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## Active video games: Can they contribute to the prevention of excessive weight gain in gaming adolescents?

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## CHAPTER 1

# General introduction

The overall aim of this thesis is to evaluate whether providing video games that require physical activity to play –hereafter called active (video) games– in the home setting, can contribute to prevention of excessive weight gain in gaming adolescents by reducing sedentary behavior and increasing physical activity. In this general introduction a rationale will be given for the research presented in this thesis by following the first three steps of the model for planned promotion of population health [1;2], as shown in Figure 1. First, the health problem is being analyzed, namely overweight and obesity in adolescents, by describing the prevalence and the importance to target this health problem (step 1: analysis of health and disease). Next, the most important underlying behaviors of overweight and obesity (step 2: analysis of behavior) are being described and it is being highlighted why adolescents form an important target group for overweight prevention interventions. Further, the determinants of these overweight-related behaviors are being described using two relevant theoretical approaches (step 3: analysis of determinants of behavior). Hereafter, it is explained why video games –and in particular active games– seem a promising a tool for health promotion and prevention of overweight. Finally, a short description of the studies that have been conducted within this thesis is given.

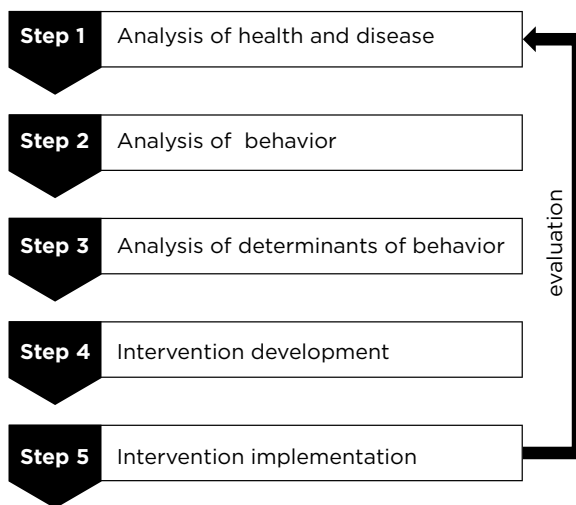


Figure 1: Model for planned health promotion (Based on Brug et al. [1] and Green and Kreuter [2])

## **Problem analysis**

Overweight in youth is a major public health concern [3-5]. The most recent edition of the Dutch nation-wide growth study showed that in 2009, 13% of the Dutch boys and 15% of the Dutch girls aged 2–21 years were overweight while 1.8% of the boys and 2.2% of the girls were obese [5]. Compared to 1980, this overweight prevalence is two to three times as high and the obesity prevalence four to six times as high. In the United States overweight and obesity rates are even higher, with 32% of 2-19 years old youth being either overweight or obese, and 17% being obese in 2011-2012 [3].

Youth overweight and obesity are associated with negative physical and psychological consequences. Overweight and obesity increases risk for high blood pressure, diabetes mellitus type 2, elevated LDL- cholesterol, depressive symptoms and low self-esteem during childhood itself [6]. Next, overweight and obesity often track into adulthood [7-9], contributing to higher risks for health problems later in life such as cardiovascular disease, hypertension, diabetes mellitus type 2 and premature mortality [10-12]. All these health risks make overweight a major burden of disease and health care spendings [13-15].

Although there are many programs aimed at treatment of overweight and obesity, results have often been disappointing, especially regarding long-term effectiveness [16]. Therefore, an important strategy is to prevent excessive weight gain (i.e., weight gain that exceeds weight gain caused by regular growth) and in this way thus prevent the development of overweight and obesity [17;18].

## **Physical activity, sedentary behavior and energy intake**

Overweight is the consequence of excessive weight gain, caused by a long-term positive energy balance, i.e., when energy intake is larger than energy expenditure. The underlying mechanisms of becoming overweight are complex and involve besides genetic and hormonal factors, also cognitive, motivational, behavioral and environmental factors [19]. An important way to contribute to the prevention of excessive weight gain is to encourage behaviors that increase energy expenditure and reduce energy intake, in other words restoring the energy balance. Important energy balance-related behaviors are physical activity, sedentary behavior and energy intake, which will be explained below.

### **Physical activity**

Physical activity is a main modifiable contributor to energy expenditure, making increasing and promoting physical activity of major importance for maintaining a healthy body weight and prevention of overweight [20-23]. However, many children have a low

level of physical activity [24-26]. The Dutch moderate intense physical activity guideline for children recommends at least 60 minutes of moderate-to-vigorous physical activity a day but only 18% of children meet this guideline [24]. Moreover, a marked decrease in physical activity is observed during adolescence making it a critical life stage for physical activity promotion [27;28].

