The independent variable BMI reveals that only children with an BMI of 25 – 30, indicating the person as 'overweight', have showed some interest in the usage of the monster game app.

In summary, it can be said that clients disliked the proposed monster companion game app.

Fighter / Horse Game – increases physical activity and healthy diet

Children were first asked If they could picture themselves using an app with which they could play alone or together with their friend's sports games. Girls and boys were presented two different versions of the game. Girls were presented a game with horses and boys were presented a game with fighters. The distinction was made for reasons of gender differences.

Negative answers were categorized in the following categories: 1. Uncool and 2. Redundant. Both the majority of boys and girls responded they like this idea. There is no major bias in the degree of liking the idea regarding the variables gender, age or BMI.

Some clients have remained indecisive and have explained they would try it out, but are not sure such game would really be interesting. One female client even considers the app to be redundant since she can ride horses outside and does not need a virtual horse. Female clients that said they rated the app as completely uncool have argued that they do not like horses in general. Implying that horses might not be the ideal game story universe for some female clients.

The male version of the game had a greater focus on competition, since it was expected, when first drawing up the questionnaire, that a competitive background storyline would appeal to male respondents. Data indicates that this assumption was correct as boys, across all ages, have repeatedly praised the competitiveness. It becomes evident that competitive games in particular attract the 14 – 16 male age range.

Reasons that were given for why the game was uncool were: *"I do not play games. I do not have games on my phone.[45]"* Implying that the normal assumption, that not every

45 Interview with children

game can appeal to everyone, is correct. Whether a game will be adapted is to some degree always dependent on the personality of the client.

Hero App - nutrition education for children

The children were also presented and asked for their opinion on a game that is intended to teach nutrition in a fun way. Children were first asked If they could picture themselves using an app with which they could educate themselves, or that would support them in a playful manner to keep up healthy eating habits. Negative answers were categorized in the following categories: 1. Uncool, 2. Childish and 3. Redundant.

It can be said that both the majority of girls and boys would welcome the idea of a food game app. The clients were not very descriptive when answering this question positively. Positive answers were only answered with attributes such as "cool" and "sounds fun". The most descriptive answer was given by a female client saying: *"Way better than the homework book.[46]"*

The data also indicates that the Hero App appeals more to children aged 14 – 16, as this specific target group had answered they would download the app from the Appstore with greater certainty then younger children. Some negative answers were given by children aged 11 – 13 such as, the game was childish, boring, or pointless. One child mentioned that they do not see the fun factor in the game. Others voiced doubt of added value explaining that they do not believe this game can teach them anything new about food they do not already know. The most interesting observation made is that it seems that older obese children are an easier target group to access regarding nutrition education. Most young children have rated the app to be childish or uncool. Male clients stated that they would only use the app if it is not to childish: *"I do not know. Is not that a bit childish? I'm not a little kid anymore. So...Umm, no. If it would be less childish, maybe.[47]"* Interesting, that two out of three clients who regarded the game as childish were 11 – 13. The interviews, unfortunately, did not show why younger male children thought the game to be to childish. Albeit, the positive answers outweighed the negative ones.

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46 Interview with children

47 Interview with children

Step Game - Reward for physical activity

Lastly, the children were also presented and asked for their opinion on a sports reward game where the user can collect points which can be exchanged into rewards through moving around the house, playing with friends, or doing actual sports.

The analysis revealed that the majority of girls and boys like the idea. As expected not everyone is fully convinced of the gamified wearable, which is why some responses are negative. Female and male clients have given various reasons for disliking the Step Game. Some clients said it did not feel like a game but more like homework. Another client mentioned the control factor. Indicating during the interview that through the app children could feel more restricted and controlled in their action. Another client viewed the step game as redundant, *"I can use a step counter for that.[48]"* A more neutral opinion was given by a male client explaining that although he can see why friends of his would like the game, he personally thinks it is not the right kind of game for him. He acknowledged the positivity of the app, although it personally does not appeal to him. One interesting observation was that this child was really fond of all the other proposed games and has repeatedly indicated to like the fun factor of all the games. The proposed step game is the least gamy so this could be an interesting observation, as it might indicate that depending on the game affinity of the child, a more serious or less serious game can offer a successful guideline. One of the male clients that rated the gamified wearable to be uncool elaborated that he prefers the proposed fighting game or PokemonGo! Because it is far more entertaining and fun to play. The fun factor for him personally lies within the virtual storyline of the game. This coincides with the other data point mentioned above. When considering the implication of the independent variable age once more into consideration, data shows that the step game seems to be slightly more appealing to children aged 11 – 13, who if we recall are less excited about games such as the Fighting Game. While 14-16 years old are really fond of the idea. This indicates that the attitude towards the game style plays a crucial role in establishing the design of a gamified wearable and directly influences the success of the guideline. It can be said that both the majority of girls and boys would welcome the step game. One client got very excited and sought attention of their parent: *"I cannot decide over a reward right now, but this is so cool. I want that.[49]"*

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48 Interview with children

49 Interview with children

4.6 Summary

The empirical analysis revealed that all interviewed programs seem to experience the same issues when trying to change the behavior of overweight and obese children towards a balanced and well-sized diet due to a lack of intrinsic motivation. Which often rules out any chance for a long-term behavior change, resulting in weight gain after the therapy ends. Because parents often not the role model they need to be. Clinicians indicated that lack of physical activity can be an issue. The clinicians stressed that a potential smartphone app should feature tools that motivate children to eat healthy, workout, and give them the possibility to control themselves better, and should also give them the possibility to control the everyday progress of their clients. Based on these statements children were presented several questions regarding their habits and preferences. They were also given several gamified wearable ideas for which they had to give their opinion. The table bellows shows a summary of the requested features in a potential gamified wearable based on the question asked in the interview.

	Female 11- 13	Male 11 - 13	Female 14 - 16	Male 14 - 16	Clinicains
Food Diary	requested	requested	requested	requested	requested
Picture Diary	requested	requested	requested	requested	n/a
Nutrition Game App	not requested	requested	requested	requested	requested
Sports Game App	not requested	requested	requested	requested	requested
Competition and Team Games	requested	requested	requested	requested	requested
Horse / Fighting Game	requested	requested	requested	requested	n/a
Nutrition Rewards	not requested	requested	requested	not requested	requested
Sport Rewards	Neutral	requested	not requested	Neutral	requested
App rewards	not requested	requested	requested	requested	requested
Step Game	Neutral	requested	requested	not requested	n / a
Support Reminders	requested	requested	requested	not requested	requested
Monster App	not requested	Not needed	not requested	not requested	n / a
Snack Estimation / Calories	requested	requested	requested	requested	requested
Nutrition game App	not requested	requested	requested	requested	requested
Hero App	Neutral	Neutral	requested	requested	n / a

Figure 4: Overview of data in table

Both female and male clients were open to the idea of using a wearable device if it could help them to lose weight and data also showed that clients were also in favor of the idea to use a gamified app which helps them to be physically more active and commit to a healthy diet. Clinicians have stated that children seem to have an issue controlling themselves when

it comes to healthy food. The children were asked if they were in need of emotional support. Both female and male respondents answered that they could use some emotional support reminders in various moments throughout the day to keep up a healthy diet. The proposed monster app was not the right tool they are looking for.

