



**Exercising with a Screen or Music and Post-Exercise Energy  
Compensation: A Randomized Crossover Trial in Male Adolescents**

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## **Abstract**

Watching television or listening to music during exercise has been shown to increase the enjoyment of the activity and decrease fatigue for some people. However, it is currently unknown how these stimuli during an exercise session play a role in post-exercise energy intake and/or physical activity energy expenditure (PAEE). The purpose of this thesis was to examine the effects of watching television or listening to music while exercising on post-exercise energy intake and expenditure in male adolescents. The study consisted of a randomized crossover design involving 24 male adolescents aged 12 to 17 years. The participants completed three experimental sessions that included walking/jogging on a treadmill at 60% of their heart rate reserve for 30 minutes while watching television, listening to music, or exercising with no other stimulus (control). Following the exercise sessions participants were given an *ad libitum* lunch and were asked to record their food intake for the remainder of the day. An Actical accelerometer was used to assess PAEE until bedtime. The primary outcome measure was post-exercise energy intake and energy expenditure. Results showed that exercising while watching television or listening to music did not significantly affect post-exercise energy intake or energy expenditure. Walking/jogging on a treadmill was found to be more enjoyable while watching television than with no stimulus present ( $p=0.03$ ). Ratings of perceived exertion were not significantly different between conditions. Overall, our results suggest that watching television or listening to music while exercising does not impact post-exercise energy intake or expenditure in male adolescents, which may have positive implications for adolescents who may need additional motivation to exercise.

## List of Abbreviations and Acronyms

<b>AUC</b>	area under the curve
<b>BLS</b>	Bureau of Labor Statistics
<b>BPM</b>	beats per minute
<b>BMI</b>	body mass index
<b>CHEO</b>	Children's Hospital of Eastern Ontario
<b>CI</b>	confidence interval
<b>CPM</b>	counts per minute
<b>EX</b>	exercise
<b>HALO</b>	Healthy Active Living and Obesity research group
<b>LPA</b>	light physical activity
<b>MET</b>	metabolic equivalent
<b>MVPA</b>	moderate-to-vigorous physical activity
<b>N</b>	number
<b>PA</b>	physical activity
<b>PAEE</b>	physical activity energy expenditure
<b>PAQ-A</b>	Physical Activity Questionnaire for Adolescents
<b>PEEC</b>	post-exercise energy compensation
<b>RMR</b>	resting metabolic rate
<b>RPE</b>	ratings of perceived exertion
<b>SED</b>	sedentary time
<b>TEE</b>	total energy expenditure
<b>TFEQ-R18</b>	Three Factor Eating Questionnaire: Revised 18-item
<b>TV</b>	television
<b>VAS</b>	visual analogue scale
<b>VO<sub>2max</sub></b>	Maximal oxygen consumption
<b>VO<sub>2peak</sub></b>	Peak oxygen consumption
<b>WHO</b>	World Health Organization

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## Contributions

I hereby confirm that all of the work presented in this thesis is my own, along with my thesis supervisor Dr. Jean-Philippe Chaput. Any published (or unpublished) ideas and/or techniques from the work of others are fully acknowledged in accordance with the standard referencing practices. For this thesis manuscript, I was responsible for the conduction of research, statistical analyses, interpretation of results and writing of the article. This is a manuscript-based thesis, which contains one paper titled: *Exercising with a Screen or Music and Post-Exercise Energy Compensation: A Randomized Crossover Trial in Male Adolescents*. All authors included read and approved the manuscript, which was accepted for publication in the journal *Appetite* in May 2018.

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## Part 1: Introduction

The global increase of sedentariness and physical inactivity in the population is concerning, especially in the pediatric population (Dodd, Welsman, & Armstrong, 2008; Thivel, Tremblay, & Chaput, 2013). Sedentary behaviour is commonly defined as a low energy expending behaviour ( $\leq 1.5$  metabolic equivalents) related to activity such as sitting, lying or reclining posture (Tremblay et al., 2017a). Increased levels of sedentariness have been associated with negative physical and psychosocial health outcomes (Carson et al., 2016a). Specifically, screen time (e.g., television watching) has been identified as a predisposing factor for obesity (Carson et al., 2016a). A large body of evidence has shown the negative effects of obesity and its association with chronic diseases such as cardiovascular disease, type 2 diabetes, various cancers, and musculoskeletal problems (World Health Organization, 2013). Additionally, children with obesity have been shown to be less physically active in general than leaner children (Carson, Staiano, & Katzmarzyk, 2015). This increase in sedentary behaviours, coupled with high rates of obesity in children and youth, has led to the proliferation of investigations aimed at addressing this issue and finding solutions.

Energy balance (energy intake in relation to energy expenditure) is a topic of major interest in obesity research (Thivel et al., 2013). Although the concept of energy balance may seem straightforward, it is highly complex and influenced by a combination of physiological and behavioural factors (Drenowatz, 2015). Recent evidence suggests that the imbalance between energy expenditure and energy intake is a key etiological

factor related to weight gain (Drenowatz, 2015). Commonly, weight loss is achieved by increasing energy expenditure through physical activity and/or decreasing energy intake through dietary restriction (Lau et al., 2007). Although there still work to be done to determine the relative roles of physical activity and diet (and their interactions) in the etiology of childhood obesity, it is a common notion that both energy intake and energy expenditure need to be targeted to decrease fat mass (Dodd et al., 2008). However, following an exercise intervention, the level by which individuals compensate by increasing their energy intake and/or decreasing their energy expenditure can vary between participants and may depend on many factors (Drenowatz, 2015; King, Burley, & Blundell, 1994). The concept of post-exercise energy compensation (PEEC) will be the topic of this thesis and will be discussed in more detail below.

Electronic screen devices and personal music players are common tools in today's society. We use them wherever we go: in the car, in stores, in our homes or while we exercise. Television (TV) viewing is currently the main sedentary activity in both adult and pediatric populations, with the average teenager spending four-and-a-half hours watching television per day (LeBlanc et al., 2017; Swinburn & Shelly, 2008). However, it is recommended that youth engage in no more than 2 hours of recreational screen time per day, which is defined as total time spent using electronic screens for non-school activities (Tremblay et al., 2011a). Screen time has also been shown to be linked with an increased risk of excessive weight gain in children, as well as the development of metabolic syndrome and type 2 diabetes (Gortmaker et al., 1996; Hamilton, Hamilton, & Zderic, 2007). Screen-based sedentary behaviours have also been related to increased

food intake in children (Thivel et al., 2013). Studies have shown that children are consuming a large portion of their daily energy intake in front of the television (Gore et al., 2003; Matheson et al., 2014; Van den Bulck & Van Mierlo, 2004). It is generally accepted that a high daily usage of electronic media is linked to a higher risk of obesity in adolescents (Komlos, Breitfelder, & Sunder, 2008; Ogden et al., 2012).

To properly understand how obesity can be prevented in adolescents, we need to understand the underlying factors that affect their energy balance. A sustained positive energy balance causes excessive weight gain. It is possible that a high amount of screen time contributes to a state of positive energy balance through a lack of physical activity and/or increase food intake due to the influence of food advertisements on television and distraction (Mitchell et al., 2013). Although it is well documented in adults (Thivel et al., 2013), there is little evidence on the effect of daily screen time or music listening on nutritional changes in children and youth (Thivel et al., 2013). This is especially true in the context of initiating a physical activity or exercise program. Specifically, it is currently unknown whether exercising with or without a screen or music leads to the same energy intake after the exercise session than without one or the combination of these stimuli. This issue is particularly topical in today's fast-paced society surrounded by external stimuli that have previously been shown to promote overconsumption of food in adolescents in the modern obesogenic environment (Chaput, Klingenberg, & Sjödén, 2010). To date, no studies have looked at the influence of screen time or music listening on PEEC (i.e., energy intake and/or energy

expenditure), thereby limiting inferences on whether exercising with or without a screen or music may ultimately affect energy balance and body weight control the same way.

## Part 2: Literature Review

### Physical Activity Compensation

Children and youth are recommended to accumulate at least 60 minutes of moderate-to-vigorous physical activity (MVPA) (>3 METS) on a daily basis (Tremblay et al., 2016). Only 7% of Canadian children and adolescents are currently meeting this guideline in Canada (Colley et al., 2017). Physical activity is important for children and youth as it has been shown to reduce cardiovascular disease risk factors, a more favourable body composition, and better psychological well-being (Ekelund et al., 2012; Lagerberg, 2007). In contrast, physical inactivity, which is defined as less than 60 minutes a day of MVPA in children and youth, has been described as one of the largest public health problems of the 21<sup>st</sup> century (Blair, 2009; Tremblay et al., 2017). It is associated with poor aerobic fitness, orthopedic complications, reduced cognitive functioning, elevated triglyceride levels, higher blood pressure and decreased insulin sensitivity in overweight children (Biddle & Asare, 2011; Carrel et al., 2005; Dietz et al., 1994; Ekelund et al., 2012; Janssen & Leblanc, 2010). Children who struggle with obesity may also experience problems with self-esteem and/or body image (Troost et al., 2001). Recently, there has been a substantial decline in physical fitness and a large increase in the prevalence of obesity among children and youth (Janssen et al., 2012). This is a particular concern given that physical activity is known to decrease substantially during adolescence (Alberga et al., 2012; Dumith et al., 2011). Part of the explanation is due to the decline in physical education classes in high school compared to elementary school (Kimm et al., 2000). Though multiple countries have come to a consensus that children

should be engaging in a minimum of 60 minutes of MVPA a day for health benefits (Tremblay et al., 2011c), the most beneficial exercise prescription for weight management in overweight/obese pediatric populations remains unclear (Paravidino et al., 2016).

In this regard, food and/or physical activity compensation is not often considered when investigating exercise interventions for prevention of overweight and obesity (Thompson, Peacock, & Betts, 2014). Physical activity compensation (i.e., reducing daily physical activity following an exercise session) may be due to various physiological and psychological factors, such as fatigue, delayed onset muscle soreness, fear of overexertion, reduce motivation and perceived time constraints (Gray et al., 2018). Additionally, daily physical activity behaviours can also be influenced by weather conditions (Chan & Ryan, 2009) and/or daylight hours (Goodman, Paskins, & Mackett, 2012) in adolescents. In general, physical activity interventions tend to have limited success by only achieving small acute changes in increasing physical activity in children (Foster et al., 2005), as well as limited changes in body mass index (BMI) in children and adolescents (Dobbins et al., 2009; Harris et al., 2009). A systematic review and meta-analysis showed that physical activity interventions indeed have a small influence on overall physical activity levels (mean standard difference of 0.12; 95% CI [0.04,0.20]) and on MVPA (mean standard difference 0.16; 95% CI [0.08,0.24]), showing only an increase in ~4 minutes of MVPA per day following interventions (Metcalf, Henley, & Wilkin, 2012).

A possibility for these minimal daily increases in physical activity over time even with physical activity interventions could be explained by the 'activitystat' hypothesis. The 'activitystat' hypothesis suggests that children compensate the physical activity performed in the interventions by decreasing physical activity in the rest of the day to maintain a total subsequent amount of physical activity energy expenditure (Rowland, 1998). This hypothesis is described as a homeostatic mechanism, where the biological centre is responsible for controlling physical activity based on a daily energy expenditure set point. However, the 'activitystat' hypothesis has had mixed findings in the literature and its nature and existence is highly debated (Reilly, 2011; Wilkin, 2011).