### **Sedentary behavior**

Furthermore, sedentary behavior –especially too much and prolonged sitting activities- may have a partially independent impact on risk for obesity and cardio metabolic disease [29-33], although the evidence to date is inconclusive, especially in youth [34-35]. However, in adults there is accumulating evidence that prolonged sitting may be detrimental to health [36]. Therefore there are concerns about the excessive amount of time children spend sedentary. On average children spend around eight hours per day sedentary [24;26]. Although there is no general accepted maximal sedentary time, often the recommendation of the American Academy of Pediatrics is applied which states that children should not spend more than two hours per day in sedentary screen activities [37]. Next to watching television, playing video games is a major and increasing contributor to sedentary behavior [38-40]. In the USA, an average of almost two hours per day playing video games was reported for 8-18 year olds, with an increase of almost one hour per day from 1999 to 2009 [38]. In the Netherlands, gaming behavior peaks during adolescence, with 95% of 13–19 years old boys and 85% of the girls spending on average 10 and 4 hours per week playing video games, respectively [39].

### **Energy intake**

It is widely acknowledged that dietary intake plays a key role in the regulation of energy balance [20]. Important modifiable contributors to energy intake are consumption of snacks and sugar-sweetened beverages. Although, the evidence is mixed [20], there are several studies showing an association between the intake of sugar-sweetened beverages and snacks and excessive weight gain in children and adolescents [41-43]. Hence, it is important to take consumption of snacks and sugar-sweetened beverages into account when investigating weight management.

### **Associations between energy balance-related behaviors**

The different energy balance-related behaviors are not independent from each other. For example, consumption of sugar-sweetened beverages and snacks has been found to be associated with sedentary screen time [44-47]. Most of these studies focused on watching TV, but more recent evidence suggests that the same may be true for gaming. For example, Chaput et al. [48] showed that a single session of video game play in healthy male adolescents was associated with an increased food intake, regardless of appetite sensations. Furthermore, an intervention study found that energy intake decreased when sedentary behaviors (i.e., TV viewing, computer use, and video gaming) decreased in non-overweight adolescents [49]. Thus, it might be that exchanging sedentary

pastime for more active time concurs with a reduction in energy intake. Further, there are concerns that that sedentary activities pulls children away from physical activity [50-52]. However a meta-analysis showed that the association between physical activity and sedentary time is very weak or even absent [53]. These potential associations between the different energy balance-related behaviors show the importance of an integrated study of both dietary and physical activity and sedentary behavior.

## **Adolescents and energy balance-related behaviors**

A critical life stage in the development and persistence of obesity and related co-morbidities into adulthood is adolescence [54;55]. Adolescence is a transitional phase from childhood to adulthood, during which children become more independent, where there is less parental control and an increasing peer pressure [54]. The adolescent life stage is characterized by unhealthy patterns in energy balance-related behaviors: high intake of sugar-sweetened beverages and snacks [25] a decrease in sport participation and other physical activities [27;28] and high levels of sedentary behavior [25;26]. Furthermore, during adolescence the amount and location of body fat changes a lot [54]. This all makes adolescence a critical phase for prevention of excessive weight gain. These unhealthy behaviors might not always have an acute noticeable effect during adolescence but may have a profound effect on health in later life [56], as unhealthy behavioral patterns as well as biomedical risk factors often track into adulthood [57]. As adolescence is the transition phase into adulthood, it is important to promote healthy behaviors in this life stage and not only in younger children. Healthy habits established during youth may similarly track into adulthood and beneficially affect health [31;56]. For example, a high level of physical activity adopted during youth and sustained into adulthood is thought to have beneficial effects regarding prevention of cardiovascular diseases and type 2 diabetes [58].

Thus adolescents are a very important target group for overweight prevention and health promotion strategies [54]. However, it is also a difficult group to motivate for health behavior change. Adolescents often do not perceive long term consequences of their behavior, do not see a reason to change their behavior, have little interest in health, are very much concerned about what their peers think of them, are experiencing stress because of low self-esteem, and have a powerful drive for independence and peer association [56]. These extra challenges in adolescent health promotion may have led to the fact that there are relatively few high quality intervention studies on overweight and obesity management in adolescents compared to other age groups, despite the fact that this age group is of such crucial importance for developing a healthy lifestyle and body-weight [56].

### Determinants of these energy balance-related behaviors

In order to improve energy balance-related behaviors (e.g. physical activity, sedentary behavior and energy intake), it is important to understand the underlying factors of these behaviors. Two specific theoretical approaches are relevant for understanding determinants of gaming behaviors, i.e., the Environmental Research framework for weight Gain prevention (EnRG) framework and the Self-Determination Theory.

