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Roundtable Discussion

Gaming, Adiposity, and Obesogenic Behaviors Among Children

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Videogames in general have been maligned for causing obesity because of their inherent sedentariness, whereas exergames have been both maligned for requiring low levels of activity and extolled for requiring physical activity to move game play along. The intensity and duration of physical activity resulting from exergame play have shown varying results, and they have been explored for use in obesity treatment and prevention, primarily among children. Other videogames have been developed and tested to help children change their diet and physical activity practices with various outcomes. As a field of inquiry, we are in the earliest stages of understanding how, or under what circumstances, videogames can influence all these behavioral and health outcomes. To deal with these complexities, we have assembled a group of investigators who have made important, but diverse, contributions to this research agenda and asked them to address five key child obesity-related issues in a Roundtable format. Brief biosketches are presented at the end of this article.

Tom Baranowski: ***Let's delve right into these vexing issues. From your perspectives, to what extent has media use, including or especially playing videogames, contributed to the problem of obesity in children? If there is a link from child videogame play to child obesity, does the usual pathway involve decreased energy expenditure or increased caloric intake?***

Ann Maloney: The common sense response is to say "of course." Sedentary screen time is NOT spent in physical activity, which means lower overall daily energy expenditure. Further, it's easy to eat (and more importantly drink) sugary, fat-laden products while sitting on the couch watching TV, where children are pummeled with advertising. From my perspective as a child psychiatrist, the children I see in our clinics and hospitals have ample access to screen time—which far exceeds their participation in sports or access to PE [physical education]. I think that the prevalence of these alluring screen options has had an impact on obesity and it is due to both increased sedentary screen time and increased caloric intake.[1]

Melanie Hingle: I am most familiar with the literature that has examined the relationship between media exposure (a very broad category that includes videogaming) and adiposity in children. The most comprehensive review to date was commissioned by the Institute of Medicine in 2006.[2] This review included a significant number of longitudinal studies that together suggested that more hours of media exposure predicted increased weight. However, these studies were mostly about television exposure, not videogame play or other media. Studies focused on videogame play have been less consistent, and whether videogames contribute to excess weight remains unclear. Some of the difficulty in determining whether or not these relationships are causal have to do with the definition of "screen time" or "media use," which are inconsistent in the literature. I attended a recent keynote address by Bill Dietz who appealed to the audience of healthy-eating researchers and policymakers to find an alternative to "screen time" (he suggested "TV time") so that we can begin to untangle the effects of each type of media (including videogaming) on child health and weight.

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Monique Simons: Overweight is a multifactorial problem and is in general the result of a positive imbalance between energy intake and energy expenditure. Important contributing behavioral factors are diet, physical activity, and sedentary behaviors (such as non-active videogame [non-AVG] play). Studies have shown an association between playing non-AVGs and increased energy intake leading to excessive body weight.[3,4] However, most of these studies are cross-sectional; so there is a need for longitudinal and experimental studies evaluating the effects of videogame play on the development of overweight in children. Another reason why videogames might be considered an important target for overweight prevention is the pervasiveness and large dose of non-active game play among children.

Modern technology-based entertainment, such as videogame play, is often blamed for distracting children from physical activities. If children spend more time playing non-AVGs and less time in physical activities, this will have a negative effect on energy expenditure and possibly contribute to obesity in children. But, studies also have shown no or a weak association between sedentary activities and physical activity, suggesting that adolescents have time for both videogame play and physical activity.

Another mechanism through which videogame play might contribute is through energy intake. Sedentary screen time, such as playing non-AVGs, has been associated with increased energy intake through snacking or soft drink consumption.[5] An intervention study found that energy intake decreased when sedentary activities (i.e., TV viewing, computer use, and videogame play) were decreased in non-overweight adolescents.[6]

Both pathways may be important mechanisms through which videogame play might contribute to the overweight problem in children, making it an even more important target for overweight prevention. AVGs might be a tool to intervene on both sides simultaneously. We are currently investigating how active and non-active gaming interacts with other energy balance–related behaviors. Substituting non-active gaming with active gaming (or exergames) may result in an exchange of sedentary pastime for active pastime, and this might induce a reduction in energy intake. Finally, it is important to know if active gaming will replace sedentary behavior or other physical activities. If active games replace other physical activities, it might lead to a reduction in energy expenditure and have an adverse effect on overweight.

Amanda Staiano: I recently found that higher TV time and having a TV in the bedroom were associated with 2–3 greater odds of a child being obese, having high amounts of visceral fat and a larger waist size, and being at elevated cardiovascular risk, including high triglycerides.[7] But, my study, like most others, was cross-sectional. I have yet to see convincing evidence that screen-time *causes* obesity, and we're not likely to see a study randomly assign children to watch high amounts of TV. Furthermore, when looking specifically at videogames, the relationship between gaming and obesity is weaker or nonexistent.