A systematic review sought to test the 'activitystat' theory in children, adults and older adults, and found that 63% of children compensated following an exercise intervention by reducing their daily physical activity energy expenditure (Gomersall et al., 2013). However, due to the various nature of the exercise interventions (e.g., durations and settings), no clear conclusions regarding the 'activitystat hypothesis' could be made (Gomersall et al., 2013). Since this study, other researchers have reported conflicting results with an exercise intervention, showing both daily physical activity compensation in children (Frémeaux et al., 2011; Wilkin et al., 2006) or no 'activitystat' effect in children and adults (Cadieux et al., 2014; Kozey-Keadle et al., 2014; Wasenius et al., 2014). Specifically, Ridgers and colleagues (2014) wanted to explore this hypothesis in obese and lean children and examined whether increased levels of physical activity in a single day were predictive of physical activity compensatory behaviours the following day (Ridgers et al., 2014). The authors found that an additional 10 minutes of time spent

in MVPA was associated with approximately 25 minutes less of light-intensity physical activity and 5 minutes less of MVPA the next day, which was consistent with the 'activitystat' hypothesis. Many studies have focused on energy expenditure following exercise interventions, but very few have examined its effect on energy intake despite its important contribution to energy balance.

### **Compensation in Energy Intake following Exercise**

By combining exercise and dietary strategies, multidisciplinary approaches can prove to be more successful in weight loss management (Thivel et al., 2012). However, the relationship between exercise and spontaneous energy intake has been overlooked (Thivel et al., 2012). In children, the results regarding post-exercise energy intake have been contradictory. Some studies in children and youth have shown a reduction in energy intake following an exercise session (Jokish, Coletta, & Raynor, 2012; Sim et al., 2014), some have showed an increased in energy intake (Erdmann et al., 2007; Laan et al., 2010; Shorten, Wallman, & Guelfi, 2009) and others have shown no significant changes (Bellissimo et al., 2007; Bozinovski et al., 2009; Dodd et al., 2008).

Energy intake has been considered by some researchers to be the largest source of energy compensation after the introduction of an exercise intervention in overweight children, because it is exclusively determined by eating behaviour (e.g., increased snacking, larger portions and more energy dense foods) (King et al., 2007; Melanson et al., 2013). Exercise could also influence macronutrient intake and food choice preferences in adults (King et al., 2007). It has also been argued that post-exercise

energy intake results from the necessity to restore carbohydrate balance as opposed to meeting total daily energy needs (Pannacciulli et al., 2007; Snitker et al., 1997). This suggests that higher intensity activities would induce higher energy intake, as they rely predominantly on carbohydrate metabolism (Drenowatz, 2015). There are several ways in which energy intake could increase following an exercise session. These include increased snacking, larger meal portions, and energy-dense foods (King et al., 2007).

The first study to explore the impact of an exercise intervention (intermittent cycling exercise) on energy intake in 19 girls (aged 9-10 years) demonstrated that a moderate exercise session (75%  $\text{VO}_2\text{peak}$ ) did not affect food consumption in the short term. In contrast, lower intensity exercises (50%  $\text{VO}_2\text{peak}$ ) resulted in a 700 kJ decrease post-exercise energy intake (Moore et al., 2004). This reduction in energy intake after exercise could be attributed to the decrease in appetite, as a result of gastric emptying (Cammack et al., 1982). A recent systematic review and meta-analysis by Thivel et al. (2016) sought to determine if acute exercise affects subsequent energy and macronutrient intake in obese and non-obese children and adolescents (Thivel et al., 2016). The authors found that although acute exercise did not affect energy intake in lean children and youth, they observed an effect on food intake post-exercise in obese youth at an intensity of  $>70\% \text{VO}_2\text{max}$ , with some participants showing an increase in food intake, while others showed a decrease. Since scientists have only recently started to explore the influence of exercise on energy intake in children and adolescents, it is difficult to come up with firm conclusions on this issue (Thivel et al., 2013).

## **Sedentary Behaviours and Screen time**

Sedentary behaviours are described as low energy expenditure activities that are part of our daily lifestyle, such as sitting, watching television and/or playing video/computer games (Tremblay et al., 2017). We begin to engage in these behaviours as early as childhood which then continues through adolescence and into adulthood (Busschaert et al., 2015; Carson et al., 2016a; Francis et al., 2011; Jones et al., 2013). Interestingly, it was not until the 1980s that researchers started to recognize that prolonged bouts of sitting can have possible negative effects on individual health (Biddle & Bennie, 2017). This has since lead to numerous publications examining the role that sedentary behaviour plays on our health (Carson et al., 2016b). Screen time (e.g. cell phone or computer use or TV viewing) is one of the main contributors to total time spent in sedentary pursuits in children and youth (Gopinath et al., 2012). Adolescents are accumulating an average of 8 hours of leisure screen time per day (Leatherdale & Harvey, 2015). This is well above the recommendation of no more than 2 hours per day for children and youth (Tremblay et al., 2016). High screen time use can have potential harmful effects on children's health as it leads to increased food intake, exposure to unhealthy food advertisements and takes away from time that could be spent engaging in physical activity (Biddle, Bengoechea, & Wiesner, 2017; Robinson & Matheson, 2015). Interestingly, self-reported screen time is consistently higher in boys than girls (Atkin et al., 2016; Bucksch et al., 2016; Leatherdale & Ahmed, 2011; LeBlanc et al., 2015).

A large review of 1.5 million participants (aged 5-17) from around the world indicated that different types of sedentary behaviours may have various impacts on health (Carson et al., 2016a). High duration (2 hours or more) of TV viewing and/or screen time (e.g. computer use and video games) per day has been associated with unfavourable health outcomes as well as lower fitness level and poorer emotional and social health indicators (self-esteem, behavioural conduct/pro-social behaviour, depression, stress and aggression) (Bickham et al., 2013; Carson et al., 2016a; Hinkley et al., 2014; Hoare et al., 2016; Jago et al., 2005; Katzmarzyk, 2010; LeBlanc et al., 2012; Owen et al., 2010; Rey-López et al., 2008; Robertson, McAnally, & Hancox, 2013; Teychenne, Costigan, & Parker, 2015; Tremblay, et al., 2011b). Specifically, excessive computer use and video games have been shown to increase the risk of obesity and cardiometabolic diseases in children and youth (Leatherdale & Harvey, 2015; Shields & Tremblay, 2008; Tremblay et al., 2011b), even more so than time spent in non-screen based activities such as sitting quietly or reading/studying (Cameron et al., 2016; Saunders, Chaput, & Tremblay, 2014). It is important to differentiate between screen (e.g. TV viewing) and non-screen (e.g. reading) activities to better understand their specific effects on individual health (Downing et al. 2017; Brunetti et al. 2016).

### ***Television and Obesity***

Television viewing is currently the main sedentary activity in both adult and pediatric populations, with the average teenager spending 4.5 hours watching television per day (LeBlanc et al., 2017; Swinburn & Shelly, 2008). Children are engaging in more time watching television than any other activity besides sleep (Huston & Wright, 1997).

However, due to changes in technology, the proportion of daily sedentary time spent using computers has increased substantially in recent years, while the proportion of watching television has decreased (Saunders et al., 2014).

In 1985, Dietz and Gortmaker found a positive relationship between television viewing and obesity in children (Dietz & Gortmaker, 1985). Since then, this association has become a popular research topic. The positive association between television viewing and body weight has been shown in both cross-sectional and longitudinal studies (Klesges, Shelton, & Klesges, 1993). However, studies have shown contradictory results, with some showing that reducing television viewing reduced body weight, while others did not find any effect (Epstein et al., 2008; Maddison et al., 2014). A study published in 2017 in children by Jackson and Cunningham found that physical activity level and dietary choices were not significant mediators of BMI z-scores. Conversely, longer time spent watching television in first and third graders was associated with higher BMI z-scores (Jackson & Cunningham, 2017). Three main mechanisms have been proposed to explain the link between television viewing and obesity.

### *1. Television Viewing Displacing Physical Activity*

Since television was first created, it has been used to replace many activities such as doing homework or studying (Hornik, 1981). The displacement hypothesis of television viewing states that by increasing the amount of television being watched, there will be less available time for physical activities (Mutz, Roberts, & Vuuren, 1993). This theory has continually been explored since the 20<sup>th</sup> century, though the findings have proven to

be inconsistent (Vandewater, Shim, & Caplovitz, 2004). Robinson and Killen (1995) found no relationship between physical activity and television viewing, whereas Durant and colleagues (1994) found a weak negative relationship. This displacement hypothesis has been regarded as the most popular premise for explaining how electronic use affects weight status for many years (Vandewater et al., 2004). However, researchers have discovered that a regular high total sedentary time is not the only mechanism for obesity development (Byun, Liu, & Pate, 2013).

### *2. Reduced Resting Metabolic Rate during Television Viewing*

It has been suggested that watching television could cause a decrease in resting metabolic rate during viewing, thereby lowering the child's daily energy expenditure (Bryant et al., 2007). Some studies have shown a small decrease in resting metabolic rate during television viewing in children aged 8-12 years while others found no change (Dietz et al., 1994; Gortmaker et al., 1996; Klesges et al., 1993). There have also been findings indicating that obese children actually have the same or higher resting energy expenditure compared to lean children (Molnár et al., 1985; Puhl, 1989). Here again, this suggested mechanism does not seem to be an important one to explain the association between television viewing and body weight status in children.

### *3. Increased Energy Intake while Watching Television*

The third mechanism for how television viewing may lead to weight gain is through an increase in energy intake, either via the influence of food advertisements or via distraction (Thivel, Tremblay, & Chaput, 2013; Vandewater et al., 2004). Studies have

shown that children are consuming a large proportion of their daily energy intake in front of the television (Gore et al., 2003; Matheson et al., 2004; Van den Bulck & Van Mierlo, 2004). It is generally accepted that a high daily usage of electronic media is linked to obesity in adolescents (Komlos et al., 2008; Ogden et al., 2012). Watching television can also play an important role in influencing energy intake behaviours. It is well known that television viewing is a promotional way for marketers to advertise their food products to customers, and can influence food consumption in children. Television advertisements have been shown to increase food intake by up to 45% in children, and approximately 26% of children's total daily energy intake is found to be consumed in front of the television (Harris, Bargh, & Brownell, 2009; Matheson et al., 2004). High-fat and high-sugared foods are constantly being shown on television, and children who watch television are more likely to consume these food products as opposed to fruits and vegetables (Gamble & Cotugna, 1999; Santaliestra-Pasías, 2012). Harris and colleagues (2009) found that there was indeed a direct causal link between food advertising and greater snack consumption in adult and child populations and, therefore, this may contribute to the obesity epidemic (Harris et al., 2009). These findings suggest that a decrease in exposure to unhealthy food advertising would be beneficial (Harris et al., 2009). The physiological mechanisms by which television viewing causes increased energy intake are currently unclear. It is possible that television creates a distraction causing delayed and decreased satiety signals and can cause habituation to food through food cues (Bellisle, Dalix, & Slama, 2004; Temple et al., 2006). There are many studies that have looked at the effect of eating behaviour

while watching television, but there is little work that has been done on the effects on television viewing on food intake after exposure to an exercise stimulus in children.

### **Cognitive and Psychological Mechanisms of Auditory and Visual Stimuli during Exercise**

Since 1979, the relationship between the enjoyment of exercise and exercise behaviour has been repeatedly explored (Ebben & Brudzynski, 2008; Perrin, 1979). Researchers have discovered many ways to increase the enjoyment of physical activity, such as putting mirrors in exercise rooms, exercising in group classes or, more recently, with the use of televisions (Chmelo et al., 2009; Focht, 2009; Raedeke, Focht, & Scales, 2007).