The EnRG framework (Figure 2) describes that besides individual, cognitive and motivational factors also environmental factors play a role in energy balance-related behaviors [19]. Individual factors and environmental factors interact with each other, as the environment can influence the subjective norm or someone's attitude towards a behavior. How the individual and environmental factors influence the person's behavior, can be moderated by personal moderators (such as demographics) and behavioral moderators (such as habit strength). Further, the framework highlights that there is not a single factor that causes weight gain and overweight, but the co-existence and interaction of several dietary and physical activity behaviors causes a positive energy balance and weight gain [19].

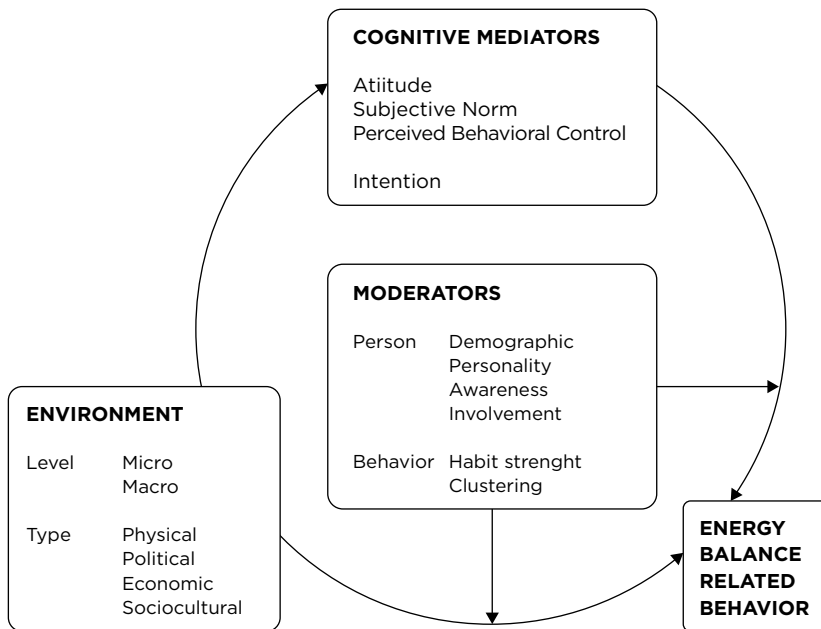


Figure 2: Environmental Research frame work for weight Gain prevention [19]

### ***Self Determination Theory***

An appropriate theory to explain why active games (which will be explained further below) hold promise in health promotion interventions is the Self Determination Theory [59]. This theory addresses the type of motivation behind behavioral choices. Intrinsic motivation refers to doing an activity because it is enjoyable and satisfying in itself, in contrast extrinsic motivation refers to doing an activity for instrumental reasons e.g. to obtain an external goal [59]. One is more likely to initiate and continue a behavior when one is intrinsically motivated [60] and therefore this type of motivation is most desirable when promoting a health behavior. Active gaming is a fun activity and adolescents may therefore be more intrinsically motivated to play these games. This is important, as it may make active gaming a promising tool for reducing sedentary time and increasing physical activity.

## **Potential of video games in health behavior change**

Because of the above-mentioned challenges in promoting health behavior in adolescents, it is recommended to use novel and tailored approaches in adolescent health promotion research and interventions [56]. Behavior change interventions are generally believed to be more effective if they fit the interest of the target group and are based on intrinsic motivation [60]. As mentioned above, many adolescents play video games and spend a lot of time on it. Next, high sales numbers confirm how popular video games are and how big the market is; total hardware and software sales for 2008 in the US were \$21.33 billion, a rise of 19% from 2007 [61]. Also, in the Netherlands the video game industry is relatively big for a small country; the Dutch video games market is expected to generate revenues of 722 million in 2017 [62].

Yet, it is clear that many adolescents are strongly appealed by video games, consequently video games seem to have a high potential to reach adolescents and may be effective in health behavior change interventions. The latter especially goes for the newest form of video gaming that has more recently emerged: active video games. Active video games directly encourage physical activity by integrating it in the gameplay. Sensors and controllers are used to capture body movements of the player, and the body movements are translated and used to play the game. This body movement component replaces the hand controller of traditional video games, which are mainly played while sitting and controlled by pushing buttons on a controller. In this thesis these traditional video games will be referred to as non-active (video) games. Studies have shown that active video games cause higher acute energy expenditure than non-active video games and other sedentary screen activities such as watching television [63;64]. Active video games generally elicit light to moderate intensity physical activity (2–6 metabolic equivalents; METS) [63;64]. So substituting non-active gaming by active gaming, results in higher energy expenditure, which may prevent excessive weight gain.