Of the several purported explanations for why screen time is linked to childhood obesity, the one with the most evidence is higher caloric intake during screen time. Furthermore, children are constantly viewing advertisements on TV, videogames, online advergames, and cell phones, many of which promote energy-dense foods. Alternatively, the "replacement hypothesis" that gaming and screen time replace physical activity has been largely debunked. Research finds that children would be doing other sedentary activities if not watching TV.

Ralph Maddison: Epidemiological research has linked increased time spent on screen-based media use with being overweight. Proposed causal mechanisms between screen time and weight status include the displacement of physical activity, exposure to advertisements, which promote energy-dense foods, and decreased metabolic rate. Of these, the two former mechanisms are most likely to contribute to this phenomenon. Clearly being overweight is the result of consistently eating too much in relation to one's daily energy expenditure, and influences on these behaviors are multifactorial. This is true of media use and obesity. For example, research suggests that watching TV and playing non-AVGs result in an energy surplus compared to rest conditions; however, the effect of exposure to ads is less clear. Experimental research has suggested that exposure to both food and non-food ads results in increased food consumption compared to no adverts. This effect is less clear with videogames, as many do not have ads; therefore other mechanisms for increased energy intake are in play, which may include more cues to eat and passive eating of energy-dense foods. There also is emerging evidence that increased media use is associated with shorter sleep duration, which may provide greater opportunity to eat. In terms of media use displacing physical activity, research evidence is less clear. Research evidence has shown a small correlation between media use (primarily TV watching) and physical activity levels, which suggests that in a given day, children can spend considerable time being sedentary, but can also meet guidelines for physical activity. From a use of time perspective, increased media use has the potential to displace physical activity; however, displacing media use does not necessarily mean children will replace this time with physical activity.

Kristi Adamo: The peer-reviewed literature contains plenty of work describing the obesogenic environment and its contribution to inactivity and subsequent obesity. The obesogenic environment refers to many factors; media, technology, and videogames would be included in this list. With regard to a direct link to videogames—I am not sure that the evidence is strong enough to confirm or deny this relationship. There are parties who would support both sides of the energy out versus energy in debate. My interpretation of the current literature is that it is inconsistent from both angles.

Tom Baranowski: ***If there is a link between time playing videogames and obesity, what steps should the designers of games for health take to minimize the risk of obesity from playing their future games?***

Ann Maloney: I have had a longstanding fantasy that we could better design motor breaks into children's school days. Years ago, I wanted to program the local school's laptops to cease functioning after a certain number of key strokes, with a prompt that motivated a child to move with a directive, such as walk around the school twice. Many states have laptop or tablet programs in place, so it could be relatively easy to

design some in-school activity breaks to prompt such motor breaks. It would be great to make a 3–5-minute bout of "StepMania" (a "Dance Dance Revolution": [DDR]–style game) the new normal. Since No Child Left Behind and the recession, resources for children have been hit hard, and they now have less access to physical activity. A current initiative to design games to reward physical activity is HopeLab's Zamzee (https://www.zamzee.com/).

Monique Simons: When designing serious games aiming to change diet, physical activity, and sedentary behavior in order to prevent overweight, it is important to incorporate elements from behavior change models, such as Self Determination Theory, Social Cognitive Theory, Theory of Planned Behavior, and Social-Ecological Perspective. If the game is going to be a non-active one (i.e., the game is played while seated and no physical activity is required to play the game), it is important to pay attention to sedentary time and to include some elements in the game that prevent excessive sedentary time. One could think of integrating real physical activity in the virtual world. For example, the player first has to achieve a physical activity goal in the real world before she or he can access the next level in the virtual world. A promising technology could be augmented reality, which combines a virtual world with the real world. This technology could encourage active transport from place to place in the real world and make the video game more "mobile," not limited to one setting (e.g., home environment). The use of portable gaming devices (e.g., smartphone, tablet) could prevent excessive sedentary time during game play because of their portability and functions such as global positioning system (GPS) and accelerometers/pedometers.

Melanie Hingle: The integration of "real world" challenges into the game storyline would be a terrific start. For example, a challenge that requires the gamer to seek something outside of the virtual world that could be measured by a mobile device could be used as an incentive, perhaps allowing the gamer to "unlock" additional levels or abilities while getting the gamer outside the home and engaged. Mobile devices have built-in features (e.g., accelerometer, camera) that can be synced with games to provide an immersive, motivational experience that also (perhaps covertly) promotes healthy lifestyle behaviors. I would also encourage companies that produce these games to eschew product placement or promotion of unhealthy foods. Gaming is obviously a lucrative business, and food and beverage companies know this. If they must advertise, asking them to limit their product promotion to healthier options is something gaming companies can insist on.

