

Summary



General introduction

Overweight in youth has substantially increased over the past decades and is a major public health concern. Youth overweight is associated with negative physical and psychological consequences during childhood itself and in addition contributes to higher health risks later in life. The underlying mechanisms of becoming overweight are complex and involve besides genetic and hormonal factors, also cognitive, motivational, behavioral and environmental factors. But simply stated, overweight is the consequence of excessive weight gain (i.e., weight gain that exceeds weight gain caused by regular growth), caused by a long-term positive energy balance, i.e., when energy intake is larger than energy expenditure.

An important way to contribute to the prevention of excessive weight gain is to encourage behaviors that increase energy expenditure and reduce energy intake, i.e. restoring the energy balance. Important energy balance-related behaviors (EBRBs) are physical activity, sedentary behavior (such as watching television, playing non-active video games) and energy intake (such as consumption of snacks and sugar-sweetened beverages). Although there are many programs aimed at treatment of overweight and obesity, results have often been disappointing, especially regarding long-term effectiveness. Therefore, an important strategy is to prevent excessive weight gain and in this way thus prevent the development of overweight and obesity.

Adolescents are an important target group for overweight prevention, as adolescence is a critical life stage in the development and persistence of overweight into adulthood. The adolescent life stage is characterized by unhealthy patterns in energy balance-related behaviors: high intake of sugar-sweetened beverages and snacks a decrease in sport participation and other physical activities and high levels of sedentary behavior. Furthermore, during adolescence the amount and location of body fat changes a lot. However, adolescents are also a difficult group to motivate for health behavior change: adolescents often do not perceive long term consequences of their behavior, have little interest in health, are experiencing stress because of low self-esteem, and have a powerful drive for independence and peer association. 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.

Because of these challenges specific to adolescence, it is recommended to use novel approaches tailored to adolescents' needs and preferences in order to promote their health. Behavior change interventions are generally believed to be more effective if they fit the interest of the target group. An activity that fits the interest of many adolescents is playing video games. Video games are an integral and important part of adolescent's life and it has even been suggested that a life without games is impossible for adolescents. The broad appeal of video games and the rise of a new generation of video games, namely active video games (video games that require physical activity to play) inspired us to evaluate the potential of active video games as a novel overweight prevention tool for gaming adolescents.

Therefore, the aim of this research project was to evaluate whether providing 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.

Main findings

Part 1: Analysis of gaming behavior

In **chapter 2** the results are presented of a cross-sectional survey in secondary schools among adolescents 1) to evaluate how many adolescents play active games and how much time they report to spend playing them, and 2) to identify subgroups in active and non-active gaming behavior. Of the participants, 3% reported to play exclusively active games, 40% reported to play both types, 40% exclusively non-active games, and 17% reported to not play video games at all. The active gaming adolescents played the active games on average on 1.5 days per school week for 36 min and 1 day per weekend for 42 min. The non-active gaming adolescents played on average on 3.3 days per school week for 65 min and 1.4 days per weekend for 80 min. Adolescents attending lower levels of education were more likely to play active games ≥ 1 h per week than adolescents attending higher educational levels. Boys and older adolescents were more likely to play non-active games >7 h per week, than girls or younger adolescents. In sum, this study suggested that many adolescents play active games, especially those following a lower educational level, but time spent in this activity is relatively low compared to time spent playing non-active games. To be feasible as a public health strategy, active gaming interventions should achieve more time is spent on active gaming at the expense of non-active gaming.

Chapter 3 describes a 24-hour recall diary study among adolescent active gamers in order to get more insight into how playing active games influences energy balance. Since active video gaming can only be beneficial for weight management when it replaces sedentary activities and not other physical activity, and when it is not associated with a

higher energy intake. Adolescents (12–16 years) with access to an active video game and who reported to spend at least one hour per week in active video gaming were invited to participate in the study. Adolescents reported the time spent in playing active and non-active video games and on other EBRBs through electronic 24-hour recall diaries on five randomly assigned weekdays and two randomly assigned weekend-days in a one-month period. Findings indicated that adolescents who reported to play active video games on assessed days also reported to spend more time playing non-active video games. No differences between these groups were found in other EBRBs. Among those who had reported to play active video games during the recorded days, active video game time was positively yet weakly associated with TV/DVD time and snack consumption. Active video game time was not significantly associated with other activities and sugar-sweetened beverages intake. These results suggest that it is unlikely that time spent by adolescents in playing active video games replaces time spent in other physically active behaviors or sedentary activities. Spending more time playing active video games does seem to be associated with a small increase in intake of snacks, suggesting that interventions aimed at increasing time spent on active video gaming may have unexpected side effects.