Auditory and visual stimuli are commonly used for attentional distractions during exercise by making the activity seem more pleasurable (Jones, Karageorghis, & Ekkekakis, 2014). The way we emotionally perceive the exercise task can affect the level to which we perform at (Overstreet et al., 2017). However, the mechanisms that underlie these processes have yet to be fully explored.

The Dual-Mode Theory of exercise states that our responses to exercise are determined by a combination of cognitive factors (e.g., attention) and internal sensory cues (e.g., acidosis, core body temperature) (Hutchinson, Karageorghis, & Jones, 2015). Psychological systems (e.g., central and peripheral) determine how external stimuli affect our body through modulating our pulmonary, cardiac and hormonal systems (Tan et al., 2015). Specifically, during lower intensity exercise, our brain is capable of allocating our attention to external distractions, which can produce positive

responses (Hutchinson et al., 2015). A study performed by Bigliassi and colleagues (2016) presented a motivational movie during exercise to their participants and found that neurological factors in the brain caused the sensation of fatigue in the working muscles to decrease. This effect did not occur when a motivational stimulus was not present, therefore alluding to the benefits of distracting stimuli. Moreover, higher intensity exercises have shown to cause the attention to turn to internal cues such as respiration or muscle acidosis (Razon et al., 2009). These fatigue related symptoms during a high intensity exercise can negatively affect motivation (Marcora, 2008). However, a study conducted by Jones et al. (2014) determined that even at high intensities, sensory stimuli can make exercise more pleasurable by temporarily overpowering the negative physiological sensations elicited by high intensity exercise.

The Hedonic Motivation Theory states that an individual will engage in activities they find more pleasurable and avoid ones they find less enjoyable (Higgins, 2006). Additionally, it elucidates that our affective responses, such as pride, satisfaction or disappointment to a certain activity determines whether and how we will participate in that activity in the future (Higgins, 2006). Recent studies have explored “psychomusicology” and the cognitive mechanisms that underlie the influence of listening to music while exercising (Hutchinson et al., 2015). A study done by Juslin and Vastifjall (2008) found that acoustic music stimulates the brain stem reflex, signaling a potential urgent event, which can increase heart rate, blood pressure, body temperature and muscle tension (Chapados & Levitin, 2008; Juslin & Västfjäll, 2008). However, the mechanisms by which motivational stimuli affect fatigue and enhance exercise

performance are largely unknown. It is possible that mental fatigue reduces physiological arousal in the frontal and central regions of the cortex, which slows down body regulation (Craig et al., 2012). Bigliassi (2016) explored this hypothesis by using audiovisual stimuli to examine the psychophysiological responses and exercise performance. They found that motivational stimuli did indeed decrease low-frequency waves (fatigue suppression), but increased beta activity (amplified arousal). This combined effect of auditory and visual stimuli appears to underlie the effect elicited on psychophysiological responses during a fatigued task (Bigliassi et al., 2016).

It is possible that by pairing physical activity with television, which is considered an enjoyable activity by many, there may be an increase in the gratification and effectiveness of the exercise sessions (Steeves et al., 2016). Television viewing, which is a combination of both auditory and visual stimuli, has been shown to improve mood when paired with exercise, regardless of the content (Rider et al., 2016). Music listening while exercising has also been shown to be an effective dissociation strategy by masking undesirable physiological feelings during exercise in adults as well as promoting an ergogenic environment by increasing endurance and strength (Bharani, Sahu & Mathew, 2004; Crust & Clough, 2006; Karageorghis, Drew, & Terry, 1996). Music listening can also affect cardiovascular performance in adults and can reduce feelings of fatigue by up to 12% (Bharani, Sahu, & Mathew, 2004; Szmedra & Bacharach, 1998). The extent to which the presence of stimuli (i.e., television and/or music listening) can enhance mood during exercise is a topic of interest to researchers,

as it could further enhance the workout routine and creates an application for possible exercise interventions (Rocheleau, et al., 2004).

### **Objective and Hypothesis**

The objective of this study was to examine the effects of watching television and listening to music (independent variables) while exercising on post-exercise energy intake and expenditure (dependent variables) in male adolescents. Based on the available evidence, we hypothesized that the PEEC would be greater in both conditions with stimuli (i.e., television and music) compared with the control condition (i.e., exercise alone).

### **Significance**

No studies to date have looked at the effects of exercising with or without electronic screen devices (e.g. TV) and/or music on PEEC. The present study provides much needed information on the impact of these stimuli on PEEC and whether one needs to pay attention to these stimuli in a context of energy balance and body weight control. Though there is a lot of work being done on the effects of screen time on children's eating behaviours and activity levels, there is a knowledge gap on how these stimuli influence eating and physical activity behaviours after an exercise session in children and adolescents. These findings may also have positive implications for new exercisers, fitness/health care professionals, and teachers and coaches when prescribing exercise. Additionally, these findings can be advantageous to parents to determine when and how screen time can most benefit their children and adolescents.

### **Part 3: Methods**

A detailed description of the methods can be found in Part 4 (Pages 34-46).

## **Part 4: Article**

### **Watching television or listening to music while exercising failed to affect post-exercise food intake or energy expenditure in male adolescents**

The manuscript that follows was accepted for publication May 11, 2018 to the peer-reviewed journal *Appetite*.

## **Watching television or listening to music while exercising failed to affect post-exercise food intake or energy expenditure in male adolescents**

Short title: Exercising with TV or music and post-exercise energy compensation

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The study is registered at ClinicalTrials.gov (Identifier: NCT03105622).

Word count: 4689, with 3 Tables and 4 Figures

AUC: area under the curve; BMI: body mass index; EX: exercise, MVPA: moderate-to-vigorous physical activity; PAEE: physical activity energy expenditure; PAQ-A: Physical Activity Questionnaire for Adolescents; PEEC: post-exercise energy compensation; RMR: resting metabolic rate; RPE: ratings of perceived exertion; TEE: total energy expenditure; TFEQ-R18: Three Factor Eating Questionnaire Revised 18-item; VAS: visual analogue scale

## ABSTRACT

Watching television or listening to music while exercising can serve as motivating factors, making it more pleasant to exercise for some people. However, it is unknown whether these stimuli influence food intake and/or physical activity energy expenditure (PAEE) for the remainder of the day, potentially impacting energy balance and weight control. We examined the effects of watching television or listening to music while exercising on post-exercise energy intake and expenditure. Our study was a randomized crossover design, in which 24 male adolescents (mean age:  $14.9 \pm 1.1$  years) completed three 30-min experimental conditions consisting of walking/jogging on a treadmill at 60% of heart rate reserve while (1) watching television; (2) listening to music; or (3) exercising with no other stimulus (control). An *ad libitum* lunch was offered immediately after the experimental conditions, and a dietary record was used to assess food intake for the remainder of the day. An Actical accelerometer was used to estimate PAEE until bedtime. The primary outcome measure was post-exercise energy intake and expenditure (kJ). We found that exercising while watching television or listening to music did not significantly affect post-exercise energy intake or energy expenditure. Exercising on a treadmill was found to be significantly more enjoyable while watching television than with no stimulus present. Ratings of perceived exertion were not significantly different between conditions. Overall, our results suggest that watching television or listening to music while exercising does not impact post-exercise energy intake or expenditure in male adolescents, which may have positive implications for adolescents who may need additional motivation to participate in physical activity.

*Keywords:* Physical activity, television, food intake, energy expenditure, appetite, energy balance

## **INTRODUCTION**

Exercise is commonly used by individuals to obtain health benefits and to control their weight. However, compensatory adaptations in components of energy balance (i.e., increasing energy intake and/or decreasing energy expenditure) are often observed after exercising (Gomersall et al., 2013; Ridgers et al., 2014; Thivel et al., 2013a). The degree to which individuals compensate by increasing their daily food intake and/or decreasing their overall physical activity level subsequent to an exercise session is variable between individuals and may depend on many factors (Drenowatz, 2015; King et al., 2007). For example, previous work has shown that being exposed to external stimuli such as screen time (e.g., television, computer or video game use) or music leads to increases in food intake compared to a control condition such as sitting quietly (Chaput et al., 2011a; Chaput, Klingenberg & Sjödén, 2010; Thivel et al., 2013b). However, previous studies have not looked at the influence of these stimuli on post-exercise energy compensation (PEEC), thereby limiting inferences on whether exercising with or without a screen/music may ultimately affect energy balance and body weight control the same way.

Electronic screen devices and/or music while exercising can serve as motivators, making it more enjoyable and even easier to exercise for some individuals (Barney, Gust & Liguori, 2012; Bharani, Sahu & Mathew, 2004; Karageorghis et al., 2012; Rider

et al., 2016). This finding may have positive implications for adolescents who are at a higher risk of being inactive (Alberga et al., 2012). However, whether watching television or listening to music while exercising impacts PEEC is currently unknown. Examining this issue can help to determine if people should limit the use of screen devices and/or personal music players while exercising in order to promote energy balance and body weight control.

The primary objective of this study was to examine the effects of watching television or listening to music while exercising on PEEC in male adolescents. Based on previous evidence under sedentary conditions (Chaput et al., 2011a; Chaput, Klingenberg & Sjödín, 2010; Thivel et al., 2013b), we hypothesized that the PEEC would be greater in both conditions with stimuli (i.e., television and music) compared with the control condition (i.e., exercise alone). Secondary objectives included examining the impact of television or music on ratings of perceived exertion and enjoyment during an exercise session.

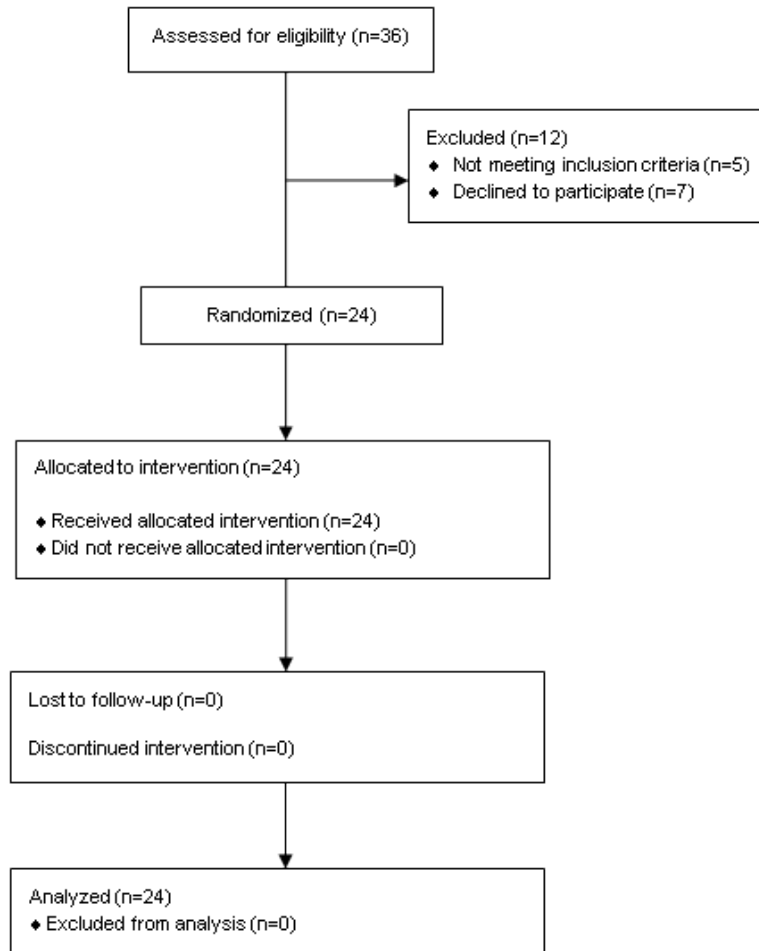
## **METHODS**

### ***Study Design***

We conducted a randomized, counterbalanced, 3-condition crossover study (within-subjects experimental design) in a laboratory setting (exercise session and *ad libitum* lunch) and in free-living conditions (remainder of the day). The CONSORT guidelines (Schultz et al., 2010) for reporting randomized trials were followed.