When asked whether clients can estimate the caloric intake of the food they consume, all but two respondents answered negatively, and had a positive attitude towards the proposal of an electronic food diary and a picture feature to count calories on a plate. The analysis on children's attitude towards rewards for keeping up a healthy diet and increased physical activity, resulted in the fact that personal rewards or a combination of personal and virtual rewards are a good extrinsic motivator. However, it is debatable whether rewards are critical guidelines for gamified wearables. A discussion on this can be found in the following chapter. Four specific games were proposed. Regarding the monster companion which is a nutrition reminder, it can generally be stated that clients disliked the proposed monster companion game app. Three other proposed gamified wearables have received mainly positive feedback. Implications and argumentations based on the above results will be made in the following chapter where the empirical analysis and existing literature are being compared to further underline the basic guidelines that can be used for gamified wearables.

5   Discussion

In order to answer the main research question of the thesis: **"What are basic and effective guidelines for gamified wearables in order to accomplish weight-loss and long-term behavior change in overweight and obese children and adolescents?"** the results of the empirical analysis need to be combined with the findings of the literature analysis and the proven therapy treatment plan for overweight and obese children. The following chapter will establish which are the basic and effective guidelines based on the conducted qualitative study. The chapter will conclude by presenting a content-analytical summary table, inspired by Miles and Huberman (1994) to point out the working guidelines for gamified wearables.

First of all, it needs to be pointed out that the named issues within the obesity treatment of the literature analysis and the empirical analysis correlate with each other. Literature shows that existing obesity therapy programs consist of physical activity, behavior change, and nutrition component (Sarah E. Barlow, 2007; Kelishadi & Azizi-Soleiman, 2014). The interviewed programs contain the same components. Although the programs are being

carefully designed and the programs coordinators are trying their best to increase the well-being of the children and change their long-term behavior, literature shows and clinicians confirm, often the weight lost is regained after the program ends because long-term behavior change was not achieved. (Ebbeling et al. (2002). Clinicians have expressed that the long-term behavior change is extremely difficult to maintain after the therapy ends. Clients regain weight when clinicians can no longer supervise their behavior patterns and are not able to provide guidance in times of need. Thus, it is of huge importance to find guidelines for gamified wearables that can uphold, deepen, strengthen, and enhance newly acquired healthy behaviors to prevent the reoccurrence of obesity.

The literature analysis has shown that overweight and obese children have an illogical and abnormal relation to food and meal sizes. Further, unhealthy food and more calories are being consumed in less time (Sarah E. Barlow, 2007; Cawley, 2010). This phenomenon has also been observed by clinicians. Which is why they have expressed the need for an obesity management tool with a control function in order to access and watch the child's daily routine. The clinician's suggestion to implement a food diary into a potential app, as the ease of food logging and exercise is simpler for patients, will help ensure a more precise and frequent documentation of the caloric consumption and energy expenditure. Clients have expressed interest in such a tool. Children have also reacted positively towards the idea of a food photo recognition feature which would provide an easy way for children to estimate calories in a meal using the smartphone camera instead of manually entering the nutritional value of their food. There are companies currently working on such a service.[50] Clinicians believe that parents should have access to such a tool. Literature showed that wearable devices can give access to these data points (Nelson et al., 2016; Spil et al., 2017; Zhao, Etemad, & Arya, 2016). The data analysis has revealed that children would be willing to wear such a device. Provided clinicians can have a third-party access to an app used by clients on a regular basis, this could pose as an obesity management tool with a control function. The data implies that an obesity management, in form of a food and picture diary tool, serves as a basic and effective guideline that is both requested and needed by clinicians and clients.

Clinicians and literature agree that interest in particular game-approaches to complement already established game elements within the current therapy format, will motivate and

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[50] https://www.sri.com/engage/products-solutions/food-recognition-technology & http://foodai.org/ & http://www.caloriemama.ai/ & http://www.popsci.com/google-using-ai-count-calories-food-photos

encourage their clients outside of therapy to behave accordingly. Gamification does indeed have the potential to engage users in normal effort tasks. Previous projects have shown that the level of physical activity can increase (Deterding et al., 2011; Xu et al., 2012). The problem is that the effectiveness can decrease over time, emphasizing that gamification needs to pique the users interest over a longer period of time. This can be achieved through matching skill and entertainment level. The difficulty of the game has to increase and new incentives have to be offered to maintain the suspension and interest in achieving new goals, and e.g. new rewards (Hswen et al., 2013; King et al., 2013). Based on the literature findings and the wish to integrate nutrition and physical activity games from the clinician's side, clients were offered several gamified wearables. Children were offered 1. A nutrition reminder app, 2. A food education game, 3. A Tamagotchi based lifestyle game for female and male patients and 4. A step based workout game with rewards. As Cugelman (2013) has reported, it is important to assess beforehand whether gamification provides a potential tool for obesity interventions and which persuasive principles need to be applied in detail. Clinicians have confirmed that potential gamified wearables need to consider gender and age differences. This is why all interviews were analyzed considering age, gender, and BMI the third variable.

Although the question of long-term use cannot be answered within this study, the interviews can shed light on basic and effective guidelines that can be implemented as to foster motivation, engage users to subconsciously reach their goals, and potentially be used over a longer period of time so that a positive behavior change towards a healthy lifestyle can be achieved with a higher degree of probability. The guidelines that were identified within the literature analysis were 1. Emotional support 2. Game-Approach 3. Rewards and 4. Education.

1. Monster companion – a nutrition reminder.

Clinicians have expressed that the reason why children consume excessive calories varies for different reasons. One of them being boredom and socialization. Sarah E. Barlow (2007) has stated within her study that next to a proven genetic risk, the environment influences the child's eating and workout habits. She explains that more ready-to eat foods, increased television viewing, and less outdoor activity have a negative impact on children. Clinicians believe that children want emotional support in moments of need, e.g. watching TV, playing PlayStation etc. the proposed Monster Companion app was not well received by the children. A motivation reminder has the potential to prevent binge-eating attacks, but the children viewed the proposed app as childish, annoying, and unnecessary. The reasoning of the clients

implies that the thought of receiving infinite messages throughout the day is viewed as annoying and controlling which is not welcomed by children as per the interviews.