Amanda Staiano: Exergames present an opportunity to introduce moderate-intensity activity during otherwise sedentary time. Encouraging players to set fitness and activity goals as part of the game can help players be mindful of the potential health benefits of those games and sustain active play over several months. Game designers could prompt children to take a break from game play every 30 minutes to go outside and play or to walk around the house to stretch their legs.

Ralph Maddison: I think there is a role for health professionals, researchers, and game designers to work together to explore opportunities to utilize videogames to maximize health gain. For example, AVGs have the potential to displace non-AVGs and thereby increase physical activity levels and energy expenditure and lower eating, by minimizing cues to eat. However, current off-the-shelf AVGs remain relatively naive in terms of graphics, character development, and storyline, which limit the immersive nature of these games, which in turn limits their use to younger children. Older gamers prefer the more complex, immersive nature of more traditional videogames. To engage this population it is important to continue with this genre of games, but consider incorporation of motion sensors to navigate and play games, which may be more interactive and promote body movement. There is also increased interest in the use of serious games that are designed to entertain players as they educate, train, or change behavior. These games have enormous potential to promote behavior change. Once a child's attention has been attracted through the videogame, he or she can be exposed to a range of embedded behavior change strategies, such as goal setting and reviewing progress, while at the same time having fun.

Kristi Adamo: If a link exists between playing videogames and obesity, and if videogames are a non-negotiable priority for children, the "active" gaming direction is logical. Perhaps limit the time that a game can be played. An automatic shut off might be used (i.e., after 1 hour the game "retires" and cannot be initiated for another 12+ hours); include WiFi-enabled monitors/sensors to assess intensity (i.e., heart rate or accelerometry, etc.) with feedback to the game console in real time; if a player subsequently is not meeting a predetermined goal or target, the player is disqualified from the game; build games that interact with the actual "real" living environment (i.e., scavenger hunts, go find these items in the fastest possible time, build an obstacle course, etc.); games on mobile phones that have GPS and accelerometer functionality that provide challenges or tasks to be completed in daily life or outside of one's home; or rather than "active" gaming there could be "nutrition" games that teach or engage children in healthful decision making (i.e., food choices, cooking lessons, which one of these items is more healthy?…provides the greatest number of vitamins and nutrients? how to make a healthier cookie?).

Tom Baranowski: ***Do, or under what circumstances do, AVGs, which require body movement to progress story or game, or exergames, which encourage physical activity by goal setting, story immersion, and character modeling of behaviors, offer any promise for obesity prevention among children?***

Ann Maloney: These strategies hold great promise. By exploiting the tension between challenge and frustration, aka "flow," we could learn a lot from the game design community. Masters who design blockbuster games learn a lot from iterative product testing and research with gamers. Being pulled into a good narrative (i.e., story immersion) is a great idea for the next generation of health games. For example, my son (age 10) and his friend were outside playing, but instead of tag or "Captain, May I?," they used the themes of their favorite videogame and became the characters, putting the game into real-time action. They took an Xbox [Microsoft] game and let it spill onto the neighborhood playground. We

can use this metaphor to incorporate ways that kids can act out their fantasies and favorite game mechanics in healthy ways. We could capitalize upon the social aspects of gaming to encourage behaviors that help prevent obesity. My son watches others play "Minecraft" [Mojang AB, Stockholm, Sweden] (on YouTube and in person) about five times as much as he plays it himself! I would like to see a Kinect [Microsoft] version of "Minecraft" to get him up and moving—one that uses gross body movements and takes advantage of this mentoring kind of relationship that he has with the people on YouTube who are a few levels above him. If they were active, it would be more cool for him.

At the ESCoNS (Entertainment Software and Cognitive Neurotherapeutics Society) (http://www.escons.org/) 2nd annual meeting (March 2013), Bruce Wexler, MD, recently received a Director's Award from NIH [National Institutes of Health] to create and test integrated games for attention deficit hyperactivity disorder that integrate cognitive training and physical activity. It would be great to have a "Khan Academy" of Exergaming. A Web-based wizard could query a child's interests and sync with a developmentally appropriate set of themed exergames, and a child who was sitting down for gaming is now playing standing up and moving. Microsoft Kinect and Sony Move are getting closer, but still lack the visual discrimination, accelerometry, and possibly even processing power to foster physical activity at a level of intensity sufficient to improve physical fitness. A dream system would mount accelerometers on each limb integrated with motion-capture cameras, a 360 degree headunit for display (like perhaps Google Glass), and a Kinect platform. This would immerse the child in a virtual world where performance was directly linked to effort. Each game could be calibrated to an individual's peak athletic abilities. We need to hurry, however, as our young digital natives grow up fast in our obesogenic environment.