## ***Participants***

Male adolescents between the ages of 12 and 17 years were recruited for the study via advertisements in the community and through word of mouth. Female adolescents were not recruited as this is the first study to address the abovementioned research question and we would not be powered enough to split our sample size by sex if interactions were found with the outcome measures. Volunteer participants were excluded for any of the following reasons: smoker, unstable body weight ( $\pm 2$  kg) during the 3 months preceding testing, excessive alcohol intake ( $>15$  drinks/week), celiac disease, metabolic disease (e.g., thyroid disease, heart disease, diabetes), medication use that could interfere with the outcome variables (e.g., metformin, thyroid medication, stimulant medication), irregular sleeping pattern (e.g., working late or overnight shifts), unfamiliarity with running on a treadmill, and/or inability to comply with the research protocol. Written informed parental consent and child assent were obtained from all participants, and ethical approval was obtained from the Children's Hospital of Eastern Ontario Research Ethics Board and the University of Ottawa Research Ethics Board. Participants received \$30 per study visit for their participation in the study (\$120 total, including the preliminary visit). Participant flow through the study is presented in **Figure 1**.



**Figure 1.** Flow of participants through the study.

## ***Study Protocol***

### *Preliminary Visit*

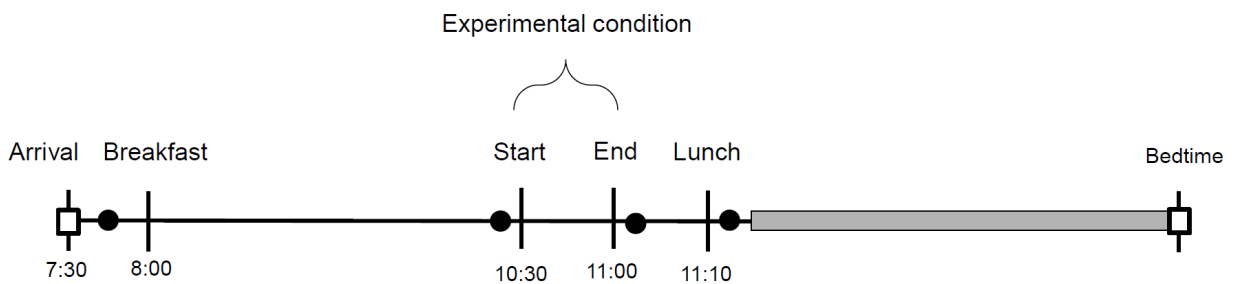
The participants came to our facilities for one preliminary visit and three experimental conditions; each visit was separated by a wash-out period of at least one week. All sessions began at 07:30, and the participants were instructed to arrive fasted and to abstain from structured exercise for 12 hours before each visit. Participants also had to

respect a normal sleep schedule (e.g.,  $\geq 8$  hours, self-reported) before testing and needed to be in good health on testing days. During the preliminary visit, research staff directly measured body weight, height, waist circumference, resting metabolic rate, and resting heart rate (details below). Participants also completed a series of questionnaires and provided any additional information that may impact their ability to participate in the study (e.g., food allergies).

### *Experimental Conditions*

A schematic overview of the study protocol is presented in **Figure 2**. An accelerometer (Phillips Respironics, Oregon, USA) was attached immediately on arrival to the facilities (07:30) and was worn until bedtime the day of the experimental conditions. Visual analogue scales (VAS) were used to record subjective measures of appetite at different time points. Participants were provided a standardized breakfast at 08:00 consisting of 2 pieces of whole-wheat bread (45 g, 460 kJ; Oats & Honey Country Harvest) or white bread (71g, 795 kJ; D'Italiano), peanut butter (18 g, 460 kJ; Kraft Smooth Peanut Butter), strawberry jam (16 mL, 251 kJ; Kraft Pure Strawberry), cheddar cheese (21 g, 377 kJ; Balderson Extra-Fort), and orange juice (200 mL, 418 kJ; Minute Maid 100% Orange Juice) or apple juice (200 mL, 377 kJ; Allen's Apple Juice from concentrate). Participants ate the same breakfast for all three experimental conditions, alone in a room with no distractions, and consumed the entire breakfast within 15 minutes. The participants did not eat between breakfast and the *ad libitum* lunch. The 30-min experimental intervention consisted of 1 of the 3 conditions, starting at 10:30.

Participants were asked to relax on a comfortable chair between the end of the breakfast and the beginning of the testing condition. After the experimental condition, an *ad libitum* test lunch was given to the participants to evaluate spontaneous food intake. A dietary record was used to assess food intake for the remainder of the day.



**Figure 2.** Overview of the study protocol. The black dots represent visual analogue scales, the white squares represent when the accelerometer was put on and taken off, and the grey rectangle represents the food diary assessment for the remainder of the day.

Each participant was engaged in each of the following three 30-min experimental conditions followed by an *ad libitum* lunch: (1) walking/jogging on a treadmill at 60% of heart rate reserve while watching television (EX + TV); (2) walking/jogging on a treadmill at 60% of heart rate reserve while listening to music (EX + Music); and (3) walking/jogging on a treadmill at 60% of heart rate reserve with no other stimulus (Control). These 3 conditions were counterbalanced to reduce the chance of the order of conditions or other factors adversely impacting the results. Participants were allowed to choose their own television content (i.e., via Netflix) and the music of their choice

(i.e., via personal music player such as an iPod) to increase external validity (i.e., mimic real-life conditions). Exercise sessions were performed on a treadmill and supervised by trained study staff. The intensity (60% of heart rate reserve) and duration (30 minutes) of the exercise sessions on the treadmill were fixed by us. The Karvonen equation (Karvonen, Kentala & Mustala, 1957) was used to determine the target heart rate training zone:  $\text{Exercise Target Heart Rate} = ((220 - \text{Age}) - \text{Resting Heart Rate}) \times \text{Exercise Intensity (\%)} + \text{Resting Heart Rate}$ . Resting heart rate was measured using heart rate monitors (Polar Electro Oy, Kempele, Finland), where participants sat comfortably in a chair for 7 minutes. Then, the beats per minute at the 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> minute were used to calculate the mean resting heart rate. Heart rate monitors were also used throughout the 30-min exercise conditions to ensure they remained in the targeted 60% heart rate training zone ( $\pm 5$  beats per minute). The incline remained at 0 for all three sessions and the speed was adjusted to maintain the 60% heart rate training zone.

## ***Measurements***

### *Anthropometric Measurements*

Body weight was measured without shoes to the nearest 0.1 kg on a calibrated electronic scale (Tanita, Arlington Heights, IL, USA). Height was measured, without shoes, after a deep inspiration, to the nearest 0.1 cm with the participant standing with feet together and head in the Frankfort plane against a wall-mounted stadiometer. Body

mass index (BMI; weight (kg)/height (m<sup>2</sup>)) was determined and interpreted with the World Health Organization BMI-for-age growth charts (de Onis et al., 2007). Waist circumference was measured to the nearest 0.1 cm by using a non-extendable linen tape and measured midway between the lower border of the last rib and the upper border of the iliac crest at the end of a normal expiration.

### *Resting Metabolic Rate*

Resting metabolic rate (RMR) was measured during the preliminary visit by indirect calorimetry (Ultima CPX metabolic cart, MGC Diagnostics, Saint Paul, MN, USA). RMR was measured for 30 minutes after a 30-minute rest period, after a 12-hour overnight fast. The first and last 5 minutes were excluded from the calculations; thus, minutes 6-25 were used to calculate RMR in our sample. Mean RMR was calculated by using the Weir equation (Weir, 1949). The coefficient of variation and reliability coefficient for the determination of RMR with this metabolic cart in our laboratory are 2.3% and  $r=0.98$ , respectively, as determined in 12 healthy participants.

### *Questionnaires*

Some questionnaires were administered during the preliminary visit to better characterize the participants. The Three-Factor Eating Questionnaire Revised 18-item version (TFEQ-R18) was used to measure three aspects of eating behavior: cognitive restraint, uncontrolled eating, and emotional eating (De Lauzon et al., 2004). The

TFEQ-R18 raw scores were transformed to a 0-100 scale [ $((\text{raw score} - \text{lowest possible raw score}) / \text{possible raw score range}) \times 100$ ] (De Lauzon et al., 2004). To assess sleep hygiene, participants completed the Pittsburgh Sleep Quality Index (Buysse et al., 1989), a self-rated questionnaire that assesses sleep quality and disturbances over the preceding month. A total score  $>5$  is associated with poor sleep. Sleep hygiene was assessed in this study because sleep has been shown to influence energy balance (Chaput, 2014). The physical activity pattern of participants was assessed by using the Physical Activity Questionnaire for Adolescents (PAQ-A), a self-report measure of physical activity that has been validated in Canadian samples (Kowlaski, Crocker & Faulkner, 2007). A score of 1 and a score of 5 indicate low and high physical activity participation, respectively. Finally, the pubertal status of adolescents was evaluated with a self-assessment questionnaire that aims to measure pubertal status by using gender-specific line drawings of the Tanner puberty stages (Taylor et al., 2001).

### *Perceived Exertion*

Ratings of perceived exertion (RPE) were used every 5 minutes during the 30-min experimental conditions to quantify participants' perceived exertion by using the OMNI scale of perceived exertion. The scale ranges from 0 (not tired at all) to 10 (very, very tired) and has been previously validated in the pediatric population (Robertson et al., 2000). Participants may find the exercise session easier to perform with the use of a stimulus (e.g., music or television program), and it is also possible that the RPE may influence PEEC. Recent findings showed that for each unit increase in RPE, children

consumed 270 more calories on the exercise day (Fearnbach et al., 2017). RPE was graphed over time (7 time points) and the area under the curve (AUC) was calculated using the trapezoid method.

### *Ad Libitum Lunch*

Spontaneous food intake was assessed by using an *ad libitum* lunch immediately after each experimental condition. The *ad libitum* meal was spaghetti Bolognese with beef (640 kJ /100 g; macronutrient composition: 22% of energy as protein, 39% of energy as fat, and 39% of energy as carbohydrate) and 250 mL tap water. The participants were instructed to eat *ad libitum*, alone, in a room without distractions. They had a maximum of 30 minutes to consume the meal, and the serving of pasta was larger than the expected intake (>900 g offered). The meal was weighed before the lunch, and the uneaten portion was weighted after the lunch to assess energy intake (kJ). We also calculated eating rate (kJ/min) for exploratory purposes. This *ad libitum* test meal has been shown to provide a reliable measure of energy intake inside the laboratory (Chaput et al., 2016; Gregersen et al., 2008).

### *Visual Analogue Scales*

For each condition, the participants were instructed to complete 9 visual analogue scales (VAS) for their sensations of hunger, satiety, prospective food consumption, fullness, and desire to eat something sweet, salty, or rich in fat. They also rated their

opinion on the general appreciation of the meal and on the overall satisfaction/enjoyment of the experimental conditions, from “extremely boring” to “extremely pleasant”. The VAS, 100 mm in length, contained statements anchored at each end expressing the most positive and most negative subjective ratings. The VAS have been shown to be both reproducible and valid for the measurement of appetite sensations in a laboratory setting (Flint et al., 2000). The VAS were completed during each experimental condition: at fasting (07:45), before the experimental condition (10:00), immediately after the experimental condition (10:45), and immediately after the *ad libitum* lunch.