It can be said that although some sort of support reminder is requested and needed, a gamified wearable that sends frequent messages is not the solution and thus does not serve a basic and effective guideline.

2. Fighting / Horse Game – a Tamagotchi based app

The proposed game number 2 is based on the Tamagotchi principle. This principle has shown as far back as the 90s, that users can grow attached to the well-being of their virtual pet (Kniestedt & Maureira, 2016). Byrne et al. (2012) showed that virtual pets can influence changes in behavior. The proposed app within this study, which was adjusted to the independent variable gender, was to encourage regular physical activity and stimulate a healthy diet by linking their lifestyle to the well-being, power, and possibilities of their virtual player. Smart-watches would be used to ensure accurate tracking of health-related data. The data of the empirical analysis has indicated that within the realms of this study all target groups, divided by age and gender, would make use of the game. It became obvious during the interviews that female clients are sensitive to the competition factor and prefer games with less competition. While male clients, especially older ones, find competition appealing. This result is not much of a surprise, since female clients are not in favor of competition games, but like the thought of sport games. Male clients favor competition features. The male version of the proposed app was designed with a greater focus on competition. A couple of the younger children were indecisive. The close analysis indicates that the background story of the fighting game might not be adequate for all younger male clients and another game story needs to be invented for the younger audience. This would intersect with Cugelman (2013) statements that developers should only make use of gamification when it seems suitable. Meaning that the right persuasive principles need to be applied for the right people.

Generally, it can be said that a gamified wearable with a game-approach such as a game where the virtual player's well-being is connected to the real-life player's well-being, can serve a basic and effective guideline.

3. Hero App – nutrition education for children

Literature and clinicians have both pointed out that an important part of therapy is to teach children about nutrition. Not only to decrease their caloric intake and achieve weight loss, but also to raise awareness of the root cause of excess weight. The goal is to trigger a dietary

behavioral change so that the clients long-term physical and emotional health can be ensured (Sarah E. Barlow, 2007). Clinicians have stated in the interviews that the most challenging part of the therapy is to change the children's attitude towards a healthy diet. Obese children's appetite is motivated by various reasons that often have nothing to do with hunger. The interviews also implied that the misinformation when it comes to food and meal sizes poses an additional challenge when trying to change the child's behavior. Children are not aware of their erroneous perceptions, despite the children stating to have a relatively good knowledge of food. They were offered a nutrition game where a virtual player tries to protect the hometown from hungry zombies through differing healthy und unhealthy foods. The empirical analysis revealed that the majority of girls and boys would welcome the idea of a food game app. Boys children seem to the be the better target audience, especially the age group 14 – 16. Interestingly a couple of younger children have stated the game is too childish. These comments were not fully understood since all older children, except one, did not perceive the game as to childish.

In summary, it can be stated that the Hero App would be a valuable tool to teach children about nutrition and enhance their knowledge. Education serves a basic and effective guideline for gamified wearables.

4. Step Game – reward for physical activity

The clients were also presented with the last game, a step game. The idea was based on 'iBitz'. The idea, Tong et al. (2015) suggested that game-based approaches with rewards can encourage physical activity. Cawley (2010) explained, often the initial success of an obesity intervention cannot be sustained if long-term behavior change within the clients cannot be generated. According to scientific literature, rewards are an effective tool for gamified wearable to help clients commit themselves long enough to the app so that the behavior change is gradually assimilated in their daily lives and the fundamental motivation to stay healthy is intrinsically developed.

In order to get a more accurate perception of the relation between rewards and children, the reward propositions were categorized in rewards for nutrition, rewards for sport, and rewards within apps. The empirical analysis revealed that younger female respondents were not extremely enthusiastic about rewards. Younger male respondents in contrast welcomed the idea of rewards. Results indicate that rewards for increasing physical activity work best for male patients within the age range 11-13. In the other 2 cases, same results were seen. Thus,

the results regarding the step game do not come as a surprise: boys 11 – 13 welcome the idea, girls 11-13 oppose the idea, boys 14 – 16 are indecisive and girls 14-16 were also in favor of the proposed app. Younger children appear to prefer the simple step game over the more complicated fighting / horse game that has a deeper background story. This also intersects with the results of the PokemonGo! question. Children were asked whether they play PokemonGo! which is a relatively simple game. Taken these 2 questions together, it appears that results indicate younger children to prefer simple games. The concept of rewards is not as widely accepted among all age classes as assumed. But still appeared to pique the children's interest. The empirical analysis results also led me to believe that sole virtual rewards will not be effective. Rather the use of personal rewards or the combination of both will stimulate the child's interest.

In conclusion, it can be said that rewards are a basic and effective guideline for gamified wearables to enhance obesity therapy.

One the next page a content-analytical summary table based on Miles and Huberman (1994) can be seen which summarizes all results and shows clear indication of which theoretical guidelines can be implemented and effectively used for future app development. The table seen above sums up the results categorized for target groups divided by age and gender. The results for the variable BMI have been omitted due to too small sample size.

It becomes evident from the empirical analysis that clinicians believe in the potential of gamified wearables and are positive that the concept can help them to tackle the challenge of a healthy diet and long-term behavior change. The empirical analysis has demonstrated that some guidelines would be adapted enthusiastically into the daily routine by the children e.g. children have shown enormous interest in the idea of using game-approach apps to lose weight and become heathy. The thought of getting displayed nutritional related data and wearing a wearable device to track health-related data, as some form of obesity management tool meets approval with most clients. The concept of rewards did not meet the approval as assumed by clinicians or myself through existing scientific literature, which comes as a surprise. One clinician explicitly stated they successfully use the concept of rewards within their program. Three clinicians have stated that in their experience children respond really well to rewards. The possibility of false statements is discussed within the limitations in chapter 7.