Monique Simons: To be effective at preventing overweight, children must enjoy playing active games and be willing to replace the non-active games with active ones. Active games capitalize on children's intrinsic motivation for playing videogames. Our survey showed that 43 percent of Dutch adolescents play active games, so active gaming interventions could have a wide reach.[8] However, time spent on active games was about half the time spent on non-active games. To be effective for preventing overweight, efforts are required to increase the duration of active game play, especially in relation to non-AVG play.[8] Only providing an active game is probably not enough to significantly increase physical activity levels in youth.[9] Our focus groups with children revealed suggestions to make active games more fun and ensure sustainable use, such as introducing more variation in games, improving the quality of the graphics, using three-dimensional images, and more precise translation of body movements into game play.[10,11] Further, these focus groups showed that active games were considered a social and family activity, more so than non-active games. As group play can encourage sufficient and sustained use, active game programs should focus on playing active games with family and friends. Increasing online-play options in active games could provide an opportunity for group play. We challenge game developers to design active games that are as fun and challenging as the traditional non-active games. Ultimately the best of all worlds should be combined: High quality in storyline, game play, and fun body movements.

Melanie Hingle: Active gaming could be one of many factors converging to make a healthier home environment. Getting teams of kids or families playing could unite peers and/or families to try healthy lifestyle behaviors together, potentially increasing the "stickiness" of the intervention. However, the trick is getting them to play together—that's where the "fun" part of the game design is essential. I don't think it's as simple as "if you build it, they will play."

Amanda Staiano: Lee Graves provided early evidence that exergaming produced moderate amounts of caloric expenditure,[12] and a systematic review found that more calories were burned when the lower body was engaged in game play[13] (e.g., dance or foot pad games). We also found that the social context of game play, such as playing with a partner, was essential for sustained caloric expenditure. A structured intervention, where children are prescribed a duration and intensity of exergame play and encouraged to play with friends and family members, may be the key ingredient.

Ralph Maddison: Our randomized controlled trial[14] showed that children who received an AVG upgrade (hardware and games) gained less weight after 6 months (approximately 1 kg) compared to children who continued with usual sedentary forms of videogame play (control). Much more research is needed to determine how best to maximize the use of AVGs to augment weight management initiatives.

Kristi Adamo: All games are not created equal. Some are better at engaging children and encouraging "real" meaningful physical activity. These games do not appeal to all children or all socioeconomic or ethnic groups, and thus their obesity prevention application is limited. While I would not discount the "promise" that they might hold, their usefulness only holds merit if they replace a typical sedentary behavior and NOT at the expense of more traditional forms of physical activity (i.e., outdoors, with friends, family, or other groups). There may be a role for such games in certain clinical or rehab populations that could be at risk for weight gain due to certain mobility circumstances.

Tom Baranowski: ***Do, or under what circumstances do, AVGs or exergames offer any promise for obesity treatment among children?***

Ann Maloney: Here's the crux, if the choice is exergames versus nothing, then it's easy to endorse AVGs. Whenever kids are a captive audience and need bouts of physical activity, they can benefit from exergames. For example, we had a warm-up DDR session for kids to play while gathering for their 90-minute, parent–child, 12-week pediatric obesity program at our teaching hospital. Schools are another place to consider.[15] Children with mental health challenges in group homes or residential care could benefit from motor breaks, since they rarely have organized PE or recreation therapists. The same goes for children on the general pediatric unit at the medical center. The Child Life Staff could have a "Wii Bowling" contest in the Teen Lounge every afternoon in which children could participate. The local public school system's

after school program could have a DDR contest for kids each week with small prizes, especially on cold wintery days when temperatures preclude outdoor activities. What about an exergaming scout badge? I have given exergame setups to pediatric clinics for their waiting rooms that have been well received.

Monique Simons: Active games could be promising for obesity treatment in the same way it could be for prevention of overweight and obesity. Both for prevention and treatment, obesity is a multifactorial problem, and therefore it is important to focus on multiple factors. A large trial among overweight and obese children (10–14 years) has shown that active games can have a small effect on BMI [body mass index] and can improve body composition.[14] It was a small effect, but the intervention consisted only of promoting active game play; thus, the behavior change for the children was relatively small (i.e., play the provided active games). However, sustainable and frequent use of active games remains a challenge.

Melanie Hingle: Healthy lifestyle behaviors promoted through a game need to be adopted by the entire family, not just the child, to be successful. A supportive home includes family members who help the child make healthy behavior changes. I don't think a game alone—of any kind—can help obese children without those other factors in place.