#### *Dietary Record*

All participants were instructed to complete a dietary record (Tremblay et al., 1983), with help from the parents, after each experimental condition to evaluate the degree of potential compensation in food intake for the remainder of the day. Participants were instructed on how to complete the dietary record and on how to measure quantities of ingested foods. The food records were reviewed with each participant upon their return to improve the validity of the information provided. Mean energy and macronutrient intakes were calculated using the Food Processor SQL software (version 11.0.137; ESHA Research, Oregon, USA) and Health Canada’s Nutrient File, and reviewed by a registered dietitian.

#### *Physical Activity Energy Expenditure*

Physical activity energy expenditure (PAEE) was assessed by using an Actical accelerometer from 07:30 until bedtime. The accelerometer, on an elastic belt, was positioned on the right iliac crest in mid-axillary position immediately on arrival at the laboratory (07:30) and worn until bedtime on the day of exercise testing. The Actical measured and recorded time-stamped acceleration counts in all directions (omni-directional) in 15-second epochs. Invalid days (<10 hours of wear time) were removed from analysis as per published guidelines, and accelerometry data underwent standardized quality control and data reduction procedures (Colley, Gorber & Tremblay, 2010; Troiano et al., 2008; Esliger & Tremblay, 2006). The level of exercise intensity was determined based on published cut-points: sedentary = counts per 15 seconds less than 25; light = counts per 15 seconds between 25 and 383; moderate-to-vigorous physical activity (MVPA) = counts per 15 seconds of 384 or greater (Puyau et al., 2004). PAEE was estimated from the Actical using validated equations (Puyau, 2004). The Actical has been validated to measure physical activity in children and adolescents (Puyau et al., 2004).

### ***Statistical Considerations***

#### *Outcome Measures*

The primary outcome measure was PEEC. The food intake outcome was assessed by using an *ad libitum* test meal immediately after the experimental conditions and a dietary record for the remainder of the day. The energy expenditure outcome was

assessed by using an Actical accelerometer until bedtime. Total energy expenditure (TEE) was calculated by using the following formula:  $TEE = (PAEE \text{ from the Actical} + RMR) \times 1.11$  (World Health Organization, 1985) where the thermic effect of food is fixed at 10% of TEE. The secondary outcome measures were appetite sensations (VAS), RPE (OMNI scale) and enjoyment (VAS).

### *Sample Size Calculation*

It was estimated that a sample size of 24 participants would provide 80% power at a 5% level of significance (2-sided) to detect a minimal group difference of 200 kJ in energy intake and expenditure, assuming a standard deviation of 300 kJ. This is based on previous studies by our group, using a similar randomized crossover design that compared active video game play with passive video game play in adolescents (Chaput et al., 2011; Gribbon et al., 2015). We used a conservative standard deviation estimate because large variability is generally observed for energy intake (especially with the use of dietary records) and to increase the likelihood of detecting a significant difference between conditions.

### *Statistical Analysis*

A 2-factor repeated-measures ANOVA was used to assess the effects of the interventions on outcome measures. A Tukey's post hoc test was used to contrast mean differences. Effect sizes were examined by using the Cohen's *d* method, reflecting the

magnitude of the difference between groups. Effect sizes were considered negligible if  $<0.2$ , small if between 0.2 and 0.5, moderate if between 0.5 and 0.8, and important if  $>0.8$ . Correlations were used to examine the association between RPE and PEEC. Data are presented as means and standard deviations unless otherwise indicated. All statistical analyses were performed by using SPSS Statistics 23.0 (SPSS Inc, Chicago, IL, USA).

## **RESULTS**

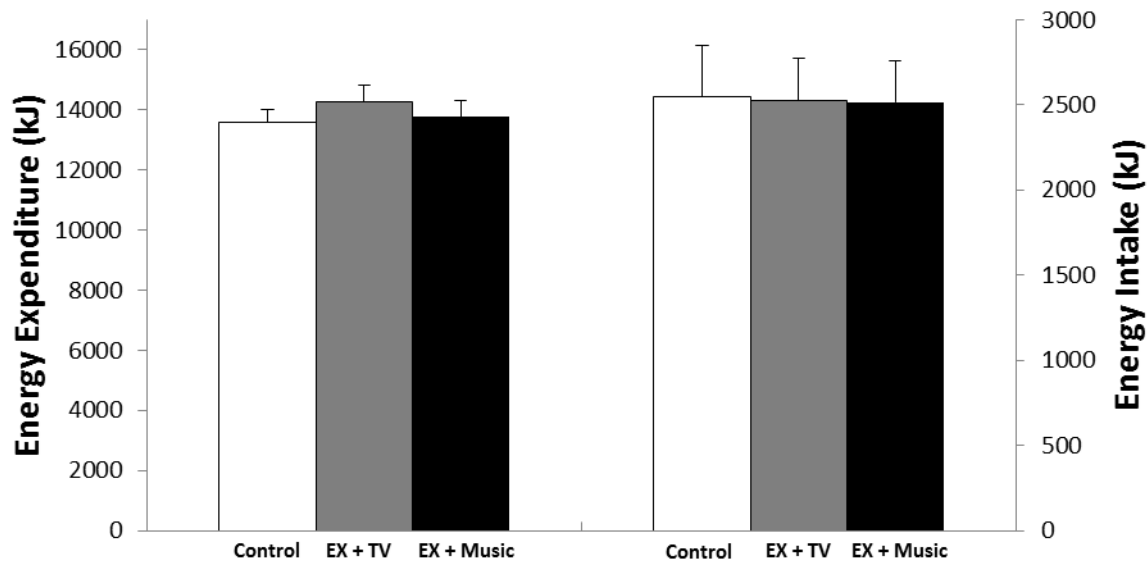
### ***Participant Characteristics***

**Table 1** shows the descriptive characteristics of the participants. Among the 24 male adolescents who completed the study, 22 were considered normal weight and 2 were considered overweight based on the World Health Organization criteria (de Onis et al., 2007). Tanner puberty levels were self-reported in the mid-to-later stages of development. Physical activity levels were considered as moderate as shown by the PAQ-A. The participants were found overall to have good sleep quality. Cognitive restraint, uncontrolled eating, and emotional eating were all considered normal, as is typically observed in male adolescents and young adults (De Lauzon et al., 2004).

### ***Energy Intake and Energy Expenditure***

There were no statistically significant differences between the experimental conditions for energy intake immediately following the experimental conditions (*ad libitum* lunch)

(**Figure 3**) or for the remainder of the day (dietary record) (**Table 2**). There were no statistically significant difference between conditions in the rate of consumption (kJ/minute) during the *ad libitum* lunch ( $373 \pm 166$  kJ,  $340 \pm 152$  kJ, and  $365 \pm 152$  kJ for the Control, EX + TV and EX + Music conditions, respectively,  $p=0.62$ ). Likewise, TEE during the testing day (**Figure 3**) and time spent sedentary, in light-intensity physical activity and MVPA were not significantly different between conditions (**Table 3**). Effect sizes for these various comparisons were in the negligible to small range.



**Figure 3.** Total energy expenditure during the testing day (07:30 until bedtime) and spontaneous energy intake from the *ad libitum* lunch offered on completion of each condition. Values are mean  $\pm$  standard error. Comparisons between groups were analyzed by ANOVA for repeated measures. There were no significant differences between conditions. For energy intake, N=24 for all sessions; for energy expenditure,

N=20 for control and EX + TV sessions, and N=23 for EX + MUSIC due to invalid days (<10 hours of wear time) for some participants. EX: exercise.

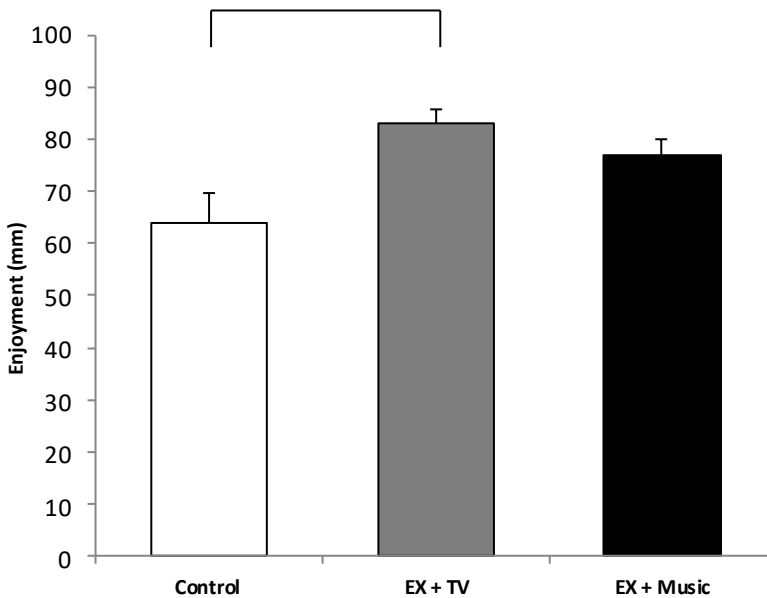
### ***Ratings of Perceived Exertion***

There was no statistically significant difference ( $p=0.60$ ) in the mean AUC ratings of perceived exertion between each condition ( $70.7 \pm 41.8$ ,  $65.5 \pm 45.9$ , and  $65.4 \pm 42.8$  for the Control, EX + TV and EX + Music conditions, respectively). The effect sizes for the different comparisons were considered negligible (Cohen's  $d$  value  $\leq 0.13$ ). Using other RPE metrics (e.g., maximum RPE reached or the average RPE over the course of the 30-min bout) also resulted in the same conclusion. There were also no statistically significant correlations between RPE and energy intake or energy expenditure ( $r < 0.10$ ) in any session.

### ***Enjoyment of the Exercise Session***

**Figure 4** shows the subjective ratings of enjoyment with the three exercise conditions as assessed with a VAS. We found that participants perceived the EX + TV condition significantly more pleasant than the Control condition ( $p=0.03$ ). The effect size was considered large (Cohen's  $d$  value: 0.90). There were no differences between the EX + TV condition and the EX + Music condition, or the EX + Music condition and the Control condition. The effect sizes between EX + TV and EX + Music (Cohen's  $d$  value: 0.46) and EX + Music and Control (Cohen's  $d$  value: 0.58) were considered moderate.

Enjoyment of exercise was not significantly correlated with *ad libitum* energy intake or PEEC.



**Figure 4.** Enjoyment of the experimental conditions using a visual analogue scale.

Values are mean  $\pm$  standard error. Comparisons between groups were analyzed by ANOVA for repeated measures, and a Tukey's post-hoc test was used to contrast mean differences. \*Statistically significant difference ( $p=0.03$ ). EX: exercise.

### ***Appetite Sensations***

No statistically significant differences in appetite sensations were found between experimental conditions at any time point (data not shown).

## **DISCUSSION**

To our knowledge, this is the first study to look at the effect of television viewing and music listening on PEEC. We hypothesized that watching television or listening to music would unfavorably affect PEEC compared to a non-stimulus control group. This was based on previous evidence conducted under sedentary conditions (i.e., sitting) showing that watching television or listening to music increased energy intake (Chaput et al., 2011a; Chaput, Klingenberg & Sjödín, 2010; Thivel et al., 2013b). Here we found that these external stimuli, compared to control, did not impact food intake or energy expenditure post-exercise. This finding is relevant to adolescents who may need additional motivation to partake in physical activity.