Critical Guidelines from the Literature Analysis	Critical Guidlines working for gamified wearables?				
	Target Groups				
	Female 11- 13	Male 11 - 13	Female 14 - 16	Male 14 - 16	Clinicains
1. Realization of Obesity management tool	implement the guideline	implement the guideline	implement the guideline	implement the guideline	implement the guideline
Food Diary	Needed	Needed	Needed	Needed	Expressed deep interest in an accurate food diary
Picture Diary	Needed Observation: Have e expressed doubts of accuracy and functionality	Needed	Needed	Needed	n/a
2. Realization of Game-Approach	implement the guideline	implement the guideline	implement the guideline	implement the guideline	implement the guideline
Nutrition game App	not needed	Needed	Needed	Needed	Elaborated on importance of nutrition education within therapy
Sports Game App	Needed Observation Have expressed doubts of accuracy and functionality	Needed	Needed	Needed	Elaborated on Sport being a crucial component of therapy, a successful treatment method, believe in motivation of
Competitive and Team Games	Needed Observation: Smaller focus on competition and more on team-work and friendship games	Needed Observation: A few clients have expressed wish to play alone	Needed	Needed	One clinicans has explained that team competition elements are already integrated into the therapy program. The others ahve expressed the strong believe in
Horse / Fighting Game	Needed Observation: Some complaints, have expressed regarding the setting of the game and competetiveness	Needed	Needed	Needed Obersation: loved the competitive focus of the game	n/a
3. Realization of Rewards	Don't implement the guideline	implement the guideline	implement the guideline	guidline indecisive	implement the guideline
Nutrition Rewards	Not needed Observation: clients looking or approval of their parents	Needed Observation: In particular virtual rewards	Needed	Not needed	Believe in the power and potential of rewards, one has already integraed such feature
Sport Rewards	Neutral Observation: seems to dependent on the personality and attitude of the client	Needed Obersation: Some have expressed a particular interest in personal rewards	Not needed	Neutral	Believe in the power and potential
App rewards	Not needed	Needed Observation: Some have expressed a particular interest in personal	Needed Observation: Only personal rewards	Needed	Believe in the power of rewards, one has already integraed such feature
Step Game	Neutral Observation: Seems to dependent on the personality and attitude of the client.	Needed	Needed	Not needed	n / a
4. Realization of Emotional Support	Don't implement the guideline	on't implement the guideline	n't implement the guideline	Don't implement the guideline	implement the guideline
Reminders & Support in moments of doubt	Needed	Needed	Needed	Not Needed	Think that clients need a stable and safe environment with guardians reminding them to lead a healthy
Monster App	Not needed	Not needed	Not needed	Not needed	n / a
5. Realization of Education	guideline indecisive	implement the guideline	implement the guideline	implement the guideline	implement the guideline
Snack Estimation / Calories	Needed Obersavtion: Expressed to see the benefit of extending their kowledge in this field	Needed Obersavtion: Expressed to see the benefit of extending their kowledge in this field	Needed Obersavtion: Expressed to see the benefit of extending their kowledge in this field	Needed Obersavtion: Expressed to see the benefit of extending their kowledge in this field	Elaborated that it is of importance that children have an idea on nutritoonal value of food they consume
Nutrition game App	Not needed	Needed	Needed	Needed	Elaborated on importance of nutrition education within therapy
Hero App	Neutral Observation: Seems to dependent on the personality and attitude of the client, but is not conceived as to childish	Neutral Observation: Game should not be to childish	Needed	Needed	n / a
Results: Which Guidelines are critical to implement into the app	1,2, and maybe 5	1, 2 ,3 and 5	1,2, 3 and 5	1 , 2 , 5 and maybe 3	Have expressed the necessity of a gamified wearable to include all the above named guidelines to resolve the current issues 1,2,3,4 and 5

Table 3: Fundamental App Guideline Content-analytical summary table based on Miles & Huberman (1994)

The clinicians and literature have indicated the importance of nutritional impact education on the degree of obesity. The data shows that education is wanted and needed by the clients. One theoretical guideline was not supported by the data of the empirical analysis: emotional support.

The analysis has shown that children and adolescents do not think a gamified wearable solution that is intended to provide emotional support is a helpful tool for them, thus indicating it is not an effective guideline.

It became clear that a potential app has to be well structured and tailored to gender and age. Clinicians have confirmed within the questionnaire that the traditional therapies are also adjusted for age variable. Within the realms of this study there have been clear differences between preference within the variables age and gender, but often only a very slight or uninterpretable difference for the variable BMI which could be due to the small number of clients within these groups

In conclusion, it can be said that the interviews have revealed that when the 4 effective guidelines are being applied and potential gamified wearable are adjusted for gender and age they have the potential to be good support tools for traditional obesity interventions.

6   Potential Gamification App: Body Balance

A prototype app which was created with the help of Yulia Byron-Moiseenko will be presented. The empirical findings were first translated into sketches and then into a functioning, well-designed prototype.

The prototype app 'Body Balance', was first created on paper and then transformed into a clickable dummy app using the platform Invision to demonstrate how a prototype obesity management and gamified app with a wearable would appear.[51] The link for the online app will be available at the end of this chapter. When following the link the static screens will transform into a clickable interactive prototype. The link can also be opened on a smartphone where it will simulate a real-life mobile application.

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51 https://www.invisionapp.com/

The idea behind the app is to incorporate it into current obesity therapy programs. The clients, their family, and the clinicians will download a version of the app to support and enhance treatment. Results have indicated that the content of a potential app should vary with gender and age. A prototype for the specific target group male aged 11 – 13 was created. This was a random choice for reasons of time and space. Only one clickable prototype could be created.

After having downloaded the app from the corresponding mobile app store the clients will enter their age and gender into the phone. The design and content of the app will adapt based on these two data points. Once the data points are entered the screen will change and children are given the ability to fill out their personal profile. Clients will need to provide: name, birthdate, patient number, doctor, weight and height. The BMI is automatically calculated.
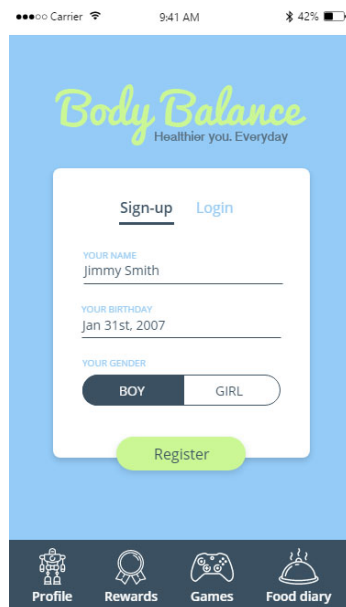

Figure 5: Landing Page

Figure 6: Profile Page

At the bottom of the screen fours tabs are visible which gives the user the ability to go to their profile, the achievement hall, the game room or their food diary. The app is an obesity management tool, utilizing the achievement hall, food diary, and games in the game room. All sections of the app contain gamified elements which synchronize with a wearable, a gamification app.