Amanda Staiano: Our team at Georgetown University demonstrated in a 20-week exergame intervention that obese adolescents who played an exergame cooperatively in teams lost on average 5 pounds versus those who competed against partners, who didn't lose weight,[16] and these were low socioeconomic African American youth in particular need of innovative physical activity options. In a separate study, children playing in pairs expended as many calories playing exergame tennis as they did playing tennis on a court in a beginner's lesson.[17] These findings indicate the importance of team play and cooperation for exergaming to be sustainable and effective.

Games could also help collect health information for parents and healthcare providers. For instance, exergames can record caloric expenditure, daily activity, diet, and weight over time in a fairly accurate and useful manner.[18]

Ralph Maddison: Following our research,[14] we suggested AVGs may be a useful addition to the armamentarium of strategies for weight management, rather than being used in isolation. For example, a prospective observational study showed that integrating AVGs as part of a multidisciplinary weight management program resulted in a reduction on BMI at 10 weeks. This study was not randomized and did not include a control group, but preliminary results are encouraging. In addition, a family-based intervention focused on reducing all leisure-based sedentary screen time (including videogames, television watching, and computer use) could incorporate AVGs, which may be helpful as a strategy for parents who may have greater success promoting the use of AVGs rather than complete abstinence from game play.

Kristi Adamo: In our randomized trial that compared the efficacy of interactive videogame stationary cycling ("GameBike") versus stationary cycling to music,[19] we anticipated that overweight/obese kids immersed in a race-based game would be more engaged and subsequently reap more benefits. On the contrary, stationary cycling to music produced a significantly better rate of exercise adherence, more time spent in vigorous physical activity, and more distance pedaled compared with interactive videogame cycling. Albeit a slight improvement in body fat percentage was realized, there were no differences between groups. Based on our data we concluded that that the high cost of investing in the "GameBike" may be unwarranted. Alternatively, there may be circumstances or certain populations for which AVGs might be useful. If there is no possible way that a child would engage in any other form of physical activity, then clearly a game would be better than nothing at all.

In my opinion exergaming is not "evil" or "offensive" with no possible "good" to come of it, but exergaming is not the "best" option for obesity treatment. The answer to the problem of how to increase physical activity and decrease obesity in youth cannot rely on one modality such as exergaming, but, if used appropriately, it could be a component of the solution. The best use for exergaming would be replacement for a sedentary game and in addition to engagement in other healthy active living behaviors.

Tom Baranowski: ***Given these interesting possibilities, what are the critical research issues that need to be addressed to more clearly answer each question?***

Ann Maloney: There are many fundamental questions to answer about exergames. What is the optimal dose (frequency, duration, intensity) to produce specific outcomes (weight loss, weight maintenance, maintain/improve fitness)? What rewards or stipends work for incentives? If games work for a few weeks, would rotating or offering new games enhance the effect? How can we improve access to games (for example, kids in group homes)? The solution isn't going to be $300–500 game consoles that require $60 games (or annual subscriptions) to play. Most smartphones have accelerometers. Can we repurpose old phones as exergame consoles? In schools, high-resolution cameras, motion-capture tags, and a decent 8-core computer with plenty of RAM might be sufficient for multiple kids to play an active game during class or afterschool.

Debra Lieberman's database of games at healthgamesresearch.org gives examples of many kinds of health games, from which one can generate dozens of hypotheses. Should physicians recommend certain nutrition apps for their patients, and will insurance reimburse for them? FDA [Food and Drug Administration] is considering some health games for cognition, so we will have to observe how this evolves in a changing healthcare system.

We need to initiate a dialogue between healthcare providers and the entertainment games industry. How can we integrate ideas about pediatric obesity treatment and computer game design? Exergamers need their own "Call of Duty," "Super Mario Bros," or similar blockbuster. Game designers know a lot about motivation, and they should educate us about how to sustain motivation.

Monique Simons: More research is necessary to understand the impact of active games on sedentary behavior, physical activity, body weight, and body composition over time.[14]

Currently, we are conducting a randomized controlled trial in The Netherlands among 300 non-active gaming adolescents and their families to evaluate if an active game intervention in a home setting can prevent excessive weight gain. The intervention consists of (a) providing an upgrade package for active gaming (PlayStation® Move), (b) an instruction to replace at least 1 hour of non-active gaming by active gaming on the PlayStation Move, (c) stimulating group play by providing an extra Move controller, and (d) stimulating long-term use by providing multiple active games. (We are currently running the analyses and expect the results by the end of 2013.)

If active games are to be used to reduce sedentary behavior and overweight in adolescents, active games must remain attractive and fun in the long run. More research is needed on which long-term strategies are effective to use active games. Future studies should focus on which active games are better appreciated, and evaluate why that is. Can active gaming reach high-risk groups, such as low socioeconomic status children? Where can active games be placed (e.g., home setting, schools, local facilities in the neighborhood, after-school programs, or child care)? Can the different settings reinforce each other? What activities will be substituted by active gaming? If children play AVGs instead of playing outdoors or other physical activities, then promoting AVG use may actually produce unwanted effects. So it is important that AVGs are played instead of, rather than next to, non-AVGs.