We found that participants did not compensate for the experimental exercise sessions (television and music) with decreased physical activity compared to the control, consistent with previous research in children (Foster et al., 2005) and adults (Alahmadi et al., 2011; Cadieux et al., 2014; Sim et al., 2014). However, these findings are inconsistent with other studies (Drenowatz, 2015; Li et al., 2014; Melanson et al., 2014), which could be due to various study designs of the exercise interventions and age of participants. These factors could affect the energy expenditure adaptations to the exercise bout long-term. More work needs to be done to better understand the heterogeneity in the response to exercise interventions in order to better tailor intervention strategies.

Energy intake is typically considered the largest source of energy compensation, because it is exclusively determined by eating behaviour (e.g., increased snacking, larger portions and more energy dense foods) (King et al., 2007; Melanson, et al., 2013). However, studies have shown conflicting results, with some showing a partial compensatory increase in energy intake in the post-exercise meal (Laan et al., 2010; Shorten, Wallman & Guelfi, 2009; Martins et al., 2007), while others have reported a decrease in energy intake after a single exercise session (Sim et al., 2014; Jokisch, Coletta, & Raynor, 2012). Our results showed no compensatory effects in energy intake after exercise at 60% of heart rate reserve with television viewing or music listening compared to the no-stimulus control. Future studies should verify these findings at various intensities and durations of exercise, and whether the effects are maintained long term.

Our study used Netflix to allow participants to choose their own television content. However, Netflix does not have food advertisements or commercials. Television advertisements have been shown to increase food intake up to 45% in children (Harris, Bargh, & Brownell, 2009) and approximately 26% of children's total energy intake is being consumed in front of televisions (Matheson et al., 2004). These findings suggest a decrease in unhealthy food advertisements would be beneficial (Harris, Bargh, & Brownell, 2009). There are many studies that have looked at the effect of eating behaviour while watching television, but there is little work that has been done on the effects on television viewing on food intake after exposure to the stimulus. It is hoped

that our findings will stimulate more work on the combined effect of exercising with a screen (multitasking) on energy balance and related behaviours.

In adults, acute lower intensity exercises have shown no or moderate effects on energy intake post-exercise (King, Burley & Blundell, 1994; Thompson, Wolfe, & Eikelboom, 1988). Bouts of higher intensity exercise have been shown to be associated with a decrease in energy intake and appetite in young men and boys (Blundell & King, 2000; Hunschede et al., 2017; King, Burley & Blundell, 1994; Sim et al., 2014; Ueda et al., 2009). In children, previous work has also shown that the amount of energy expended during exercise is not compensated for by an increase in post-exercise energy intake and may indeed even cause a decrease in energy intake (Saunders et al., 2014; Thivel et al., 2013a). The present findings agree with these results and are encouraging for future exercise interventions that also involve screens or music.

Participants found that watching television during the experimental condition was significantly more enjoyable than the no-stimulus control. Interestingly, Hutchinson, Karageorghis and Jones (2014) found that exercising while watching television and listening to music together showed the lowest level of RPE and highest levels of dissociation compared to the music condition or with no stimulus in young adults. Privitera et al. (2014) suggest that by allowing individuals to choose their content, it can influence how individuals perceive the exercise, which we deemed would best represent real-life conditions. Previous findings have also indicated that television paired with

exercise is more enjoyable than without television, regardless of the content (Hutchinson, Karageorghis and Jones, 2014; Rider et al., 2016). These findings should be considered when developing public health messages to promote physical activity among adolescents.

Out of 24 male adolescents tested in the present study, only two of them (8%) were considered overweight while the majority had healthy weight (92%). It was thus not possible to examine possible differences in PEEC between lean and overweight/obese participants. Previous investigations have shown distinct differences between lean and obese samples in regards to post-exercise energy intake behaviours (Thivel et al., 2016; Thivel et al., 2013a). Future studies should thus determine if similar findings are observed in populations with excess weight.

Along the same lines, the present study was comprised of male adolescents who reported moderate physical activity levels and moderate-to-high enjoyment of exercising. Although the present findings may have positive implications for adolescents who may need additional motivation to be active, it is still unclear if the results can be applied to populations at risk for low physical activity levels (e.g., adolescent girls or individuals with obesity). More research is needed to confirm our findings and increase the external validity of these results.

As with any study, there are strengths and limitations to this work. This work examined the acute effect of television viewing and music listening during an exercise session on PEEC; to aid in informing public health messages, future work should focus on examining the long-term effect of various exercise stimuli on PEEC. However, to our knowledge, this was the first study to compare different types of stimuli on PEEC. Future randomized trials with larger sample sizes, longer follow-up periods, and a variety of intensities, durations and types of exercise will be needed to confirm our findings. Self-reported questionnaires and food intake diaries can also suffer from response bias, especially in children (Dhurandhar et al., 2015). Food intake is one of the hardest variables to measure and its assessment is a highly debated topic in research (Archer et al., 2013; Schoeller et al., 2013). Additionally, *ad libitum* meals can cause overeating in laboratory settings, as a result of impulsive overdrive to eat more when food is offered free-for-all (Larson, Rising, Ferraro, & Ravussin, 1995). Finally, the generalizability of our findings is restricted to the sample studied (male adolescents with predominantly healthy weight) and future studies should investigate this question in female and other populations (e.g., overweight/obese, adults, inactive, etc.) to improve external validity.

In conclusion, this randomized cross-over trial showed that exercising while watching television or listening to music resulted in the same PEEC as exercising without any stimulus. This finding is interesting given that using an external stimulus may provide important motivation for adolescents to engage in physical activity. Watching television

while exercising was also found to be more enjoyable compared to the control condition. An interesting next step would be to examine an “authentic” condition where children and adolescents could run outside, around a track or on a trail and see how these conditions differ in terms of PEEC and enjoyment. Future research should also confirm our findings, including in other populations and with longer follow-ups.

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## **CONFLICTS OF INTEREST**

None.

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## TABLES

**Table 1.** Descriptive characteristics of participants (N=24).

Age (years)	14.9 ± 1.1
Height (cm)	170.2 ± 11.5
Body weight (kg)	66.4 ± 10.2
BMI (kg/m <sup>2</sup> )	20.7 ± 2.3
Waist circumference (cm)	74.9 ± 5.7
RMR (kJ/day)	8171 ± 1402
Resting heart rate (bpm)	63.6 ± 9.1
Tanner puberty stages (self-assessed)	3.9 ± 0.7
Genitals	3.4 ± 0.9
Physical Activity Questionnaire	2.5 ± 0.5
Pittsburgh Sleep Quality Index	4.8 ± 2.4
TFEQ-R18	
Cognitive restraint	20.2 ± 14.5
Uncontrolled eating	36.4 ± 13.5
Emotional eating	24.7 ± 12.8

Values are mean ± standard deviation. BMI: body mass index; RMR; resting metabolic rate; TFEQ-R18: Three-Factor Eating Questionnaire Revised 18-item.

**Table 2.** Mean energy and macronutrient intake for the remainder of the day (dietary record only) for each experimental condition (N=24).

	Control	EX + TV	EX + Music
Total energy	6513.5 ± 2423.3	6626.4 ± 2770.7	6754.9 ± 3240.6
Fat			
(kJ)	2297.3 ± 1190.4	2352.1 ± 1407.7	2178.5 ± 1176.33
(%)	35.0 ± 9.3	34.7 ± 8.7	32.7 ± 8.6
Carbohydrate			
(kJ)	3234.3 ± 1557.3	3357.1 ± 1699.9	3517.9 ± 220.9
(%)	49.8 ± 9.9	51.0 ± 10.6	51.4 ± 11.9
Protein			
(kJ)	981.9 ± 570.2	917.2 ± 434.7	1058.5 ± 582.0
(%)	15.2 ± 5.9	14.3 ± 4.4	15.8 ± 4.9

Values are mean ± standard deviation. Comparisons between groups were analyzed by repeated-measures ANOVA. There was no significant difference between groups. EX, exercise.

**Table 3.** Energy expenditure characteristics for each experimental condition (from 07:30 until bedtime).

	Control (N=20)	EX + TV (N=20)	EX + Music (N=23)
Number of steps	9928.1 ± 5004.7	12107.3 ± 3433.6	11923.0 ± 3690.6
MVPA (min)	44.2 ± 24.8	54.7 ± 21.1	49.1 ± 20.8
LPA (min)	110.9 ± 55.3	108.15 ± 31.1	113.2 ± 37.3
SED (min)	444.8 ± 76.4	437.4 ± 41.5	437.8 ± 46.3

Values are mean ± standard deviation. Comparisons between groups were analyzed by repeated-measures ANOVA. There was no significant difference between groups.

MVPA: moderate-to-vigorous physical activity; LPA: light-intensity physical activity;

SED: sedentary time; EX, exercise. The sample size is smaller than N=24 due to invalid days (<10 hours of wear time) for some participants.

## **Part 5: Global Discussion**

### **Energy Compensation Post-Exercise**

Our study found that male adolescents did not compensate by decreasing their physical activity following an 30-minute exercise session while watching television or listening to music compared to no stimulus (control). Our results are consistent with previous research in children (Foster et al., 2005) and adults subjected to an exercise intervention without stimuli (Cadieux et al., 2014; Sim et al., 2014). Additionally, we found that participants did not compensate by eating more after the exercise sessions with television or music compared with the control condition. These findings are encouraging and suggest that male adolescents should not be worried about using screens or listening to music while exercising with regards to PEEC.

Currently, evidence on PEEC following exercise interventions is equivocal, with large inter-individual variability. There are multiple factors that could contribute to the conflicting results in the field, including validity and accuracy issues associated with tools used to measure energy intake (standard deviation of 25%) and energy expenditure (standard deviation of 10%) phenotype (Melanson et al., 2013; Schoeller & Thomas, 2015). Additionally, non-exercise activity thermogenesis (NEAT), which is used to calculate total energy expenditure, is considered highly variable (Levine, 2002) and can be influenced by environmental and biological factors (Esparza et al., 2000; Joosen et al., 2005). It is also extremely difficult to replicate real-life conditions in a

laboratory setting. Future studies should combine the use of activity monitors with double-labeled water, which is currently the gold standard, to provide the most accurate prediction of energy expenditure. However, these methods are expensive and do not always capture all of factors to consider in a 24-hr period. Therefore, when assessing energy expenditure we need to also examine the behavioural and psychological components (Drenowatz, 2015; Melanson et al., 2013), as well as physiological mechanisms (Thivel et al., 2016) and sleep characteristics (e.g. duration, quality, chronotype). Additionally, more research needs to be done on the full spectrum of energy balance that focuses on the influence of individual characteristics (i.e., age, sex, socioeconomic status, body weight, fitness level, food beliefs) (Melanson et al., 2013), as well as exercise prescription (i.e., duration, intensity, frequency, and type of exercise) and dietary aspects (i.e., macronutrient content, meal frequency, timing and food availability) (Drenowatz, 2015; Melanson et al., 2013).

## **Perception of Exercise**

### ***RPE and Energy Intake***

A study published in 2017 by Fearnbach and colleagues found that total energy intake was positively related to children's RPE at an intensity of 70%  $\dot{V}O_2$  peak . Children consumed 270 more kilocalories on the exercise day (Fearnbach et al., 2017). These findings suggest that greater perceived difficulty of exercise may result in over-compensation energy intake in post-exercise session in children (Fearnbach et al., 2017). Additionally, a study done in overweight women found that RPE was associated

with weight regain following a successful weight loss (Brock et al., 2010). However, our study found that the RPE was not correlated with energy expenditure or energy intake. It is currently unknown whether the perceived difficulty of exercise is associated with post-exercise energy intake or if certain exercise prescription parameter might be good predictors of energy intake (Fearnbach et al., 2017). It is possible that the way we perceive exertion can predict individual responses to an exercise bout (Fearnbach et al., 2017). Studies suggested that RPE and energy intake following exercise could be related to increased subjective hunger ratings (King et al., 2008), higher levels of disinhibition (Bryant et al., 2012), and greater emotional eating (Chandler-Laney et al., 2010). Previous studies have examined the difference in post-exercise energy intake but the cognitive mechanisms underlying these differences are unclear, particularly in children (Fearnbach et al., 2017).