Within the achievement hall clients are able to see their progress and their physical health status. It was decided to integrate this tool because the interviews made it obvious that clients interpret their own skills and health status inaccurately. Clients can also display the average value of the past week/month and see the value of their caloric intake and the physical steps

taken. This section also monitors weight loss progress. All three information screens are visually implemented using a color scheme to display the positive or negative current state of health. All data points have the potential to earn badges and also provide the opportunity for self-improvement. The gamified element badges are being used to verify the reality of the client's health status and to provide them with a sense of amusement and accomplishment. When the achievement hall tab is opened brief feedback and motivating messages are displayed that are intended grab the attention of the client and encourage them, for example,
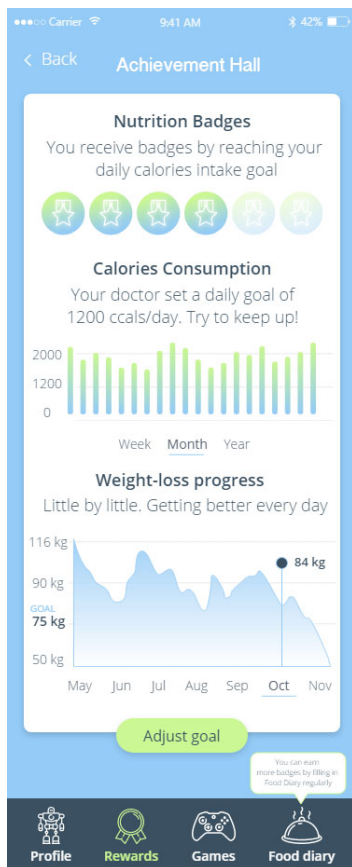

Figure 7: Achievement Hall

to increase their step count. These messages are only displayed within the tab and are not repetitive because clients have stated that an excessive number of reminders would be considered annoying. Male clients aged 11 – 13 prefer virtual and personal rewards. Which is why the tool was developed. In the lower right hand corner, a *Help button* can be found which can be used if a client needs support.

Step Goals and caloric intake are discussed and predetermined by the clinicians and parents. These can be difficult goals to achieve leading to dissatisfaction if goals cannot be attained, and the color scheme indicates this to the client over a period of time. Therefore, they can contact their clinicians or parents to adjust the step and caloric intake goal through the *Help button*. The data is being captured primarily from the wearable and the food diary. The data will be transferred automatically through Bluetooth or Wi-FI. The weight loss progress needs to be entered manually. This serves as an obesity management tool.

Clients can also choose to enter the game room. The game room contains a section that will increase their physical activity. In the prototype app 'Body Balance' three games are displayed. The steps game named '*Balance up'*, the fight game name "Fight your way to the top" and the hero game '*From Zero to Hero'*. For reasons of simplicity only the step game will be illustrated.

'*Balance up'* counts steps that can be changed into rewards and games.[52] User's will have an animated mannequin, a so called virtual player, at their disposal which will move itself depending on the steps the client takes on a virtual landscape. The landscape of the virtual player adjusts depending on the season (e.g. winter wonderland, summer camp, Halloween haunted castle etc.). Every time a client has reached a new destination which correlates with a predetermined step goal that has been set by the parents and clinicians, children will not only be rewarded with a personal reward by their parents, but will also receive virtual rewards such as badges, level rank, small animated videos, or accessible mini games. Again, the number of steps is captured from the wearable device. It is important to mention that a low amount of step does not lead to penalties.
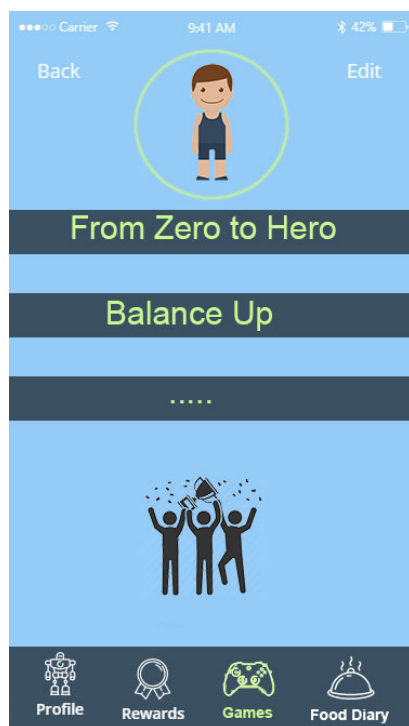

Figure 8: Game room

Figure 9: Balance up - Halloween edition

Clients can also enter a second obesity management tool, the food diary. The food diary is equipped with a food photo recognition feature, a barcode scanner, and a food database that delivers nutritional values for any type of food. Clients can view their caloric intake, their energy consumption, and the remaining number of calories. There is a tool that gives them information on what additional foods they can consume after having burned a certain number of calories. The proposition of the app will be based on the foods the user eats regularly as

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52 https://itunes.apple.com/us/app/ibitz-by-geopalz-kids/id588227932?mt=8

this will be classified as favorite food. Further they can see the macro level category of their nutritional intake, referencing fats, carbohydrates or proteins. They can log food into the corresponding section e.g. breakfast, snack and so forth. Additionally, clients are being provided a button to express their emotions towards a meal with an emoji and can add notes into the additional free space. These emoji's can be viewed by clinicians and parents to offer the client emotional support when experiencing a bad day. Also, patterns regarding their food habits can be revealed.
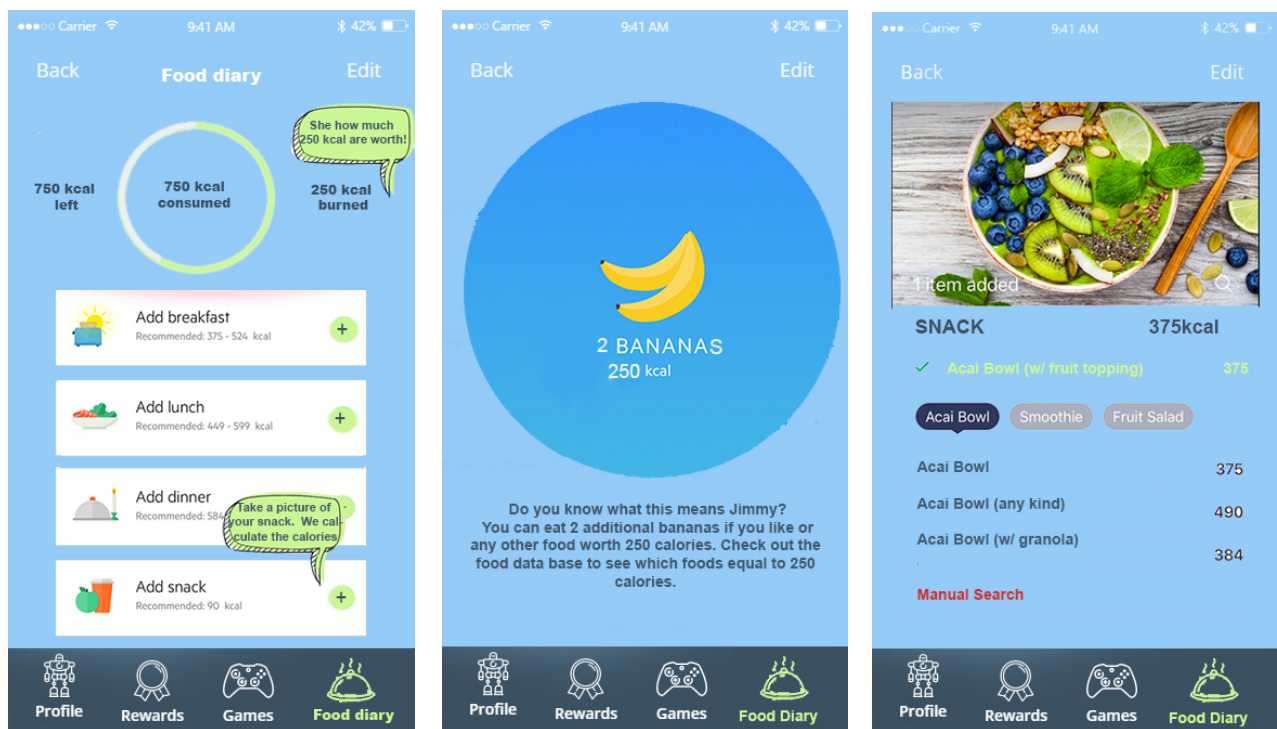