Melanie Hingle: Reliable measurement of different types of media exposure, including videogame play, remains a major challenge. Without reliable measures, it is impossible to untangle the effects (positive, neutral, or negative) of videogame play on health. I would also like to understand the "stickiness" of a gaming intervention. Kids will pick up something novel and play for awhile, but after time, it will be used less and less. It would be helpful to have a better understanding of how these interventions work and for whom they work best.

Amanda Staiano: We have yet to see studies indicating "transfer effects" from gaming (i.e., children who play exergames improve their sports-specific skills and transfer them to activity outside of game play). Obese teenagers in our exergame studies reported more outside physical activity during the intervention than at baseline, so exergames may be a "gateway" to encourage more overall activity in the day.

Though my research team has explored the social context of gaming, we need to better understand the role of self-efficacy, self-esteem, and motivation during game play. Does the scaffolding and intermittent positive reinforcement make exergaming a unique way to reach out to children who are otherwise too self-conscious or too apathetic to play on traditional sports teams? Could social networking complement exergame play and provide sufficient social interaction to sustain and motivate activity? Keeping eyes on the screen rather than on each other may help children to focus on what's best about physical activity—that it's fun!

And, most importantly, though two studies have found weight loss from exergame interventions,[14,16] many more studies are needed to test exergaming both in controlled clinical trials and in free-living community programs, to see under what circumstances exergaming may effectively promote physical activity and healthy weight. Exergames hold promise, but we need a lot more evidence!

Ralph Maddison: Research in this area is still in its infancy. There is a lack of well-conducted, sufficiently powered trials to determine the effects of videogames on physical activity and dietary behavior as well as health outcomes. In particular, studies need to be of sufficient duration to determine the effect of sustained play and to understand whether there is an opportunity cost to playing such games. For example, do children substitute traditional forms of physical activity to play AVGs, or do families choose to buy their child an AVG over more traditional items of sport equipment (e.g. a bat or ball)? Do games can have a positive impact on health outcomes? While there is some evidence supporting game use for promoting a healthy diet, it is not clear whether such changes result in changes in body composition. Do these games provide a viable option for improving self-management of chronic conditions, such as diabetes and asthma?

Given the lack of understanding of how videogame play impacts weight status, more research is needed to understand the longer-term impact of videogames on energy balance. There is some evidence that sedentary videogame play is associated with greater *ad libitum* energy intake compared to rest; however, AVG play was associated with lower energy intake compared to television and non-AVGs. Future weight management studies need to accurately measure both physical activity and energy intake to address this issue.

Do videogames displace physical activity? Behavioral Economics Theory (BET) may be useful here: Engaging in AVG play involves choosing this over a competing sedentary behavior such as non-AVGs. Choice is dependent on the relative ease of accessing the competing activity and its reinforcing value (e.g., enjoyment). According to BET, physical activity and sedentary behavior are considered behavioral substitutes; therefore displacement of non-AVGs (or being sedentary) may lead to substitution with AVGs (or being active) as this time is reallocated. Yet it is also possible that one sedentary behavior (e.g., non-AVG) could be substituted with another (e.g., TV viewing). Research needs to determine how children allocate their time.

Kristi Adamo: There are some really basic things we need to know like why do children choose active gaming? Is it because they like videogames, or do they not like to play outside? Are they self-conscious about being active with others or to be seen? Do they feel this is a healthy choice? Are there enough choices to avoid boredom? Do they play with friends in the same location or "virtually"? Do they prefer this type of game over an activity outside with friends or family, and why? If games are built with a fail-safe mechanism that ensures a player is engaged in the active aspects, would kids still play? Do they still watch TV and play non-AVGs (i.e. does this replace that time or add to it?)? Are the risks of injury the same for an AVG versus engaging in a supervised activity (i.e., a sport, etc.)? Do parents monitor their child's choice of game and/or time spent playing? Does playing these games take away from other "healthful" activities or replace less typically sedentary pursuits? Do these games increase energy expenditure long term or just acutely? Do kids compensate for this behavior? Do they snack less, spend less time sedentary, etc.?

Do we really want to encourage kids to spend more time with a screen?

Tom Baranowski: ***So, our Roundtable Discussants (RTDs) expressed diverse opinions about each of these issues. Time spent playing videogames appears likely to contribute to obesity, but this has not been thoroughly researched; the effect appears weaker than time spent watching TV; and the pathway of influence could be through low activity or higher caloric intake. Further targeted research is warranted.***

To the extent there is a link between videogame play and obesity, RTDs suggested that game designers could minimize that risk by incorporating active gaming principles (e.g., game progression dependent on player's level of physical activity) using movement sensors or introduce breaks or imposing time limits on game play.