### ***Influence of television viewing or music listening on RPE and enjoyment***

In the past, studies have explored how music and/or television can influence attention and thereby potentially change exercise behaviour (Barwood et al., 2009; Hutchinson et al., 2015; Jones et al., 2014; Razon et al., 2009). Our study found that participants perceived watching television during exercise as more enjoyable than exercising with no television. This can be attributed to dissociative focus when an individual concentrates on cues that are not relevant to the exercise, such as auditory/visual stimuli (Stevinson & Biddle, 1998). This dissociative focus may provide distraction from internal physiological or psychological cues (fatigue, breathing, and exertion) (Chow & Etnier,

2017). Dissociative strategies can reduce RPE during exercise conducted at low-to-moderate intensities, which make them an interesting focus for exercise interventions (Chow & Etnier, 2017).

Since 1979, the relationship between enjoyment and exercise behaviour has been explored (Perrin, 1979). Surprisingly, little research has focused on combining exercise with one of the most popular leisure time activity, watching television (Bureau of Labor Statistics, 2013). Our study found that compared to the control, participants found exercising with television more enjoyable. This is consistent with a recent study by Overstreet (2017) that found that an acute bout of cycling while watching television was rated more enjoyable than a cycling bout without television. These results implicate a practical application for watching television without commercials while exercising. This is commonly seen in fitness centres and student gyms. If watching television enhances the exercise experience for adolescents, it can potentially increase adherence to exercise.

## **Conclusions**

To our knowledge, this is the first experimental study to look at the effect of television viewing and music listening on PEEC. Our findings revealed no difference in PEEC with or without TV/music in in male adolescents. Watching television while exercising was also found more enjoyable compared to no stimulus (control). This finding is interesting and warrants further investigation on how screens and/or music listening may play a

role in motivation and improving adolescents engagement to exercise daily. Youth spend countless hours a day in front of screens, thereby creating an outlet for possible exercise interventions. Future research should explore how these electronic devices affect PEEC chronically with longer follow-up periods. Additionally, though content of television and music listening has been explored in adults, there is little work on how the content of these devices affects the mood and attitude in adolescents during and after an exercise session or an exercise program. Lastly, there are other populations that warrant investigation such as female adolescents, individuals with obesity and adults. Given that electronic screen devices are pervasive in our society and traditional approaches for exercise interventions have been largely unsuccessful, more efforts are needed to use electronic screen devices at our advantage in populations needing it the most (i.e., high-risk, inactive individuals).

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# Appendices

## Appendix A: Ethics Approval Documents

### A.1 Children's Hospital of Eastern Ontario



#### CHEO Research Ethics Board Approval - Minor Modification

**Principal Investigator:** Dr. Jean-Philippe Chaput  
**REB Protocol No:** 17-022X  
**Romeo File No:** 20170002  
**Project Title:** CHEOREB# 17-022X - Exercising with or without a screen and post-exercise energy compensation in adolescents  
**Primary Affiliation:** HALO HALO  
**Protocol Status:** Active

**Date Modifications Approved:** September 18, 2017

#### Documents Reviewed & Approved:

Document Name	Comments	Version Date
Recruitment Materials	Poster (clean)	2017/09/13
Assent Form	Assent form (clean)	2017/09/13
Consent Form	Consent form (clean)	2017/09/13
Protocol	Protocol (clean)	2017/09/13

The CHEOREB has reviewed and granted approval of the study documents listed above; which is to be conducted by the investigator noted above at CHEO and/or CHEO Research Institute. The minor modification was reviewed and approved by the Chair, and would be ratified by the full Board at its subsequent meeting.

Approval is granted with the understanding that the investigator agrees to comply with the following requirements:

1. The investigator must conduct the study in compliance with the protocol and any additional conditions set out by the Board.



#### CHEO Research Ethics Board Approval - Delegated Review

**Principal Investigator:** Dr. Jean-Philippe Chaput  
**REB Protocol No:** 17-022X  
**Romeo File No:** 20170002  
**Project Title:** CHEOREB# 17-022X - Exercising with or without a screen and post-exercise energy compensation in adolescents  
**Primary Affiliation:** HALO HALO  
**Protocol Status:** Active  
**Approval Date:** February 08, 2017  
**Valid Until:** January 15, 2018  
**Annual Renewal Submission Deadline:** 15 December 2017

#### Documents Reviewed & Approved:

Document Name	Comments	Version Date
Assent Form	Assent Form Version 2 CLEAN	2017/02/07
Consent Form	Consent Form Version 2 CLEAN	2017/02/07
Other Document	Dietary Record	2017/02/07
Protocol	Protocol Version 2 CLEAN	2017/02/07
Questionnaire/Survey	Questionnaire - Tanner Stages Boys	2017/01/04
Questionnaire/Survey	Questionnaire - Tanner Stage Girls	2017/01/04
Questionnaire/Survey	Questionnaire - Physical Activity	2017/01/04
Questionnaire/Survey	Questionnaire - Sleep	2017/01/04
Questionnaire/Survey	Questionnaire - Eating Behaviour	2017/01/04
Recruitment Materials	Poster received 2017/02/07	

2. The investigator is responsible for complying with all applicable guidelines and regulations regarding human research ethics conduct, as applicable to the research project.
3. Investigators must submit an annual renewal report to the REB 30 days prior to the expiration date stated on the final approval letter.
4. The investigator must not implement any deviation from, or changes to, the protocol without the approval of the REB except where necessary to eliminate an immediate hazard to the research subject, or when the change involves only logistical or administrative aspects of the study (e.g., change of telephone number or research staff). As soon as possible, however, the implemented deviation or change, the reasons for it, and, if appropriate, the proposed protocol amendment(s) should be submitted to the Board for review.
5. The investigator must, prior to use, submit to the Board changes to the study documentation, e.g., changes to the informed consent letters, recruitment materials.
6. Investigators must provide the Board with French version of the consent form, unless a waiver has been granted. An interpreter should be offered to participants as required or at the request of the participant throughout the course of research.
7. For clinical drug or device trials, investigators must promptly report to the REB all adverse events that are both serious and unexpected (SAEs) or unexpected and untoward occurrences (including the loss or theft of study data and other such privacy breaches). For SAE reports on clinical drug or device trials, the investigator must also comply with the hospital-wide Policy regarding Procedures for Considering Medical Error in the Differential Diagnosis of Severe Adverse Events (SAE) Associated with the Drugs Administered in a Clinical Trial.
8. Investigators must promptly report to the REB any new information regarding the safety of research participants (e.g., changes to the product monograph or investigator's brochure for drug trials). Where available, any reports produced by the Data Safety Monitoring Board should also be promptly submitted to the REB.
9. Investigators must notify the REB of any study closures (closed to accrual, temporary, premature or permanent).
10. Investigators must submit a final report at the conclusion of the study.

The investigator must conduct the study in compliance with the protocol and any additional conditions set out by the Board.

The CHEO REB operates in compliance with, and is constituted in accordance with, the requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonization Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; And Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA, 2004) and its applicable regulations. The CHEO REB is registered with the U.S. Department of Health and Human Services (DHHS) Office for Human Research Protection (OHRP).

If you have any questions, pertaining to this letter, please contact the Research Ethics Board office at (613) 737-7600, ext. 3350 or 2128.

This is to notify you that the Children's Hospital of Eastern Ontario Research Ethics Board has granted approval to the above named research study on the date noted above. Your project was reviewed under the delegated review stream, which is reserved for projects that involve no more than minimal risk to human subjects.

Final approval is granted for the above noted study, with the understanding that the investigator agrees to comply with the following requirements:

1. The investigator must conduct the study in compliance with the protocol and any additional conditions set out by the Board.
2. Investigators must submit an annual renewal report to the REB 30 days prior to the expiration date stated above.
3. The investigator must not implement any deviation from, or changes to, the protocol, consents or assents without the approval of the REB.
4. The investigator must, prior to use, submit to the Board changes to the study documentation, e.g., changes to the informed consent letters, recruitment materials.
5. Investigators must provide the Board with French versions of the consent form, unless a waiver has been granted. An interpreter should be offered to participants as required or at the request of the participant throughout the course of research.
6. The investigator must promptly report to the REB all unexpected and untoward occurrences (including the loss or theft of study data and other such privacy breaches).
7. Investigators must notify the REB of any study closures (closed to accrual, temporary, premature or permanent).
8. Investigators must submit a final report at the conclusion of the study.

Should you have any questions or concerns, please do not hesitate to contact the Research Ethics Board Office at 613-737-7600 ext. 3350 or 2128.

## A.2 University of Ottawa



# Université d'Ottawa University of Ottawa

Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

### LETTRE D'APPROBATION ADMINISTRATIVE | LETTER OF ADMINISTRATIVE APPROVAL

Numéro de dossier / Ethics File Number	A09-17-01	
Titre du projet / Project Title	Exercising with or without a screen and post-exercise energy compensation in adolescents	
Type de projet / Project Type	Master's thesis	
CÉR primaire / Primary REB	CHEO REB	
Statut du projet / Project Status	Administrative Approval	
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	20/09/2017	
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	15/01/2018	
<b>Équipe de recherche / Research Team</b>		
<i>Chercheur / Researcher</i>	<i>Affiliation</i>	<i>Role</i>
Jean-Philippe CHAPUT	Faculty of Medicine / Pediatrics	Supervisor
Holly LIVOCK	Faculty of Health Sciences / School of Human Kinetics	Student-Researcher

#### Conditions spéciales ou commentaires / Special conditions or comments:

L'Université d'Ottawa a signé une Entente, conforme aux exigences de la plus récente version de l'EPTC et tout autre règlement ou législation applicable, permettant au CÉR ci-haut nommé d'être désigné comme CÉR primaire pour les projets de recherche où

- 1) les activités principales de recherche sont menées sous l'autorité ou sous les auspices de l'établissement lié au CÉR primaire et
- 2) Une partie du projet est également réalisé sous l'autorité ou sous les auspices de l'Université d'Ottawa.

Cette lettre confirme que l'Université d'Ottawa a autorisé que le CÉR primaire soit le CÉR officiel pour l'évaluation et la supervision de ce projet de recherche. Ceci n'est pas une approbation éthique.

Afin de nous aider à garder votre dossier à jour, veuillez soumettre une copie de toutes demandes de modification, renouvellement d'approbation éthique etc. soumis à et approuvé par le CÉR primaire dès qu'elles sont disponibles.

Cette approbation administrative est valide pour la durée indiquée ci-haut et est sujette aux conditions énumérées dans la section intitulée « Conditions spéciales ou commentaires ».

The University of Ottawa has signed an Agreement, compliant with current TCPS guidelines and any other applicable guidelines or legislation regarding multisite review, allowing the REB named above to serve as Board of Record (BoR) for research projects where

- 1) the main research activities are conducted within the auspices or jurisdiction of the BoR's institution and
- 2) parts of the project are also conducted under the jurisdiction or auspices of the University of Ottawa.

This letter confirms that the University of Ottawa has authorized the REB named above to serve as Board of Record for the review and oversight of this research project. This is not an REB approval.

In order to help us keep your file up to date, please submit a copy of all amendment requests, project renewals or any other changes submitted to and approved by the BoR, as they become available.