Figure 10: Food diary

It should be mentioned that both the clinicians and parents will be able to download a corresponding app that will provide them access to the client's data by entering the name, client number, and a PIN. Both parties then have access to all health-related data from the wearable. This includes step counting, speed/distance tracking, heart rate, and quality of sleep monitoring. Through this app clinicians and parents can see whether the child has activated the help button in the achievement hall to request emotional support. They can view the food diary documentation and log onto From Zero to Hero to set rewards for step goals.

Follow the link: **https://projects.invisionapp.com/share/UJCGGGP5A#/screens** in order test the clickable prototype online. Or insert the link into your internet browser on a smartphone.

7 Conclusion

7.1 Limitations

The conducted study has several limitations. There is a potential for bias due to the small and uneven distributed sample size. The study was comprised of 11 males and 7 females. For example, it appears that boys are a more receptive target audience for several of the proposed tools and games. It should be taken into consideration that a larger and more age diverse sample size was the reason. It also has to be noted that while some BMI classes have various interview subjects allocated to them, some only have one or in the case of female respondents, none. Despite this fact, it was still decided to consider female respondents within the analysis. First, the difference between gender is important. Second, results illustrate various discussion points.

In conclusion future studies that will build upon this research need to consider a larger sample size in order to provide more accurate results.

It is also possible that results are biased due to the interview method. The interview subjects were under age so their parents accompanied them to the interview. Children were looking to their parents for approval when answering the questions. Their body language and wording led me to believe that some questions, especially the reward question may not have been answered truthfully. Various children gave an answer to appease the parent by stating rewards would not serve the right purpose and they would need to find the motivation to change within themselves.

Follow-up studies need to interview children separate from the parents to remove this potential bias. A room where the respondents are isolated from their parents would help to eliminate this ambiguity. Such limitation could be avoided for future studies by including a control variable like length of being in therapy and current attitude towards existing gamified elements to detect whether intrinsic motivation should have already been developed. This could give insight as to whether children have answered truthfully.

7.2 Implication

The goal of this research was to answer the research question: "**What are basic and effective guidelines for gamified wearables in order to accomplish weight-loss and long-term behavior change in overweight and obese children and adolescents?**" Conclusions can be drawn for the variables age and gender. The results for the variable BMI have been

neglected due to limited sample size. An extensive literature analysis, an empirical analysis, and a fully designed prototype app based on the evaluation of open-ended survey was developed. The objective is to devise guidelines that can be applied to benefit obesity therapy programs to increase weight-loss and motivate long-term behavior change.

The results have shown that gamified wearables are expected to help to manage obesity by helping clients to reduce weight. The rationale is because overweight and obesity is, according to Pulgarón (2013), the result of continual high caloric intake, because more calories are being consumed than expended daily. All 4 effective guidelines support children not only by teaching them relevant knowledge about nutrition, but would also motivate them to increase their daily physical activity through games, resulting in a higher expenditure of energy. Additionally, the app reinforces the child's self-management by providing accurate health-related data through the wearable and assisting in the documentation of consumed food. The objective is that this will lead to an inherent knowledge of nutrition and its health implications.

The qualitative analysis has also revealed that triggering long-term behavior change will, despite utilizing a gamified wearable, still pose a major challenge. Rewards, according to the clinicians and literature, pose as an effective tool to entice user to remain committed to a gamified wearable. Surprisingly, it has become clear that children are not sure what they think of rewards as incentive to commit to healthy behaviors like a healthy diet and regular physical activity.

In conclusion, clinicians and patients need a multi-faceted technological solution in order to achieve weight-loss and enduring behavior change which will complement obesity therapy. Results indicate that the theoretical effectiveness of the guidelines will differ with age and gender of the clients. Based on this it was established that a potential gamified wearable will have to be developed for specific target groups. Within the thesis a gamified wearable, the 'Body Balance' app was developed for the target group 11 – 13 and male. 'Body Balance' integrates 4 of the main guidelines into a gamified wearable in order to accomplish weight loss and long-term behavior changes. These basic and effectives guidelines are: 1. Obesity Management Tool, 2. Game-approach 3. Rewards and 4. Education.

7.3 Outlook

In order to obtain more accurate results steps need to be taken to examine the long-term effectiveness of a combination of wearables with gamified health apps. Additional studies are needed with larger sample sizes and more diverse gender, age, and BMI groups. Additional research is needed show how the development and implementation for wearables and gamified health apps can be realized. Future studies should also consider further development of therapy programs such as existing gamification approach in traditional therapy, diet plans, and psychological therapy, to examine how a comprehensive app can influence therapy.

Based on the results of this study I conclude that gamified wearables will undeniably contribute to the enhancement of current obesity therapy resulting in a healthier lifestyle for children. Provided clinicians, parents, and children collaborate in partnership to accomplish this objective and the four guidelines are applied.

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9 Appendix

9.1 Appendix 1

In order to evaluate the suitability, the intervention developers should consider (1) the intervention users, (2) the user's social context, (3) the intended psychological and behavioral outcomes, (4) the fit of the intervention's logic model/theory of change with the persuasive architecture of gamification, (5) the interactive product or platform that is being planned, (6) the compatibility of the interactive product, users, and community with the 7 gamification strategies and (7) the compatibility of the interactive product, users, and community with gamification tactics (Cugelman, 2013).