RTDs felt that exergames could be used for obesity prevention, but the exergames need to have their stories and artwork more fully developed, involve families and peers in game play, and emphasize lower body movement. A concern was expressed, requiring further research, on whether time spent on exergames displaces time on inactive game use or types of more activity (e.g., sports), which would be unhealthy.

Exergames could be used for treatment as well as prevention, subject to the same concerns.

RTDs expressed a broad variety of foundational and innovative key research needs to advance our understanding of how best to design and deliver exergames. I hope graduate students needing research topics read this. Collaborations were advocated among game design and healthcare companies and academics to advance what might be done on the increased use and health benefits of exergames. Alternatively, one of our RTDs asked whether we really wanted to encourage kids to spend more time in front of a screen?

I hope you, the reader, enjoyed reading this as much as I did putting it together. All the investigators who pursue these research issues should consider submitting their findings to **Games for Health Journal.**

References

1. Maloney AE. Pediatric obesity: A review for the child psychiatrist. Pediatr Clin North Am 2011; 58:955–972, xi.
2. Institute of Medicine (US), Committee on Food Marketing and the Dlets of Children and Youth. *Food Marketing to Children and Youth: Threat or Opportunity?* (J. M. McGinnis, J. A. Gootman, V. I. Kraak, eds.) The National Academies of Science, 2006.
3. Carvalhal MM, Padez MC, Moreira PA, et al. Overweight and obesity related to activities in Portuguese children, 7–9 years. Eur J Public Health 2007; 17:42–46.
4. Stettler N, Signer TM, Suter PM. Electronic games and environmental factors associated with childhood obesity in Switzerland. Obes Res 2004; 12:896–903.
5. Chaput JP, Klingenberg L, Astrup A, et al. Modern sedentary activities promote overconsumption of food in our current obesogenic environment. Obes Rev 2011; 12:e12–e20.
6. Epstein LH, Roemmich JN, Paluch RA, et al. Influence of changes in sedentary behavior on energy and macronutrient intake in youth. Am J Clin Nutr 2005; 81:361–366.
7. Staiano AE, Harrington DM, Broyles ST, et al. Television, adiposity, and cardiometabolic risk in children and adolescents. Am J Prev Med 2013; 44:40–47.
8. Simons M, Bernaards C, Slinger J. Active gaming in Dutch adolescents: a descriptive study. Int J Behav Nutr Phys Act 2012; 9:118.
9. Baranowski T, Abdelsamad D, Baranowski J, et al. Impact of an active video game on healthy children's physical activity. Pediatrics 2012; 129:e636–e642.
10. Simons M, De Vet E, Hoornstra S, et al. Adolescents' views on active and non-active videogames: A focus group study. Games Health J 2012; 1:211–218.
11. De Vet E, Simons M, Wesselman M. Dutch children and parents' views on active and non-active video gaming. Health Promot Int 2012 December 4 [Epub ahead of print]. doi: 10.1093/heapro/das064.
12. Graves L, Stratton G, Ridgers ND, et al. Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: Cross sectional study. BMJ 2007; 335:1282–1284.
13. Biddiss E, Irwin J. Active video games to promote physical activity in children and youth: A systematic review. Arch Pediatr Adolesc Med 2010; 164:664–672.
14. Maddison R, Foley L, Ni Mhurchu C, et al. Effects of active video games on body composition: A randomized controlled trial. Am J Clin Nutr 2011; 94:156–163.
15. Maloney AE, Stempel A, Wood ME, et al. Can dance exergames boost physical activity as a school-based intervention? Games Health J 2012; 1:416–421.
16. Staiano AE, Abraham AA, Calvert SL. Adolescent exergame play for weight loss and psychosocial improvement: A controlled physical activity intervention. Obesity (Silver Spring) 2013; 21:598–601.
17. Staiano AE, Calvert SL. Wii tennis play for low-income African American adolescents' energy expenditure. Cyberpsychology 2011; 5:article 1.
18. Staiano AE, Calvert SL. The promise of exergames as tools to measure physical health. Entertain Comput 2011; 2:17–21.
19. Adamo KB, Rutherford JA, Goldfield GS. Effects of interactive video game cycling on overweight and obese adolescent health. Appl Physiol Nutr Metab 2010; 35:805–815.