Part 2: Analysis of determinants of engaging in game behaviors

Chapter 4 presents a focus group study among adolescent gamers to explore 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). Six focus groups were conducted with adolescents (12–16 years old) representing a range of education levels. A semi structured question route was used containing questions about perceptions and the context of gaming. Results showed that the adolescents had positive attitudes toward active video gaming, especially the social (i.e. playing with others) and the interactive aspect, which was greatly appreciated. Adolescents seemed to enjoy non-active video games more than active ones, mainly because of better game controls and more diversity in non-active video games. Active video games were primarily played when there was a social gathering. Few game-related rules and restrictions at home were reported. We concluded that, given the positive attitudes of adolescents and the limited restrictions for gaming at home, active video games might potentially be used in a home setting as a tool to reduce sedentary behavior. However, to make active games as appealing as non-active games, attention should be paid to the quality, diversity, and the long-term appeal of active games, as these aspects are currently inferior to those of traditional non-active games.

The results from chapter 4 informed the cross-sectional survey study described 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 video 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. We conducted a survey assessing game behavior and potential personal, social, and game-related correlates among adolescents (12-16 years, N=353) recruited via schools. Overall, this study showed that various factors were associated with active gaming ≥ 1 h/wk and non-active gaming > 7 h/wk. Adolescents who reported more negative attitudes with respect to non-active video games were more likely to play active video games ≥ 1 h/wk. Further, adolescents who reported more positive attitudes with respect to active video games, were more likely to play active video games ≥ 1 h/wk. Next, adolescents who reported to have brothers and sisters that play active video games a lot were also more likely to play active video games ≥ 1 h/wk their selves. On the other hand, adolescents who reported a more positive attitude with respect to playing non-active video games, were more likely to play non-active video games > 7 h/wk. Also, adolescents who reported to have brothers and sisters that play non-active video games a lot were more likely to play non-active video games their selves. Habit strength appeared a correlate of both active and non-active video gaming, indicating that both types of gaming are habitual behaviors. Although these results should be interpreted with caution because of the cross-sectional nature of the study, they do provide important preliminary insight in factors that should be taken into account when developing interventions that aim for replacing non-active gaming by active gaming among adolescents.

Part 3: Intervention development and evaluation

The findings of part 1 and 2 were used as input for the design of the active video game intervention that is central to part 3. The content of the active video game intervention as well as the design and rationale of a randomized controlled trial to evaluate the intervention, are outlined in **chapter 6**. The intervention consisted of providing a PlayStation Move upgrade package to play the active video games on a PlayStation 3 console in the home of the adolescents. The PlayStation Move uses a handheld motion controller wand, a motion-capture PlayStation Eye camera that tracks the player's position and inertial sensors in the wand that detect its motion. Thus, every movement of the player is mimicked on-screen in the game. The following active video games were provided during the intervention: Sport Champions, Move Fitness, Start the Party and Medieval Moves, Dance Star Party and Sorcery. We included three elements to support continuing active video game play: 1) because variation in video games is important the participants in the intervention group received four active Move video games with different game genres (Sport Champions, Move Fitness, Start the Party and Medieval

Moves) at the beginning of the study and two additional video games (Dance Star Party and Sorcery) after four months; 2) because social and family play is important, we provided two controllers to promote playing together with family and friends; and 3) at each contact moment we explicitly asked and encouraged the participants to substitute non-active gaming with active gaming as much as possible and for at least one hour per week. One hour per week corresponds to approximately 70 kcal (which is equivalent to the energy imbalance that can result in unnecessary weight gain) and was regarded as a feasible change.