Administrative approval is valid for the period indicated above and is subject to the conditions listed in the section entitled "Special conditions or comments".

## Appendix B: Questionnaires

### B.1 Three-Factor Eating Questionnaire - Revised 18-item

Participant ID: PEC -	<input type="text"/>	Technician Initials:	<input type="text"/>			
Date:	<input type="text"/>	/	<input type="text"/>	/	<input type="text"/>	<input type="text"/>
Time:	<input type="text"/>	:	<input type="text"/>			

#### The Three-Factor Eating Questionnaire — Revised 18-Item

1. When I smell a sizzling steak or juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal.

Definitely true (4).....   
Mostly true (3).....   
Mostly false (2).....   
Definitely false (1).....

2. I deliberately take small helpings as a means of controlling my weight.

Definitely true (4).....   
Mostly true (3).....   
Mostly false (2).....   
Definitely false (1).....

3. When I feel anxious, I find myself eating.

Definitely true (4).....   
Mostly true (3).....   
Mostly false (2).....   
Definitely false (1).....

4. Sometimes when I start eating, I just can't seem to stop.

Definitely true (4).....   
Mostly true (3).....   
Mostly false (2).....   
Definitely false (1).....

5. Being with someone who is eating often makes me hungry enough to eat also.

Definitely true (4).....   
Mostly true (3).....   
Mostly false (2).....   
Definitely false (1).....

Quality Control Staff Initials:	<input type="text"/>	Date:	<input type="text"/>	/	<input type="text"/>	/	<input type="text"/>	<input type="text"/>
Data Entry Staff Initials:	<input type="text"/>	Date:	<input type="text"/>	/	<input type="text"/>	/	<input type="text"/>	<input type="text"/>

Participant ID: PEC - <input type="text"/>	Technician Initials: <input type="text"/>
Date: <input type="text"/> / <input type="text"/> / <input type="text"/>	Time: <input type="text"/> : <input type="text"/>

6. When I feel blue, I often overeat.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

7. When I see a real delicacy, I often get so hungry that I have to eat right away.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

8. I get so hungry that my stomach often seems like a bottomless pit.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

9. I am always hungry so it is hard for me to stop eating before I finish the food on my plate.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

10. When I feel lonely, I console myself by eating.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

11. I consciously hold back at meals in order not to weight gain.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

Quality Control Staff Initials: <input type="text"/>	Date: <input type="text"/> / <input type="text"/> / <input type="text"/>
Data Entry Staff Initials: <input type="text"/>	Date: <input type="text"/> / <input type="text"/> / <input type="text"/>

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Participant ID: PEC -

Technician Initials:

Date:   /    /

Time:   :

12. I do not eat some foods because they make me fat.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

13. I am always hungry enough to eat at any time.

- Definitely true (4).....
- Mostly true (3).....
- Mostly false (2).....
- Definitely false (1).....

14. How often do you feel hungry?

- Only at meal times (1).....
- Sometimes between meals (2).....
- Often between meals (3).....
- Almost always (4).....

15. How frequently do you avoid "stocking up" on tempting foods?

- Almost never (1).....
- Seldom (2).....
- Usually (3).....
- Almost always (4).....

16. How likely are you to consciously eat less than you want?

- Unlikely (1).....
- Slightly likely (2).....
- Moderately likely (3).....
- Very likely (4).....

17. Do you go on eating binges though you are not hungry?

- Never (1).....
- Rarely (2).....
- Sometimes (3).....
- At least once a week (4).....

Quality Control Staff Initials:

Date:   /    /

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18. On a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

## B.2 Physical Activity Questionnaire

Participant ID: PEC -	<input type="text"/>	Technician Initials:	<input type="text"/>
		Date:	<input type="text"/> / <input type="text"/> / <input type="text"/>
		Time:	<input type="text"/> : <input type="text"/>

### Physical Activity Questionnaire

We are trying to find out about your level of physical activity from *the last 7 days* (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

**Remember:**

- There are no right and wrong answers — this is not a test.
- Please answer all the questions as honestly and accurately as you can — this is very important.

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row.)

	No	1-2	3-4	5-6	7 times or more
a) Skipping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Rowing/ canoeing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) In-line skating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Tag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Walking for exercise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Bicycling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Jogging or running	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) Aerobics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i) Swimming	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j) Baseball, softball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k) Dance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Quality Control Staff Initials:	<input type="text"/>	Date:	<input type="text"/> / <input type="text"/> / <input type="text"/>
Data Entry Staff Initials:	<input type="text"/>	Date:	<input type="text"/> / <input type="text"/> / <input type="text"/>

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Participant ID: PEC -

Technician Initials:

Date:  /  /

Time:  :

	No	1-2	3-4	5-6	7 times or more
l) Football	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
m) Badminton	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
n) Skateboarding	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
o) Soccer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
p) Street hockey	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
q) Volleyball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
r) Floor hockey	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
s) Basketball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
t) Ice skating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
u) Cross-country skiing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
v) Ice hockey/ ringette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other:					
w) _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
x) _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

- I don't do PE .....1
- Hardly ever .....2
- Sometimes .....3
- Quite often .....4
- Always .....5

Quality Control Staff Initials:

Date:  /  /

Data Entry Staff Initials:

Date:  /  /

Participant ID: PEC -         Technician Initials:

Date:   /    /

Time:   :

3. In the last 7 days, what did you normally do *at lunch* (besides eating lunch)? (Check one only.)
- Sat down (talking, reading, doing schoolwork).....:1
  - Stood around or walked around .....:2
  - Ran or played a little bit.....:3
  - Ran around and played quite a bit.....:4
  - Ran and played hard most of the time.....:5
4. In the last 7 days, on how many days *right after school*, did you do sports, dance, or play games in which you were very active? (Check one only.)
- None .....:1
  - 1 time last week .....:2
  - 2 or 3 times last week.....:3
  - 4 times last week.....:4
  - 5 times last week.....:5
5. In the last 7 days, on how many *evenings* did you do sports, dance, or play games in which you were very active? (Check one only.)
- None .....:1
  - 1 time last week .....:2
  - 2 or 3 times last week.....:3
  - 4 times last week.....:4
  - 5 times last week.....:5
6. *On the last weekend*, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)
- None .....:1
  - 1 time .....:2
  - 2 - 3 times .....:3
  - 4 - 5 times .....:4
  - 6 or more times .....:5
7. Which *one* of the following describes you best for the last 7 days? Read *all five* statements before deciding on the *one* answer that describes you.
- All or most of my free time was spent doing things that involve little physical effort.....:1
  - I sometimes (1 - 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics).....:2
  - I often (3 - 4 times last week) did physical things in my free time .....:3
  - I quite often (5 - 6 times last week) did physical things in my free time .....:4
  - I very often (7 or more times last week) did physical things in my free time .....:5

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Data Entry Staff Initials:         Date:   /    /

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Participant ID: PEC -

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Date:   /    /

Time:   :

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

	None	Little bit	Medium	Often	Very often
a) Monday	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Tuesday	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Wednesday	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Thursday	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Friday	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Saturday	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Sunday	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes.....:

No.....:

If Yes, what prevented you? \_\_\_\_\_

Quality Control Staff Initials:

Date:   /    /

Data Entry Staff Initials:

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### B.3 Pittsburgh Sleep Quality Index

Participant ID: PEC -       Technician Initials:   
Date:  /  /   
Time:  :

#### PITTSBURGH SLEEP QUALITY INDEX

**INSTRUCTIONS:**

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?

BED TIME \_\_\_\_\_

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

NUMBER OF MINUTES \_\_\_\_\_

3. During the past month, what time have you usually gotten up in the morning?

GETTING UP TIME \_\_\_\_\_

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)

HOURS OF SLEEP PER NIGHT \_\_\_\_\_

***For each of the remaining questions, check the one best response. Please answer all questions.***

5. During the past month, how often have you had trouble sleeping because you . . .

a. Cannot get to sleep within 30 minutes

Not during the past month.....1

Less than once a week.....2

Once or twice a week.....3

Three or more times a week.....4

Quality Control Staff Initials:       Date:  /  /   
Data Entry Staff Initials:       Date:  /  /

Participant ID: PEC -

Technician Initials:

Date:  /  /

Time:  :

b. Wake up in the middle of the night or early morning

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

c. Have to get up to use the bathroom

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

d. Cannot breathe comfortably

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

e. Cough or snore loudly

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

f. Feel too cold

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

g. Feel too hot

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

Quality Control Staff Initials:

Date:  /  /

Data Entry Staff Initials:

Date:  /  /

Participant ID: PEC -

Technician Initials:

Date:  /  /

Time:  :

h. Had bad dreams

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

i. Have pain

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

j. Other reason(s), please describe \_\_\_\_\_

How often during the past month have you had trouble sleeping because of this?

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

6. During the past month, how would you rate your sleep quality overall?

- Very good .....
- Fairly good .....
- Fairly bad .....
- Very bad .....

7. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

Quality Control Staff Initials:

Date:  /  /

Data Entry Staff Initials:

Date:  /  /

Participant ID: PEC -

Technician Initials:

Date:   /    /

Time:   :

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

- No problem at all.....1
- Only a very slight problem .....2
- Somewhat of a problem.....3
- A very big problem.....4

10. Do you have a bed partner or room mate?

- No bed partner or room mate.....1
- Partner/room mate in other room.....2
- Partner in same room, but not same bed.....3
- Partner in same bed .....4

If you have a room mate or bed partner, ask him/her how often in the past month you have had . . .

a. Loud snoring

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

b. Long pauses between breaths while asleep

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

Quality Control Staff Initials:

Date:   /    /

Data Entry Staff Initials:

Date:   /    /

Participant ID: PEC -         Technician Initials:

Date:   /   /

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c. Legs twitching or jerking while you sleep

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

d. Episodes of disorientation or confusion during sleep

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

e. Other restlessness while you sleep; please describe \_\_\_\_\_

- Not during the past month.....1
- Less than once a week .....2
- Once or twice a week.....3
- Three or more times a week .....4

Quality Control Staff Initials:         Date:   /   /

Data Entry Staff Initials:         Date:   /   /

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## B.4 Male Tanner Stages

Participant ID: PEC -

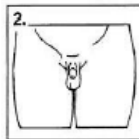
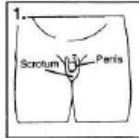
Technician Initials:

Date:   /    /

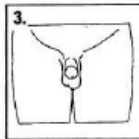
Time:   :

- Please look at the **Penis and Scrotum only** in these pictures.
- Please put a tick in the box that looks most like you now.

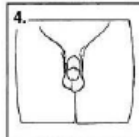
Scrotum and Penis same size as when you were younger.



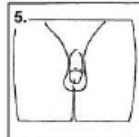
The Scrotum has lowered a bit and the Penis is a little larger.



The Penis is longer the Scrotum is larger.



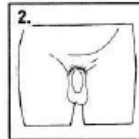
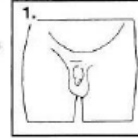
The Penis is longer and wider the Scrotum is darker and bigger than before



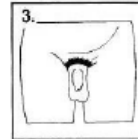
The Penis and Scrotum are the size and shape of an adult.

- Please look at the **Pubic Hair only** in these pictures.
- Please put a tick in the box that looks most like you now.

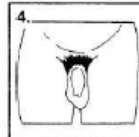
No hairs



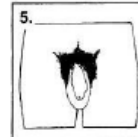
Very little hair



Quite a lot of hair



The hair has not spread over the thighs



The hair has spread over the thighs

Quality Control Staff Initials:

Date:   /    /

Data Entry Staff Initials:

Date:   /    /