Brief Biosketches

Kristi Adamo, MSc, PhD, is a scientist and the leading member of the Healthy Active Living and Obesity Research Group. She has a multidisciplinary background that includes an undergraduate degree in human kinetics, a Master's degree in physiology, and a Doctorate in cellular and molecular medicine. Her research program, Power of Prevention in the Early Years, focuses on early lifestyle intervention and upstream prevention of childhood obesity. Specifically, her research team explores the applicability of healthy active living intervention strategies during key phases of growth, development, and determination of long-term health (intrauterine, preschool, elementary school). She holds an Early Researcher Award from the Ministry of Research and Innovation for her work on tackling childhood obesity, starting with MOM and a Canadian Institutes of Health Research New Investigator Award for her work in the preschooler population (i.e., Activity Begins in Childhood).

Melanie Hingle, PhD, MPH, RD, is an Assistant Research Professor and Registered Dietitian in the Department of Nutritional Sciences at the University of Arizona. Dr. Hingle's research focuses on identifying and understanding the determinants of behavioral and weight-related outcomes (adiposity, BMI) in children, adolescents, and families and on developing and testing novel approaches to promoting healthy lifestyle changes in diverse populations. Recently, Dr. Hingle's research has been mostly within the multidisciplinary sphere of "mobile health"—the practice of public health and medicine using mobile devices (e.g., phones, tablets, sensors)—and she is the current chair of the University of Arizona's Mobile Health (mHealth) Special Interest Group (www.mhealth.arizona.edu).

Ralph Maddison, BHSc, MSc (Hons), PhD, is an Associate Professor and Programme Leader for Physical Activity Research at the National Institute for Health (NIHI) (formerly the Clinical Trials Research Unit), University of Auckland. He is a recipient of a Health Research Council Sir Charles Hercus Fellowship (2012–2016). He joined NIHI in 2005, and his research interests include physical activity and behavior change using novel, innovative, and theoretical-based interventions in children, young people, and special populations (people with cardiovascular disease). He was Principal Investigator (PI) of eGAME, a randomized controlled trial of an AVG intervention on body composition in overweight New Zealand children. He is currently PI of several trials, including (1) SWITCH—a trial to reduce screen-based sedentary behaviors in children, (2) HEART—a trial of an mHealth intervention to improve exercise capacity in people with cardiovascular disease, and FIT2QUIT—a trial to determine the effectiveness of exercise to augment smoking cessation outcomes. Other research initiatives include physical activity measurement and digital technologies to facilitate physical activity, healthy diet, and lifestyle change.

Ann E. Maloney, MD, is a board-certified Child Psychiatrist and Assistant Professor of Psychiatry and Pediatrics at University of Massachusetts Medical School. Prior to medical school, she was a pediatric nurse. She works in the lab of Jean A. Frazier, MD, at the Child and Adolescent Neurodevelopment Initiative (CANDI Lab). Her prior research has focused on early-onset schizophrenia and autism spectrum disorders. Treatments for these conditions often include medications that promote rapid weight gain. Side effects of medications lead to exergaming studies in an effort to find healthy physical activity for children. Her studies have used off-the-shelf games (DDR) with various locations and populations. She is also interested in games to boost neurocognition and social skills and recently completed a study with Linmarie Sikich, MD, at the University of North Carolina Chapel Hill with children suffering from psychosis.

Monique Simons, MSc, is a PhD researcher at the Department of Health Sciences and the EMGO Institute for Health and Care Research at VU University Amsterdam and a scientist at TNO (Organization for Applied Scientific Research) in The Netherlands. She graduated in Human Movement Science at the VU University Amsterdam. After her study she worked at the VU University Amsterdam and TNO on multiple projects on physical activity promotion and prevention of overweight in the target groups of youth and employees. She has a special interest in the use of videogames for promotion of physical activity and has been working on several projects on exergaming: for example, energy expenditure of playing exergames, energy intake during TV viewing and (exer)gaming, exergaming in a school setting, exergaming in a work setting, adolescents' and parents' views on exergames, and prevalence and correlates of exergaming. She's currently working on a PhD project studying the potential of exergames as a tool for prevention of excessive weight gain in adolescents in a family setting.

Amanda E. Staiano, PhD, MPP, is a research fellow at Pennington Biomedical Research Center in Baton Rouge, LA. Dr. Staiano earned a bachelor of science in psychology at Louisiana State University, a master of public policy at Georgetown Public Policy Institute, and a PhD in developmental psychology at Georgetown University. Her dissertation, under the mentorship of Professor Sandra Calvert, examined weight loss, caloric expenditure, psychosocial change, and acute cognitive effects from a 20-week exergame intervention for obese African American adolescents. She also examined the utility of exergames as data collection tools, the social context of competitive versus cooperative versus solitary exergame play, and the policy implications of gaming and obesity. Dr. Staiano has 32 peer-reviewed publications, of which 12 focus on exergaming. Her other research examines the clinical, behavioral, and sociodemographic determinants and correlates of childhood obesity and related comorbidities.