9.2 Appendix 2 – State of the Art

Apps	Function
Monster Manor	"Monster Manor is a free game that helps families of young children with Type 1 diabetes stay on top of their testing and logging schedule. It aims to engage children in their health management and improve their adherence to treatment while having fun.[53]" → Gamification through collecting points approach
MySugr Junior	"mySugr Junior is a diabetes app designed to provide communication between children living with diabetes and their caregivers. It gives the caregiver a sense of security and control of diabetes management, even when apart, while playfully engaging the growing child in their own diabetes therapy.[54]" The app features following: - enter blood glucose, carb intake and medication (ease of use) - take pictures - send information and pictures via email to your e.g. doctor - receive feedback from a funny and adorable diabetes monster - collection of points for motivation and engagement
Smash your food	The smash your food app raises awareness in children for nutritional values of different foods.

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[53] https://play.google.com/store/apps/details?id=com.ayogohealth.monstermanor&hl=en

[54] https://itunes.apple.com/us/app/mysugr-junior/id702919897?mt=8

	This happens by letting children guess the nutritional numbers and then smash their chosen foods in a compressor to check the real nutritional values. " FEATURES: • Choose from 40 foods to SMASH, on 5 levels – from doughnuts and burgers to full meals! • High definition video - Yes, we did do this to real food! • Vivid sound effects – you can actually hear every squish, glop, fizz and pop! • CRAZY FOOD! Unlock stacks of Crazy Food for even messier splats – there are 10 of these in the game! • A compelling, fun way for children to get important health information while having a blast, and —there's no mess to cleanup! • Personalized nutrition tips and advice are emailed to parents as their children master each level. [55]"
Eat & Move-O-Matic	"Learn about the foods you eat and how they help fuel your body for your favorite activities. Use the Eat & Move-O-Matic to make new discoveries about your favorite foods and get interesting tips on how small changes can make big differences.[56]"
Healthy Heroes 1	„Yogopolis is in trouble and it needs your knowledge of nutritious foods to save it! Hungry monsters have come to destroy the city, and the only way to satisfy their appetites is by feeding them with fruits and vegetables. Are you up for the food-chomping challenge? FEATURES: - Choose between 20 cool Yogotars - 6 hungry and funny monsters - 36 levels of fun - Delicious and fun variety of fruits and vegetables[57]"
iBitz by GeoPalz	"GeoPalz encourages kids and parents to be more active and think healthy through their line of pedometers for kids by motivating them through rewards found in the app. Their ibitz by GeoPalz Kids pedometer syncs wirelessly to the free app on select iOS Bluetooth Low Energy compatible devices (see below), allowing for endless game interaction fueled by their physical

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55 https://itunes.apple.com/us/app/smash-your-food-hd/id502316034?mt=8

56 https://itunes.apple.com/us/app/eat-move-o-matic/id522849906?mt=8

57 https://itunes.apple.com/us/app/id608703978?mt=8&ign-mpt=uo%3D8

	activity. As your child runs, jumps and plays, they power their GeoBotz virtual character along on an epic adventure through the galaxy, exploring different planets and having adventures along the way! The ibitz device wirelessly syncs to the app so the child can see their progress and access the rewards they have earned, such as screen time, play time with a parent or a trip to the zoo. Parents can manage the goals and rewards directly from the app. It is never been easier to help your child stay active and develop healthy habits that will last a lifetime.[58]" Features: - Tool for parents to customize goals and rewards - Use of GeoBotz character that encourages consistent usage - No in-app purchases - Compatible parent companion app
Sworkit Kids	„Turn Fitness into a game with your children with customizable workouts for Strength, Agility, and Flexibility! No matter where you are, every moment is an opportunity to get active and have fun getting fit.[59]"
Sqord	"Sqord makes active play more fun for kids! Check in to an online world filled with your friends and family. Customize your PowerMe character however you want. Send High Fives and Squawks to other players (and get them back!). Post your Thought Bubble for all to see. And when you get your very own Sqord Pod, earn Activity Points to climb the Sqord Leaderboard, gain levels, and earn Sqoins and other cool online rewards![60]" FEATURES: - Wearable and App

9.3 Appendix 3 – FitPet

"In order to motivate people to engage with the virtual pet more frequently and grow an emotional attachment to the pet, individuals' daily physical activity progress towards their goals was mapped to the development of the virtual pet in two ways. First, individual can convert his/her daily step count to FitPet game coins. Then, s/he can use the game coins to interact with the virtual pet, feed the pet, or provide medical aid to the pet when the pet is

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[58] https://itunes.apple.com/us/app/ibitz-by-geopalz-kids/id588227932?mt=8

[59] https://play.google.com/store/apps/details?id=com.sworkit.kids&hl=en

[60] https://play.google.com/store/apps/details?id=com.smashingboxes.sqordmobile&hl=en

sick. Secondly, the growth level of this virtual pet is related to the accumulated total steps and how many days the player completes the daily step goal. The general idea of this mobile application is to take care of the pets by taking care of the player himself/herself … The step-coin game economics (dynamics), growth level and goal rule (mechanics), and visual design (aesthetics) are the key mechanics and dynamics implemented to

encourage more engagement from the players with their virtual pets. The acrylic painting game interface was designed to differentiate FitPet game from traditional Tamagotchi-type (general pixel style) games. This is to inspire more emotional responses to their virtual pet from people."

- **Tong, X., Gromala, D., et al. (2015). *Encouraging physical activity with a game-based mobile application: FitPet.* Paper presented at the Games Entertainment Media Conference (GEM), 2015 IEEE.**

9.4 Appendix 4 – Questionnaires

9.4.1 Clinicians

Interview Clinicians

Traditional Therapy

1.) **Do you think there is a difference in the weight loss therapy success of boys and girls? (e.g. ifference in gender)**

2.) **Have you observed a difference in the willingness of children to reduce weight depending on their BMI?**

3.) **Would you say there is a connection between age and willingness to reduce weight in obese children? If so, please elaborate which age range is the most willing to reduce their weight?**

4.) **Do children at the age of 11 – 13 react differently to weight loss therapy than 14 - 16 year olds? If so, please elaborate on the difference. Which tactics work best for which age range?**

5.) **Do weight reduction interventions need to be adjusted to the child's age?**

6.) **What is the biggest challenge in the treatment of weight reduction in obese children?**

7.) **What have you personally experienced to be the most effective tool in changing a child's long-term behavior to live a healthier lifestyle?**

8.) Success factors in therapy

    A. *How important is exercise of sports in the process of weight reduction and long-term behavior change in obese children?*
    B. *How important is a healthy diet in the process of weight reduction and long-term behavior change in obese children?*
    C. *Which is harder to achieve: exercise or diet?*

9.) How might parents contribute to the process of weight reduction and long-term behavior change of their obese children?