Chapter 7 presents the results of this randomized controlled trial. Effects of and adherence to the active game promotion intervention on anthropometrics, sedentary screen time and consumption of sugar-sweetened beverages and snacks among gaming adolescents are reported who primarily were of healthy weight. We assigned 270 gaming (i.e. ≥ 2 hours/week non-active video game time) adolescents randomly to an intervention group ($n=140$) (receiving active video games and encouragement to play) or a waiting-list control group ($n=130$). The control group decreased significantly more than the intervention group on BMI-SDS and sum of skinfolds. The intervention group had a significantly higher decrease in self-reported non-active video game time and total sedentary screen time than the control group. The process evaluation showed that 14% of the adolescents played the Move video games every week ≥ 1 hour/week during the whole intervention period. Thus, the active video game intervention did not result in lower values on anthropometrics in a group of 'excessive' non-active video gamers (mean ~ 14 hours/week) who primarily were of healthy weight compared to a control group throughout a ten-month-period. Even some effects in the unexpected direction were found, with the control group showing lower BMI-SDS and skin folds than the intervention group. The intervention did result in less self-reported sedentary screen time, although these results may be biased by social desirability.

General discussion

The general discussion presented in **chapter 8** integrates the findings of all studies and provides directions for future research and implications for practice. Overall, the findings from this thesis show that active video games seem a promising activity because of a high and broad reach of adolescents and a positive attitude of adolescents towards active games. However, many adolescents did not consider active video games as an attractive replacement of non-active video games. Also, findings suggested that playing non-active games was a habitual behavior. Hence, encouraging adolescents to replace their non-active gaming by active gaming seems not an easy task. In line, our intervention, consisting of providing active video games to adolescents who already played non-active games, did not result in a substantial active game play time and did not contribute to the prevention of overweight.

Because the level of sustained engagement in active gaming was low, future research should examine which factors can enhance participation. Simply providing an active game seems not enough to result in sufficient active game play and increase physical activity. Should the active games be embedded in a structured program for example at schools? Does integrating a competition or cooperation element contribute to increased active game time? Are active games more promising in other target groups? How can we achieve that active games hook people in the same way that non-active games do? Do we need new (better) active games? Our study results indicate that there is need for a new generation of active games to be able to compete with non-active games. Active video games may need to incorporate features that are more aligned to relevant principles that are used in non-active games. Multidisciplinary collaboration (e.g. game designers, health professionals, behavior change experts) is recommended to further develop and apply a comprehensive set of principles for best practice of active games. Smart phones and new technologies such as GPS, wearable sensors, but also virtual reality glasses (e.g. Oculus Rift) provide many opportunities to bring active games a step further.

General conclusions

Video games are an integral and important part of adolescent's life. Therefore, it makes sense to find ways to use the popularity of video games for good purposes. Based on this thesis, the following conclusions can be drawn on active video games as a tool to prevent excessive weight gain in gaming adolescents:

- The majority of adolescents play video games and almost half play active video games, but time spend on playing active video games is much lower than on non-active games.
- Both boys and girls play active video games, and especially adolescents attending lower educational school levels play active video games.
- Playing active video games is considered a social activity, as it is played often with friends and brothers and sisters. Further, having other people (brothers/sisters and friends) around you increases the likelihood of playing active games yourself.
- Gaming adolescents do not consider active video games as an attractive alternative for non-active games. Together with the finding that habit strength is an important correlate of actual gaming behavior, it may be hard to replace non-active game time with active game time.
- Playing active video games does not seem to replace other physical activities. We found preliminary indications that playing active video games can result in less sedentary time and non-active game time. The effects of playing active video games on energy intake are unclear yet.
- Providing and promoting active video games to adolescents who already play non-active games does not result in a substantial active game play time and does not contribute to the prevention of overweight.

Future studies are necessary to evaluate which strategies can motivate gaming adolescents to play active video games instead of non-active ones for a substantial and sustained amount of time or whether active video games might be more suitable for other target groups than gaming adolescents. To conclude, when aiming for prevention of excessive weight gain, we do not recommend providing active video games to gaming adolescents in their home with only a light encouragement to play them.