Well-known examples of active video games are the Wii, Kinect and PlayStation Move. These commercially available active video games are developed to entertain people and sell as many products as possible, and not as an overweight prevention tool. However, this entertainment factor might also be useful to utilize in promoting healthy behaviors and there is an emerging research field that evaluates whether active video games can be used to replace non-active video games as a means for decreasing sedentary behavior and increasing physical activity in children. As competing to a highly valued activity as gaming seems unrealistic [65;66], active video games might offer an alternative and more realistic strategy.

## Outline of the thesis

To explore the possible contribution of active video games to preventing excessive weight gain in gaming adolescents, we first analyzed game behavior and its correlates and then designed and evaluated an active video game intervention, based on steps 2 – 5 of the model for planned promotion of population health [1;2] (Figure 3). The chapters in this thesis addresses these steps as follows:

### Part 1: Analysis of gaming behavior

We started with analyzing gaming behavior, i.e., playing active video games and non-active video games. Hereto, we conducted a cross-sectional survey in secondary schools among adolescents 1) to evaluate how many adolescents play active video games and how much time they report to spend playing them, and 2) to identify subgroups in active and non-active gaming behavior, presented in chapter 2.

Next, a 24-hour recall diary study among adolescent active video gamers who reported their activities on seven random days over a one-month period in order to get more insight into how playing active video games influences energy balance (chapter 3). This diary study sought to investigate in a naturalistic setting to what extent active video game time in everyday life' is associated with time spent in sedentary behaviors, other physical activities and consumption of snacks and sugar-sweetened drinks

### Part 2: Analysis of determinants of engaging in game behaviors

Chapter 4 describes the results of a focus group study among adolescent gamers that explored adolescents' views on active and non-active gaming and potential correlates of active gaming and non-active gaming. The specific aims were to explore adolescents' reasons for playing active and non-active games (aspects liked/not liked, preference for active or non-active games, prerequisites for long-term engagement) and the context of active and non-active gaming (when do you play, with whom, rules and restrictions at home).



The results from chapter 4 and complemented with input from health behavior theories, informed a cross-sectional survey study reported in chapter 5 among a larger group of adolescents to further study correlates of gaming in a quantitative way. The research aims of this study were to: (1) examine potential personal, social, and game-related correlates of active gaming in adolescents; and (2) examine potential personal, social, and game-related correlates of non-active gaming in adolescents; and (3) compare the correlates of active gaming with those of non-active gaming.

### Part 3: Intervention development and evaluation

Chapter 6 describes the content of the active video game intervention -informed by the findings of the previous studies-, and the design and rationale of the randomized controlled trial. Next, chapter 7 presents the results of this randomized controlled trial. Effects of and adherence to the active video game promotion intervention on anthropometrics, sedentary screen time and consumption of sugar-sweetened beverages and snacks among gaming adolescents are reported. Research questions were: 1) will an active gaming promotion intervention result in a lower body mass index (BMI) adjusted for mean standard deviation score (BMI-SDS), a smaller waist circumference-SDS, hip circumference and skin fold thickness, lower self-reported time in sedentary screen activities and lower self-reported intake of sugar-sweetened beverages and snacks after four and ten months? And 2) what is the adherence to and appreciation of the active game intervention? With whom and where do they play the active games? What are potential adverse effects (occurrence of injuries because of playing with the Move games)? Which activities are being replaced by active gaming? And do the adolescents intend to continue playing the active games after the study period?

Finally, chapter 8 gives an overview of the main findings of the conducted studies, describes the broader perspective and implications of these findings and provides a critical reflection on methodological aspects. In addition, recommendations for practice and future research will be discussed.

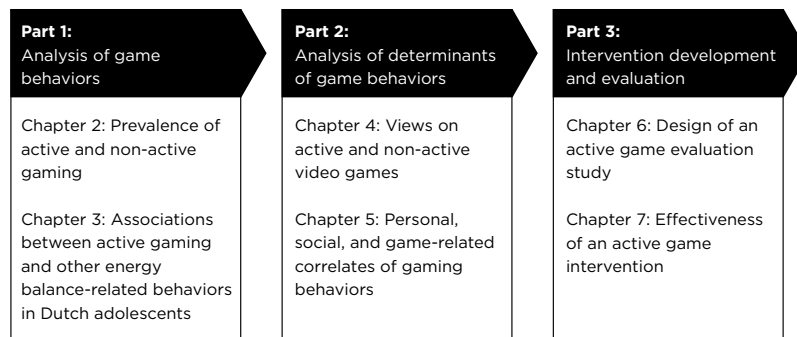


Figure 3: Outline of the thesis

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