Gamification Game App for therapy process

1.) Do you think it is easier for obese children to lose weight with the help of games, so in a gamelike way? So, is it easier for kids to lose weight by utilizing game apps, as opposed to parents trying to motivate their children to play games outside or force them to join a sport? Please elaborate on your answer?

2.) Do you believe that gamification game apps in connection with wearables (e.g. smart watches) can positively support the therapy process? If so, to what extent?

3.) Do you have any previous experience with smartphone apps for weight reduction in overweight and obese children? Please elaborate.

4.) What do you personally think should a gamification game app for weight reduction in overweight and obese children contain? (Food diary, sport games, nutrition games, control functions for therapist, doctors and parents ...) What else?

5.) Should such an app be adjusted to the age range of children or adjusted to other factors?

9.4.2   Children / Clients

Questionnaire

Gender:
Age:
BMI:
Do you have a mobile phone?

Games & Sport

1. Have you ever played games like PokemonGo!, GeoCaching, Ingress, Zombies Run or sports games on Nintendo Wii? If so, did you like them?

2. Do you prefer playing games like Nintendo Wii Sports or exercise in school (mandatory sports classes or in a club, association)?


3. Do you have the feeling that you are moving your body and exercising when you are playing these games?

4. Do you feel more motivated to do sports when you receive a treat (being rewarded) afterwards? *Possible rewards: spending a day with your parents at a place of your choice, stay up a bit longer, have your friends stay over for a slumber party, receive a small present*

5. Would you rather prefer playing sports in teams / groups or compete with your friends than exercising by yourself?

Nutrition

1. Do you feel like it is hard to eat healthy and commit to a healthy diet without the help of visual material / manuals? (e.g. pyramid of food)
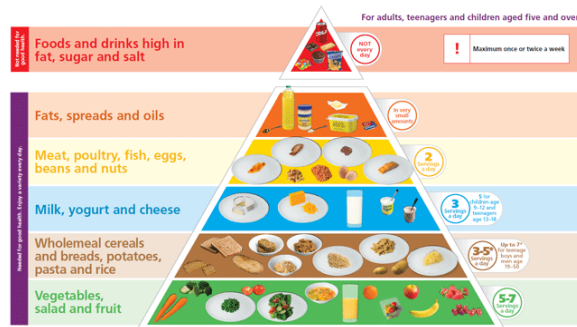
2. **Do you think it is hard or easy to guess whether a meal or snack is healthy? Elaborate!**

3. **Can you guess the calories of your meals easily or not? Elaborate!**

4. **Would you prefer filling out your food diary on your smartphone / tablet or on a piece of paper which your carry around with you?**

5. **Would you think it is easier to take a picture of your meal / snack instead of writing a food diary? Would you prefer that option rather than writing everything down? Do you associated the 'taking a picture' feature with any benefits?**

6. **Do you have the feeling it easier to eat healthy when you are being rewarded for it?**
   Possible rewards: spending a day with your parents at a place of your choice, stay up a bit longer, have your friends stay over for a slumber party, receive a small present

7. **Do you wish someone would give your more emotional support to stay on track sometimes (e.g. school breaks, watching TV, when being bored)?**
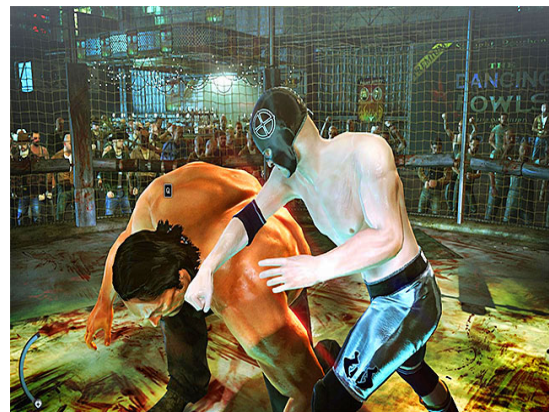
App

1.) **Would you be willing to wear a wearable device e.g. smart watch (like apple watch) around your wrist or ankle if this mean you would be able to become healthy again?**

2.) **Have you ever used or are using one of the following apps:**
   a. *An app that helps you to exercise?*

b. *An app that helps you to learn new things like music, math, a language or what is healthy food?*
c. *An App that helps you to count calories?*

3.) **How do you like the idea of having a game-like – app on your phone that helps you to exercise, lose weight and be healthy and which rewards you for your achievements?**
   a.) *Game-like app that helps you with your healthy diet*

   b.) *Game-like app that helps you to work out on a regular basis*

   c.) *Apps that rewards you*

4.) **Would you download and play a game, where you can train your player with sport and nutrition in such a way that the player wins' matches? The more you personally workout and the healthier you eat, the stronger your player gets and can win in the game universe, as the player receives points. Elaborate!**

<u>**Boys:**</u> You are creating a payer with whom can fight against other virtual players in an arena. The players your encountering are your friends. Your player is only as strong as yourself. If you are fit and healthy, your player will be strong. Further you are collecting coins through your regular workouts / healthy diet. The coins can be exchanged for protection equipment and boosters within the game. If you do not work out enough or eat unhealthy, your player will be weak. You can play the game with your friends by competing against them or play against random players. You can also form teams with your friends.

<u>**Girls:**</u> You are creating a virtual horse back and rider and a horse. Together you and your horse can participate in competitions and beauty pageants. The other horse back rider you are encountering in the virtual game are your friends. Your horse back rider(player) is only as good, as you are fit and healthy. You are collecting coins through your regular workouts / healthy diet. The coins can be exchanged for horse

treats and new equipment within the game. If you do not work out enough or eat unhealthy, you will not be able to rise to new levels. You can play the game with your friends, play against random players or participate in horseback riding tournaments. You can also form teams with your friends.

5.) Do you think it would be helpful to have a little (monster) companion on your phone that gives you advise and reminds you to live healthy? Elaborate why!

> This app will send your short messages throughout the day to give you emotional support and remind you to stay on track.

6.) Would you play game that helps you to learn about healthy and unhealthy food? Let's imagine the following game:

You are creating a virtual player which is a hero as he tries to protect your hometown from hungry zombies that are trying to eat the brains of everyone on your city. The hungry zombies are not yet in the city but they are preparing themselves by eating a lot of junk food. The only way you hero can weaken the hero will have to pick the

right choice between various options. If he is not picking the right groceries, the zombies will destroy the city.

7.) Would you download and use the following app?

You know you have to work out, right? Imagine you collect points as you walk, run with your friends around the block, jump in the backyard, play soccer with your friends, – no matter where you are …. at home, in school or at your friend's house. All the collected points you can exchange for different rewards which you define with your parents beforehand.